QGISRed

User manual v0.19

QGIS plugin for modelling and managing water distribution networks

November 2026

REDHISP Hydraulic Networks Group · Universitat Politècnica de València

Contents

🚀 **Welcome to QGISRed**

👥 Credits and Authorship

1 🛠️ **Getting started**

1.1 System requirements

1.2 Installation from repository

1.3 Installation from local ZIP

1.4 Dependency management

2 ⚡ **Quick Guide**

2.1 Toolbar Summary

2.2 Typical workflow

3 📁 **General**

3.1 Project manager

3.2 Create project

3.3 Open and import

4 🗃️ **Project**

4.1 Overview and layer management

4.2 Project Settings
4.3 Save, export and close project
5 ✏️ **Editing and Modeling**
5.1 Creation of elements
5.2 Geometric and topological manipulation
5.3 Element properties
5.4 Group editing
5.5 Patterns and curves
5.6 Controls and rules
6 ✅ **Verifications**
6.1 Topology and connectivity
6.2 Attribute verification
6.3 Hydraulic sectors
7 🔧 **Tools**
7.1 Hydraulic properties
7.2 Demands and scenarios
7.3 Demand sectors and tree
8 🔍 **Queries**
8.1 Element Explorer
8.2 Thematic maps
8.3 Property inquiries
8.4 Statistics
9 📊 **Analysis**
9.1 Execution and Options
9.2 Results Viewer
9.3 Model Export
10 🧬 **Digital Twin**
10.1 Connections and Shut-Off Valves
10.2 Sensors and Meters
11 📂 **Technical Appendix**
12 📜 **Change Log**

🚀 Welcome to QGISRed

QGISRed is a powerful open access QGIS plugin designed to facilitate the construction of hydraulic models of water distribution networks, the analysis of results, the planning of improvements and the efficient management of water use through the Digital Twin

The best thing about QGISRed is that it combines the features of a **GIS Environment** with the calculation power of **EPANET**, allowing you to manage cartographic information to convert it into a hydraulic model capable of reproducing flows, pressures and water quality under any working hypothesis. In addition, powered by field data, it also allows the real state of the network to be reproduced through a digital twin.

Why use QGISRed?

- **Hydraulic analysis and water quality tool.** QGISRed fully reproduces and extends the calculation capabilities of EPANET up to the latest version 2.3. It is a perfect environment for training in network hydraulics
- **Full georeferencing**: Take advantage of all the advantages of QGIS to geolocate network elements, and superimpose them on any cartographic background, as well as to interact with said backgrounds.
- **Simple Data Management**: Allows you to import INP files and SHP files, georeferenced or not, with a simple and intuitive relational structure. The QGISRed data model is open and allows interoperability with other applications.
- **Specialized Tools**: Includes utilities for network debugging, automatic assignment of lengths, elevations and roughness, assignment of demands to nodes, scenario management and complete analysis of the results without leaving QGIS.
- **Digital Twins**: Supports additional elements such as connections, manual valves and meters for an advanced level of detail. The connection of these elements with field data allows us to reproduce the real mode of behavior of the network.
- **From the academic world to the professional:** From building simple diagrams of hydraulic systems, to modeling reality to plan actions aimed at improving hydraulic performance, energy efficiency or water quality, to monitoring the behavior of the network based on real data for decision making.

Ready to get started? Check Credits, Installation Guide or jump directly to Quick Guide.

👥 Credits and Authorship

QGISRed is a project developed by the Hydraulic Networks Group **REDHISP** of the **Institute of Water and Environmental Engineering (IIAMA)** of the **Polytechnic University of Valencia, Spain (UPV)**.

Project Management

- **Fernando Martínez Alzamora**
- *Professor of Hydraulic Engineering at the UPV*
- 📧 fmartine@upv.es

Development and Maintenance

- **Néstor Lerma Elvira**
- 🏢 Fluit (from v 0.19)
- 🏢 WaterPi (up to v 0.17)
- 📧 nestor@fluit.es
- **Elena Melchor Gil**
- 🏢 Fluit (from v 0.19)
- 📧 elena@fluit.es
- **Vitor Moura Vieira**
- 🏢 Ingeniousware (since v 0.18)
- 📧 contact@watering.online
- **Carlos Peñas Bernabeu**
- 🏢 Master in Data Science Statistics, from Univ. Carlos III. Madrid (since v 0.18)
- 📧 carlospb8@gmail.com

Institutions

The development of QGISRed is part of the research and technology transfer activities of the **Universitat Politècnica de València (UPV)**.

Entity	Logo
QGISRed Portal	

Entity	Logo
REDHISP	
IIAMA	
UPV	

Collaborators

Entity	Logo
Fluit	
Ingeniousware	
WaterPi	

Financing

QGISRed starts in Nov 2018 with **Aid from the Generalitat Valenciana (GV)** for the hiring of Support Personnel for Technology Transfer (APOTI/2018/006). Since July 2019, financing is covered with **the REDHISP group's own funds until version 0.17**.

QGISRed versions starting at **0.18** are being financed by the **Inter-American Development Bank (IDB)** through contract C-RG-T4041-P001.

Entity	Logo
Inter-American Development Bank (IDB)	

1 💻 Installing QGISRed

QGISRed is a free plugin for QGIS that installs in just a few minutes. There are two methods: from the official QGIS repository (recommended) or from a local ZIP file.

Prerequisites

Requirement	Minimum version
Operating system	Windows x64
QGIS	3.28 or higher (compatible up to 4.x)
.NET Framework	4.8.1

> QGISRed is only available for **Windows**. The calculation engine (dependencies) is based on DLLs compiled in .NET and does not have a native version for Linux or macOS.

In this section

- System requirements — compatibility and pre-check details
- Installation from repository — recommended method, with automatic updates
- Installation from local ZIP — for specific versions or without access to the repository
- Dependency management — what are dependencies and how are they installed

1.1 System Requirements

Before installing QGISRed, verify that your computer meets the following requirements.

Operating system

Windows 10 or higher (x64).

QGISRed is not available for Linux or macOS. The calculation engine uses DLLs compiled in .NET that require the Windows environment.

##QGIS

Version 3.28 or higher, including the 4.x series.

How to check your QGIS version

Go to **Help** → **About QGIS**. The version appears in the first line of the dialogue.

If your version is earlier than 3.28, download the latest LTR (Long Term Release) version from qgis.org.

> Versions prior to 3.28 are no longer supported by the plugin since QGISRed 0.18. If you need to work with an older version of QGIS, use QGISRed 0.17 or earlier.

.NET Framework

Version 4.8.1.

How to check if it is installed

1. Open **Control Panel** → **Programs** → **Programs and Features**.
2. Click **Turn Windows features on or off**.
3. Look for **.NET Framework 4.8.1** in the list. If it appears checked, it is already installed.

On Windows 11 and recent versions of Windows 10, the .NET Framework 4.8.1 may come preinstalled. On older versions or on Windows Server, you may need to download and install it manually from Microsoft.

Internet connection

Necessary **the first time** the plugin is used, to download the dependencies (the DLLs of the calculation engine). Subsequent downloads (plugin updates) also require connection.

Once the dependencies are installed, QGISRed can work **without an internet connection**.

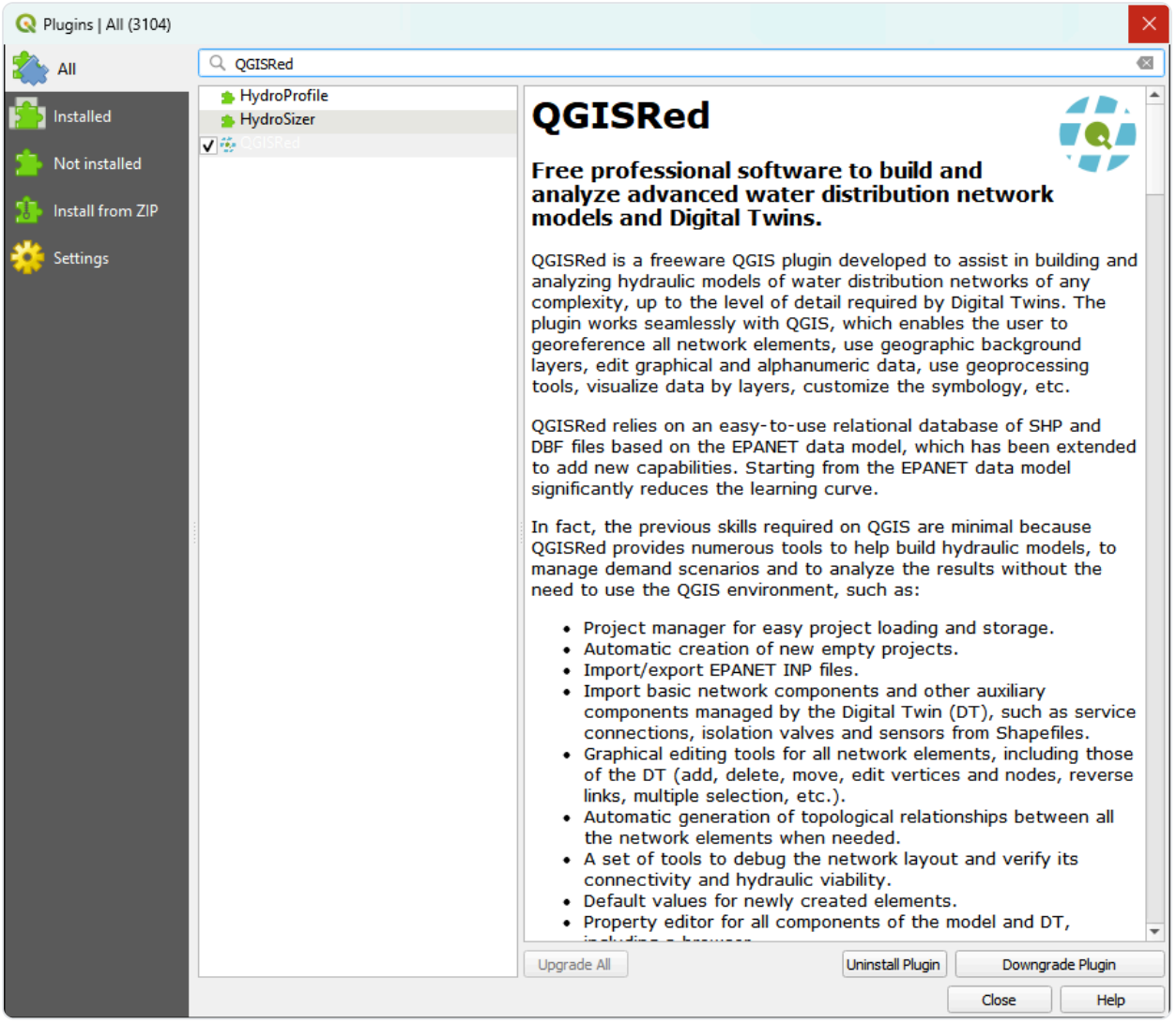
> If you do not have an internet connection, you can install the dependencies manually: ask someone to provide you with the ZIP of the dependencies and the .NET Framework 4.8.1 MSI installer. With both files you will be able to complete the installation without needing a connection. See section Dependency management for more details.

1.2 Installation from Repository

It is the recommended method. Install QGISRed directly from the official QGIS plugin repository and allow you to receive automatic updates.

Step by step

1. Open QGIS.
2. Go to the menu **Plugins → Manage and install plugins…**
3. On the **All** tab, type `QGISRed` in the search box.
4. Select **QGISRed** in the results list.
5. Click **Install Plugin**.



"All" tab of the add-in manager with QGISRed located after the search.

When finished, the main QGISRed bar and the **QGISRed** menu will appear in the menu bar in QGIS.

First run

The first time you use any plugin tool, QGISRed detects that the **dependencies** are not installed and displays an installation dialog. See Dependency management for details.

Automatic updates

When starting QGIS, QGISRed checks if a new version is available. If it exists, the QGISRed news window will automatically open informing you of the new version. To update from there:

1. Go to **Plugins → Manage and install plugins…**
2. Open the **Updatable** tab.
3. Select **QGISRed** and click **Update Plugin**.

> You can also activate automatic updating in the **Settings** tab of the plugin manager.

Troubleshooting

QGISRed does not appear in search results

The plugin manager needs to have the official QGIS repository configured. Go to **Plugins → Manage and install plugins… → Settings** and verify that the `https://plugins.qgis.org/plugins/plugins.xml` repository is active.

The "Install Plugin" button is disabled

It may be because the installed QGIS version is older than 3.28. Update QGIS first.

1.3 Installation from ZIP Local

Use this method when you need to install a specific version of the plugin that is not in the repository, or when your computer does not have Internet access at the time of installation.

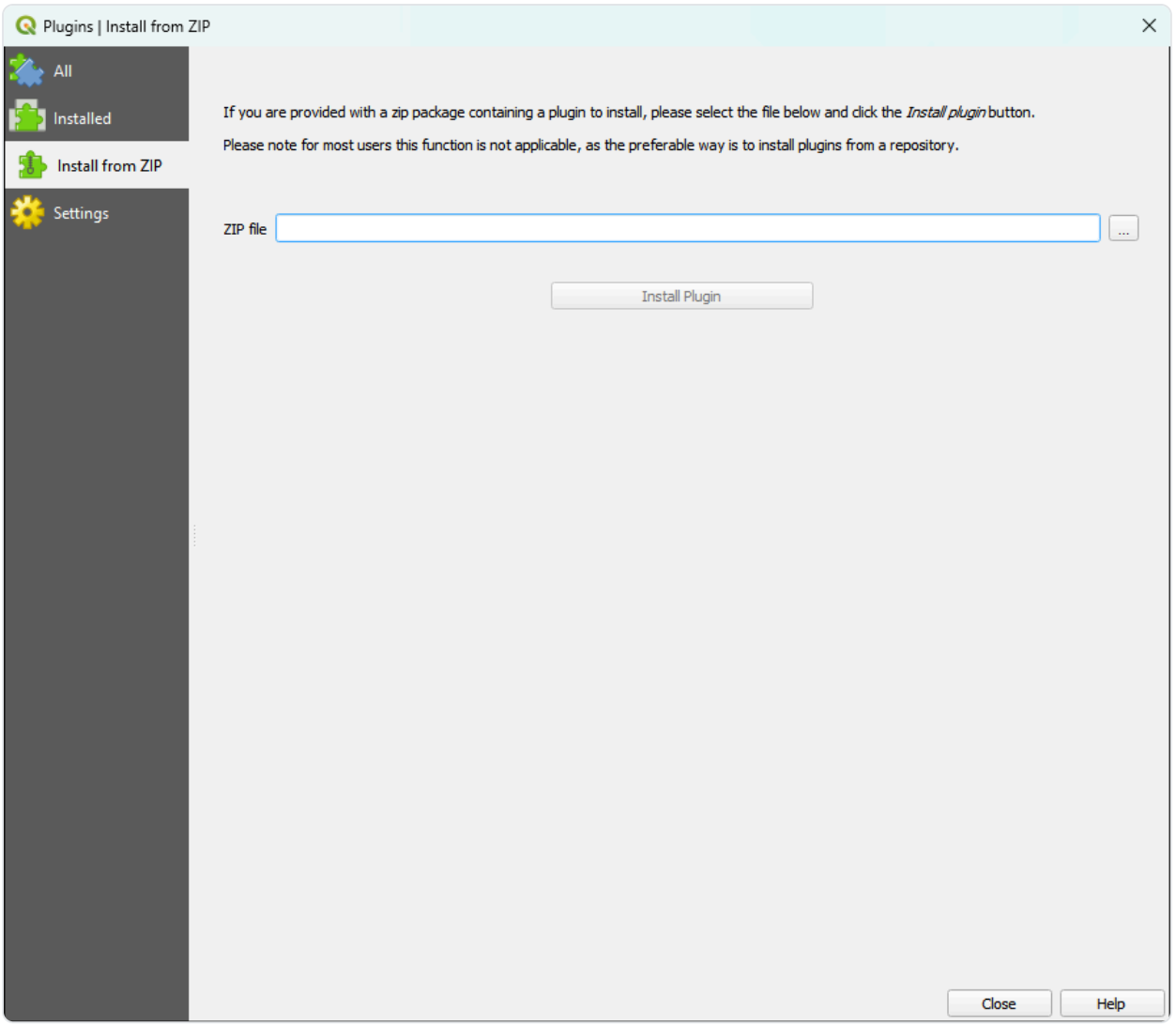
Get the ZIP file

Download file `QGISRed.zip` from:

- The official QGIS Plugins repository (previous versions section).
- The project's GitHub repository.
- A file shared by the development team.

Step by step

1. Open QGIS.
2. Go to the menu **Plugins → Manage and install plugins…**
3. Select the **Install from ZIP** tab.
4. Click the `…` button and select the `QGISRed.zip` file.
5. Click **Install Plugin**.



"Install from ZIP" tab of the QGIS plugin manager.

Security notice

QGIS will display a notice indicating that the plugin does not come from the official repository. This is normal for any local file installation. Press **Yes** to continue with the installation.

Notes

- If you already have a previous version of QGISRed installed, installing from ZIP replaces it. Existing projects are not affected.
- **dependencies** are not included in the plugin ZIP. They are downloaded separately the first time you use the plugin, just like installing from the repository. If your

computer does not have an internet connection, see section Dependency management to see how to install them manually.

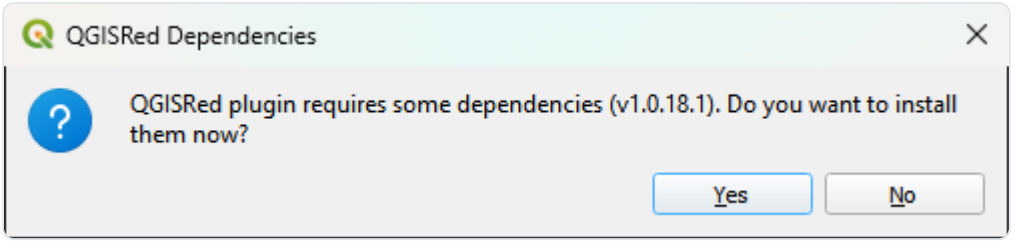
- This installation **does not receive automatic updates**. To update, you will have to repeat the process with the ZIP of the new version.

1.4 Dependency Management

QGISRed needs a set of external calculation libraries **(QGISRed plugin dependencies)** to be able to run most of its tools. These libraries are DLLs compiled in .NET that contain the hydraulic motor (based on the EPANET 2.3 toolkit) and the geospatial processing algorithms.

First installation

The first time you try to use any QGISRed tool, the plugin detects that the dependencies are not installed and displays a confirmation dialog:



QGISRed requests permission to download the dependencies.

- **Yes**: QGISRed downloads and installs the libraries automatically. The download requires an internet connection and may take a few seconds depending on the connection speed.
- **No**: The tool does not run. The dialog will appear again the next time you try to use the plugin.

> Installation **does not require administrator permissions**. The DLLs are installed in the user folder `%APPDATA%\QGISRed\`, not in system folders.

Where are they installed

The dependencies are stored in:

```
C:\Users\{tu_usuario}\AppData\Roaming\QGISRed\
```

You can access this folder by typing `%APPDATA%\QGISRed` directly into the address bar of Windows Explorer.

Update dependencies

When a new version of QGISRed is released that includes an updated version of the dependencies, the plugin automatically detects this upon startup and proposes the update with the same confirmation dialog.

Troubleshooting

Download fails or is interrupted

Verify that you have an internet connection and that no corporate firewall is blocking the download. If the problem persists, contact your network administrator to allow outgoing connections from QGIS.

The plugin displays the dependencies dialog every time it is opened

It means that the libraries were not installed correctly in previous sessions. Check that folder `%APPDATA%\QGISRed\` exists and contains files `.dll`. If it is empty, delete it completely and try the installation again.

The device does not have internet access

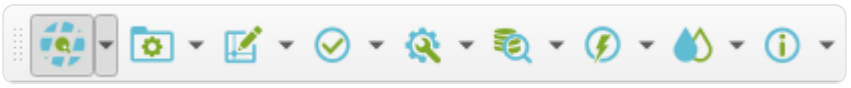
You can install dependencies offline if you have the necessary files:

1. **ZIP of dependencies**: asks someone with the plugin already installed for the contents of their `%APPDATA%\QGISRed\` folder (same version of QGISRed). Copy those files to your own folder `%APPDATA%\QGISRed\`.
2. **.NET Framework 4.8.1 Installer**: Download it to another computer with internet or request the MSI from someone. Run it before using the plugin.

Once the DLLs have been copied and with the .NET Framework 4.8.1 installed, the plugin will work without requiring an internet connection at any time.

2 🧭 The QGISRed Interface

QGISRed integrates into QGIS as a set of **specialized toolbars**. Each bar groups the tools of a stage of the workflow: project management, network editing, verification, simulation, etc.



QGISRed main bar with the drop-down buttons of each toolbar

QGISRed main bar: each dropdown button activates/deactivates a toolbar.

The main bar

When you install the plugin, a **main bar** appears in QGIS with a drop-down button for each secondary toolbar. Clicking on any of these buttons shows or hides the corresponding bar. In addition, the drop-down menu for each button directly lists all the actions of that toolbar, allowing them to be executed without having the bar visible.

To the right of the main bar is a **units indicator** (for example `LPS | D-W`) that shows the flow units and head loss formula for the active project.

Toolbars

QGISRed includes **8 toolbars** organized by work area:

Bar	Main function
General	Create, open and import projects
Project	Configuration, Layers and Backup
Edition	Draw and edit the hydraulic network
Debug	Verify the quality and consistency of the model
Tools	Calculation and data management tools
Queries	Consult, filter and view information
Analysis	Simulate and explore results

Bar	Main function
Digital Twin	Connections, shut-off valves and sensors

> 💡 **TIP**: Activate only the bars you need at any given time to keep the workspace tidy. The visibility status of each bar is automatically saved between sessions.

The QGISRed project

All network data is stored in a project folder as **SHP + DBF** files. The network name (for example `MiRed`) is the common prefix of all those files (`MiRed_Pipes.shp`, `MiRed_Junctions.shp`, etc.).

QGISRed does not work with the QGIS `.qgz` file as a source of truth: the source of truth is always the project's SHP files. The `.qgz` is optional and is used to save the visual appearance (styles, visible layers, etc.).

Check out Toolbar Summary to see what each tool does, or jump straight to Typical workflow if you want to get started as soon as possible.

2.1 Toolbar Summary

An overview of everything QGISRed can do, organized by toolbar.

🗂️ General — Project Management

Entry point for any work session. From here you create, open or import projects.

Tool	What does it do
Project Manager	Recent projects list, clone, rename, delete
Open project	Open an existing project indicating name and folder
Create project	Generate the SHP file structure for a new network
Import project	Create a project from an EPANET `.inp` file or external SHPs

---

📋 Project — Settings and layers

Open project management tools.

Tool	What does it do
Summary	Shows the number of elements of each type in the network
Add data by import	Import additional elements to the already opened project
Layer Manager	Controls which layers are active; recover accidentally deleted layers
Legend Editor	Customize the symbology of any layer in the project
Project Options	Configure EPANET options: units, loss formula, quality
Default values	Defines ID prefixes, geometric tolerances and initial hydraulic values

Tool	What does it do
Table of materials	Manage the list of materials with their initial roughness and age increments
Save map	Save the QGIS project (`.qgz`)
Close project	Close the current project

> 💡 The export of the project (ZIP portable) is no longer in this bar: it is done from the **Export** button of the Project Manager (see Save, Export and Close Project).

✏️ Edition — Network creation and editing

Tools to draw and modify the network topology directly on the map.

Tool	What does it do
Add Pipe	Draw a pipe; automatically creates extreme nodes
Add tank	Convert an existing node into a Tank
Add reservoir	Converts an existing node into a reservoir (Reservoir)
Insert valve	Split a pipe and insert a valve
Insert pump	Split a pipe and insert a pump
Select elements	Multiple selection of nodes and lines
Move nodes	Move a node by dragging it; maintains connectivity
Edit vertices	Add, move or delete intermediate vertices of a pipe
Reverse link	Change the reference flow direction in pipes/valves/pumps
Split / Join pipes	Split a pipe at one point or join two consecutive pipes
Split / Merge nodes	Separate a node into two or merge overlapping nodes

Tool	What does it do
Create / Revert T	Create or break a tee connection over an existing pipe
Create/Revert crossover	Manage crossovers between geographically overlapping pipes
Move valve / pump	Reposition a valve or pump to another pipe
Change status	Modifies the initial state (Open/Closed/CV) of pipes, valves and pumps
Delete items	Delete selected elements and rebuild connectivity
Edit properties	Open the attributes form of an element
Patterns and curves	Manage demand, efficiency and head-flow curves
Controls and rules	Define simple controls and condition-based rules

---

🐛 Debug — Verification and debugging

Tools to ensure the topological and attribute integrity of the model.

Tool	What does it do
Consolidate and review data	Verify and consolidate all attributes; generates an incident report
Remove overlapping elements	Detect and delete duplicate pipes or nodes in the same position
Simplify link vertices	Eliminates redundant vertices in straight sections
Join consecutive pipes	Merges adjacent pipes with the same diameter, material and year of installation
Create T connections	Create connection nodes where pipes intersect without a common node

Tool	What does it do
Verify connectivity	Analyze network connectivity and identify isolated areas
Eliminate isolated areas	Deletes subzones without connection to any pressure source
Check lengths	Detects pipes that are too short or long with respect to the defined thresholds
Check diameters	Check that the diameters are within valid ranges
Check materials	Detects pipes without assigned material
Check dates	Check consistency in installation dates
Hydraulic sectors	Calculates and visualizes the network sectors (H-Q, H-nQ, nH-Q, nH-nQ) according to their relationship with sources and demand nodes

---

🔧 Tools — Calculation tools

Utilities to automate model preparation and management tasks.

Tool	What does it do
Calculate lengths	Recalculate the lengths of the pipes from their geometry
Interpolate dimensions	Assigns dimensions to the nodes from an MDT in `.asc` format
Assign roughness	Calculate the roughness coefficient based on the material and age
Convert roughness	Transform the roughness coefficients between formulas (D-W ↔ H-W ↔ C-M)
Nodal demand builder	Distribute consumption between nodes from area polygons or georeferenced points

Tool	What does it do
Scenario Builder	Export and import model parameters (roughnesses, demands, dimensions, states, qualities) in bulk to manage variants without duplicating projects
Isolated segments	Calculate the segments that would be isolated when each shut-off valve is closed
Demand sectors	Generates sectors based on demand and consumption patterns
Minimum cost tree	Calculates the spanning tree of minimum hydraulic resistance from a selected source node

---

🔍 Queries — Consultations

Model query and inspection tools without modifying its data.

Tool	What does it do
Search item by ID	Locate and select any element based on its identifier
Element properties	Shows all the properties of an element when you click on it
Thematic maps	Generate thematic display layers by any numeric attribute
Property inquiries	Filters elements that meet conditions on their attributes
Statistics	Calculates descriptive statistics of any numeric field

---

📊 Analysis — Simulation and results

Tools to run hydraulic simulation and explore the results.

Tool	What does it do
Run model	Launch the EPANET simulation and load the results as layers

Tool	What does it do
Results viewer	Open the side panel to explore variables over time
Status Report	Displays the text report generated by EPANET
Analysis options	Configure hydraulics, quality, times and energy
Time series	Graphically represents the temporal evolution of an element
Export results	Export all results to CSV files
Export to INP	Generates an EPANET compatible `.inp` file

🧬 Digital Twin — Digital Twin

Advanced elements to represent the real network infrastructure.

Tool	What does it do
Add connection	Create a service connection from the network to a point of consumption
Add shut-off valve	Incorporates manual sectioning valves into the network
Add meter (submenu)	Add different types of sensors: flowmeter, pressure gauge, counter, level, quality, energy, status, opening, tachometer
Load readings	Import real sensor readings for calibration or comparison
Initial state from valves	Applies the real state of the shut-off valves as the initial state of the model
Load field data	Import georeferenced data from capacity campaigns
Convert connections	Transform the connections into pipes and demand nodes of the model

2.2 Typical Workflow

This is the usual path to build, verify and simulate a distribution network with QGISRed.

Step 1 — Create or open the project

Use the **General** bar to get started:

- **New project from scratch**: *Create project* → choose name, folder and reference system. QGISRed automatically generates the 6 base SHPs (Junctions, Pipes, Tanks, Reservoirs, Valves, Pumps).
- **Existing project**: *Project manager* → double click on the project in the recent list.
- **From an EPANET file**: *Import project* → select the `.inp`. QGISRed converts it to SHP and opens it.

Step 2 — Configure project options

From the **Project** bar, access *Project Options* to define:

- **Flow units** (LPS, GPM, CMH…)
- **Head loss formula** (D-W, H-W, C-M)
- **Quality Model** (None, Chlorine, Age, Tracer)

The indicator on the main bar (`LPS | D-W`) always reflects the active values.

Step 3 — Build the network

Activate the **Edition** bar and draw the network on the map:

1. Start with the **pipes** — the extreme nodes create themselves.
2. Add **tanks and reservoirs** by clicking on existing nodes.
3. Insert **valves and pumps** by clicking on a pipe.
4. Edit the **properties** of each element (diameter, roughness, dimension, demand...).

> 💡 You can import existing geometry (infrastructure SHP, background orthophoto) and plot the network on top of it.

Step 4 — Check model quality

Before simulating, use the **Debug** bar:

1. **Consolidate and review data** — detects incomplete or inconsistent attributes.
2. **Verify connectivity** — identifies isolated areas without a pressure source.
3. **Hydraulic sectors** — check the power supply to each sector.

Correct any problems noted in the incident report before continuing.

Step 5 — Prepare demand data

From the **Tools** bar:

- **Interpolate elevations** if the nodes do not have elevations assigned.
- **Assign roughness** based on material and installation date.
- **Nodal demand builder** to distribute consumption.

Step 6 — Simulate

From the **Analysis** bar:

1. *Analysis options* — check the duration and time step.
2. *Run model* — the simulation can take from one second to several minutes depending on the size of the network.
3. When finished, QGISRed automatically loads the result layers and opens the **Results Viewer**.

Step 7 — Explore results

In the side panel of the Results Viewer:

- Select which **variable** to show in nodes (Pressure, Demand, Quality) and in pipes (Flow, Velocity, Unit Loss...).
- Move the **time slider** to see the evolution throughout the simulated period.
- Activate **Map Notices** to read values when you mouse over any element.
- Use **Time Series** to graph the evolution of a specific point.

Step 8 — Save

- *Save Map* saves the QGIS project (`.qgz`) with the visible layers and styles.
- *Export project* (from the Project Manager) generates a portable ZIP of the project.

> ❗ **IMPORTANT**: QGISRed does not modify the layers while they are in **Edit Mode** of QGIS. Be sure to commit (`Ctrl+S` on the layer) or discard your changes before using any plugin tools.

3 🗂️ General

The **General** bar is the entry point to any work session with QGISRed. It contains the four actions to manage the life cycle of projects: create them, open them, import them and manage the history.



QGISRed General Toolbar with its four buttons

General Bar: Project Manager, Open, Create and Import.

What is a QGISRed project

A QGISRed project is a **folder** containing a set of SHP and DBF files with the same prefix (the name of the network). For example, for a network named `RedUrbana`:

```
RedUrbana/
├── RedUrbana_Junctions.shp/.dbf/.shx/.prj
├── RedUrbana_Pipes.shp/.dbf/.shx/.prj
├── RedUrbana_Tanks.shp/.dbf/.shx/.prj
├── RedUrbana_Reservoirs.shp/.dbf/.shx/.prj
├── RedUrbana_Valves.shp/.dbf/.shx/.prj
├── RedUrbana_Pumps.shp/.dbf/.shx/.prj
├── RedUrbana_Options.dbf
├── RedUrbana_Title.dbf
```

```
├── Issues/
├── Queries/
└── Results/
```

> **Warning**
>
> Never move, rename or delete these files manually from Windows Explorer. Always use QGISRed tools to ensure consistency of the set.

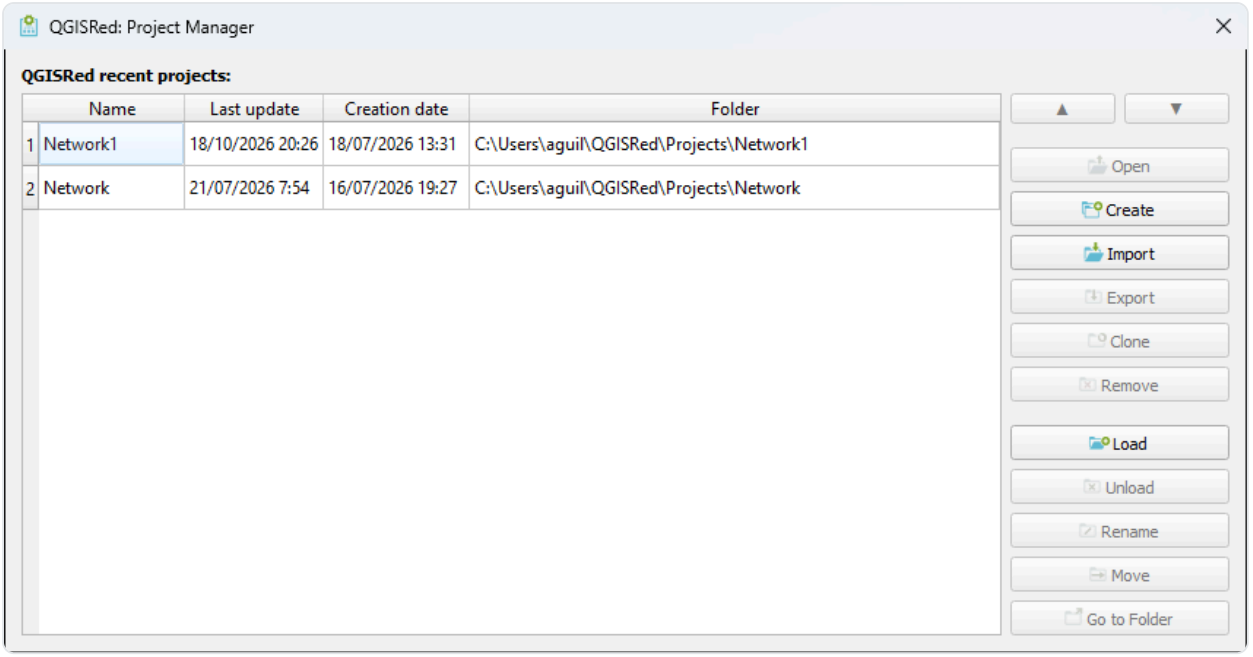
In this section

- Project manager — history, clone, rename, delete
- Create project — new project from scratch
- Open and import — open existing or import from `.inp`

3.1 Project Manager

General Bar → **Project Manager** (or from the QGISRed menu → General → Project manager)

The Project Manager is the central administration window of QGISRed. Allows access to all known projects without having to remember where they are stored.



QGISRed Project Manager Window

Project Manager window: list of recent projects and available operations.

List of recent projects

The window shows all projects that have ever been opened on this computer. For each project the **network name** and **folder path** are displayed.

- **Double click** on any project → opens it directly.
- If there is an open project with unsaved changes, QGISRed will ask for confirmation before closing it.

> 📝 If the `.qgz` / `.qgs` file registered for the project no longer exists at the expected path (for example, after moving the folder by hand outside QGISRed), the warning *"We cannot find the QGIS project file. Do you want to find this file*

> *manually?"* appears. Answering **Yes** lets you locate it with a file explorer; answering **No**, QGISRed rebuilds the project directly from the groups saved in the metadata (Inputs, Results, Issues… all that exist), not just the input layers.

Available operations

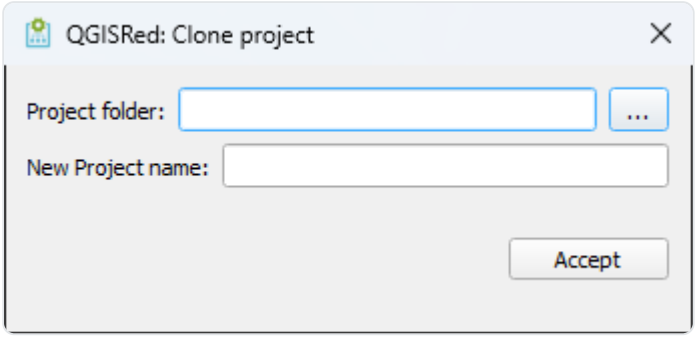
Load

Allows you to add a project that does not appear in the history to the list (for example, if the project was created on another computer and the folder was copied).

1. Press **Load**.
2. Enter the **network name** (no extension, no folder prefix).
3. Select the **project folder** with the explorer.
4. QGISRed will verify that the file `{nombre}_Pipes.shp` exists in that folder before opening it.

Clone

Create a complete copy of the project under a different name. Useful for creating variants without losing the original.



Project Clone Dialog

1. Select the project you want to clone.
2. Press **Clone**.
3. Enter the new network name.
4. Choose the destination folder (it can be the same folder if the name is different).

> 💡 Cloning copies all SHP, DBF files and metadata. Simulation results are **not** cloned to save space.

Export

Packages the selected project in a portable ZIP (SHP/DBF, `.qgz` and, optionally, results, issues, queries, auxiliary layers and complementary data). This is the only way to export a project: there is no longer an equivalent button in the **Project** bar.

1. Select the project from the list (it is not necessary to have it open in QGIS).
2. Press **Export**.
3. Complete the export dialog.

See the full detail of the dialogue, what is included and what is not, in Save, export and close project.

Rename

Renames the network and automatically updates the name of **all files** in the project (SHP, DBF, PRJ, etc.). It is not a simple name change in the list: it moves and renames the files on disk.

1. Select the project.
2. Press **Rename**.
3. The dialog offers three independent boxes: **Rename project data** (renames the network data files) and **Rename project map file** (also renames the QGIS project `.qgz` / `.qgs`, if it exists) — both checked by default — and **Rename project folder:** (also renames the folder containing the project), unchecked by default. At least one must be marked.
4. Enter the new name in the field corresponding to each active box. The folder field automatically suggests the same name as the project as long as it hasn't been edited by hand.

> 📝 **Rename project folder** is disabled, with the warning *"Another project in this folder is currently open in QGIS"*, if the folder contains a different project from the one you are renaming and that other project is currently open in QGIS — to avoid

> moving or deleting files that QGIS holds a lock on. The rest of the projects sharing the folder keep appearing normally in the list after the rename.

> **Warning**
>
> If you have the project open in QGIS, close it before renaming it to prevent QGIS from maintaining locks on the files.

Delete from list (Unload)

Removes the project from recent history **without deleting files on disk**. The project still exists in your folder and can be added back with **Upload**.

Delete from disk (Delete)

Removes the project from history and sends all its files (including a `.qgz` saved outside the project folder, if any) to the Windows **recycle bin** — it does not delete them permanently.

> ❗ QGISRed will ask for confirmation: *"Project files will be moved to the recycle bin. Are you sure?"*. If a file can't be moved to the recycle bin, QGISRed asks whether to delete it permanently; if that would leave the project only partially deleted, it warns first that the project will be left in an inconsistent state.

Open folder

Open Windows Explorer directly to the selected project folder.

How QGISRed identifies the active project

When you open QGIS with a `.qgz` project already saved, QGISRed automatically recognizes the active network by searching the loaded layers for which one corresponds to `_Pipes.shp` and has the internal property `qgisred_identifier`.

If the piping layer is loaded but does not have that identifier (for example, because it was added manually without going through QGISRed), the plugin will warn with the

message:

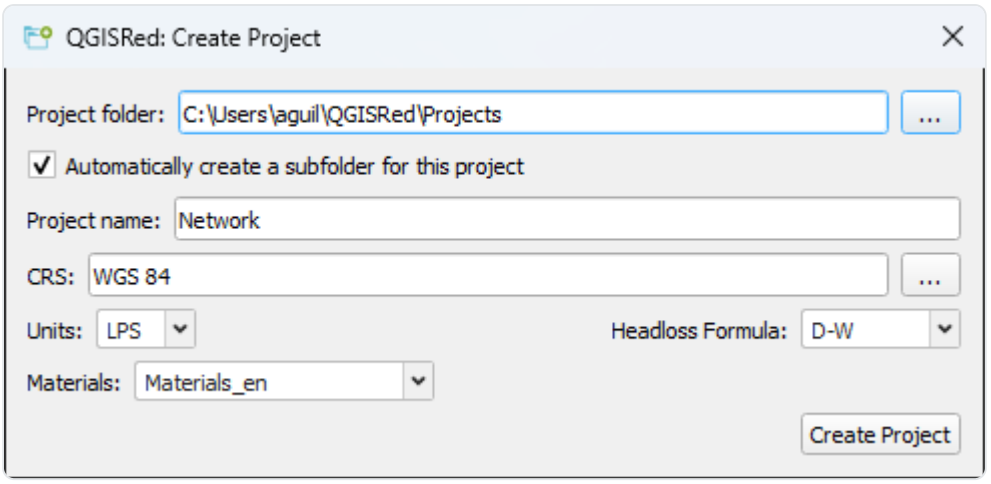
> *"Please, open the project from the QGISRed Project Manager"*

In that case, close the layers and use the Project Manager to open the project correctly.

3.2 Create Project

General Bar → **Create project** (or QGISRed menu → General → Create project)

Create a completely new QGISRed project from scratch, generating the SHP file structure necessary to define a distribution network.



New project creation dialog

Project creation dialog: name, folder and reference system.

Step by step

1. Network name

Enter a short name without spaces or special characters (letters, numbers, and underscores are safe). This name will be the **prefix** of all files in the project.

- ✅ Correct: `RedUrbana`, `Red_Norte_2024`, `SectorA`
- ❌ Avoid: `Red Urbana`, `Réseau_Côte`, `Red/Norte`

2. Project folder

Select or create the folder where all files will be saved. **Several projects can coexist in the same folder** as long as they have different names.

3. Coordinate Reference System (CRS)

Select the appropriate CRS for your work area. QGISRed will assign it to all SHP files in the project.

> 💡 If you are going to import geometry from other sources (orthophoto, cadastre, etc.), use the same CRS as those sources or the most common one in your country to avoid reprojections.

4. EPANET Initial Options

In the same dialog you can configure the basic parameters of the model:

Parameter	Description
Flow units	LPS (liters/second), GPM, CMH, etc. Determines if the project works in the SI or US system
Head loss formula	Darcy-Weisbach (D-W), Hazen-Williams (H-W) or Chezy-Manning (C-M)

These parameters can be changed later from *Project Options*, but it is recommended to set them from the beginning because they affect which units are displayed in all network properties.

5. Materials catalog

Select the **materials catalog** that will be used in the project. This catalog is a `.dbf` file that defines the available pipe materials (name, initial roughness coefficient, and aging increment).

QGISRed looks for the catalogs available in the `materials` and `global_defaults` folders of `%APPDATA%\QGISRed\`. If there is no catalog installed, the dropdown will appear empty and the project will be created without predefined materials.

> The materials catalog is used to automatically estimate the roughness of pipes based on their material and age, making it easy to calibrate the hydraulic model.

Generated files

Upon confirming the creation, QGISRed generates the following files in the chosen folder and automatically uploads them to QGIS:

File	Content
`{Red}_Junctions.shp`	Demand nodes
`{Red}_Pipes.shp`	Pipes
`{Red}_Tanks.shp`	Tanks
`{Red}_Reservoirs.shp`	Reservoirs or feeding points
`{Red}_Valves.shp`	Regulating valves
`{Red}_Pumps.shp`	Pumps
`{Red}_Options.dbf`	EPANET options (units, formula, quality...)
`{Red}_Title.dbf`	Project metadata (scenario name, notes…)

They are all grouped together in the QGIS legend under a group called **"{Red}" → "Inputs"**.

What to do next

Once the project is created, the next step is to **build the network** using the **Edition** bar. See section Editing and Modeling to see how to add pipes, nodes, and special elements.

> 💡 If you already have an EPANET `.inp` file, it's faster to use Import project than creating from scratch.

3.3 Open and Import Projects

QGISRed offers three ways to start working with an existing network:

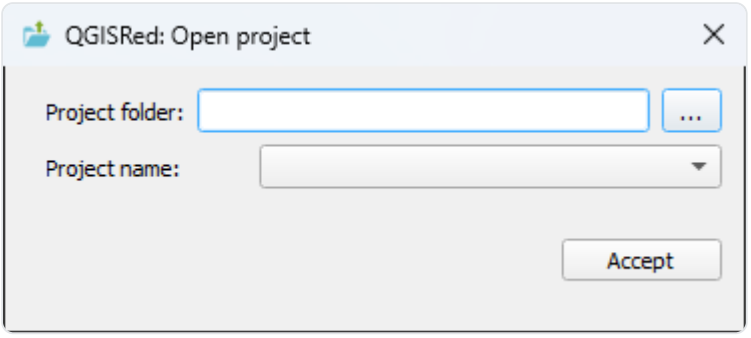
Option	When to use it
Open project	The project has already been created with QGISRed and its SHP files are on disk
Import project	You have an EPANET `.inp` file, external SHPs without QGISRed structure, or a ZIP previously exported with QGISRed
Add data by import	You already have an open project and want to incorporate additional data

---

Open project

General Bar → Open project

Opens an existing QGISRed project (previously created with the plugin) that does not appear in the Project Manager, or that was moved from a folder.



Project opening dialog

Opening dialog: enter the network name and select the folder.

Process

1. Enter the **network name** exactly as it appears in the SHP files prefix (without extension).
2. Select the **folder** where the files are.

3. QGISRed verifies that `{nombre}_Pipes.shp` exists in that folder and loads all the project layers.

What happens when you open

- The layer group **Inputs** is loaded with the 6 base SHPs plus any auxiliary layers (multiple requests, sources, etc.).
- If the project has results from previous simulations, the **Results** group is also loaded.
- The project options (`_Options.dbf`) are read and the units indicator in the main bar is updated.
- If the visual styles (QML) have changed with respect to the version of the plugin with which it was saved, they are automatically updated.
- If the project was saved with the plugin in another language, QGISRed automatically renames the layers (including thematic maps and results layers), groups, legend labels and map tips to the active language.

> 💡 The quickest way to open a known project is to **double click** on the Project manager. The "Open Project" option is for projects that do not appear in that list.

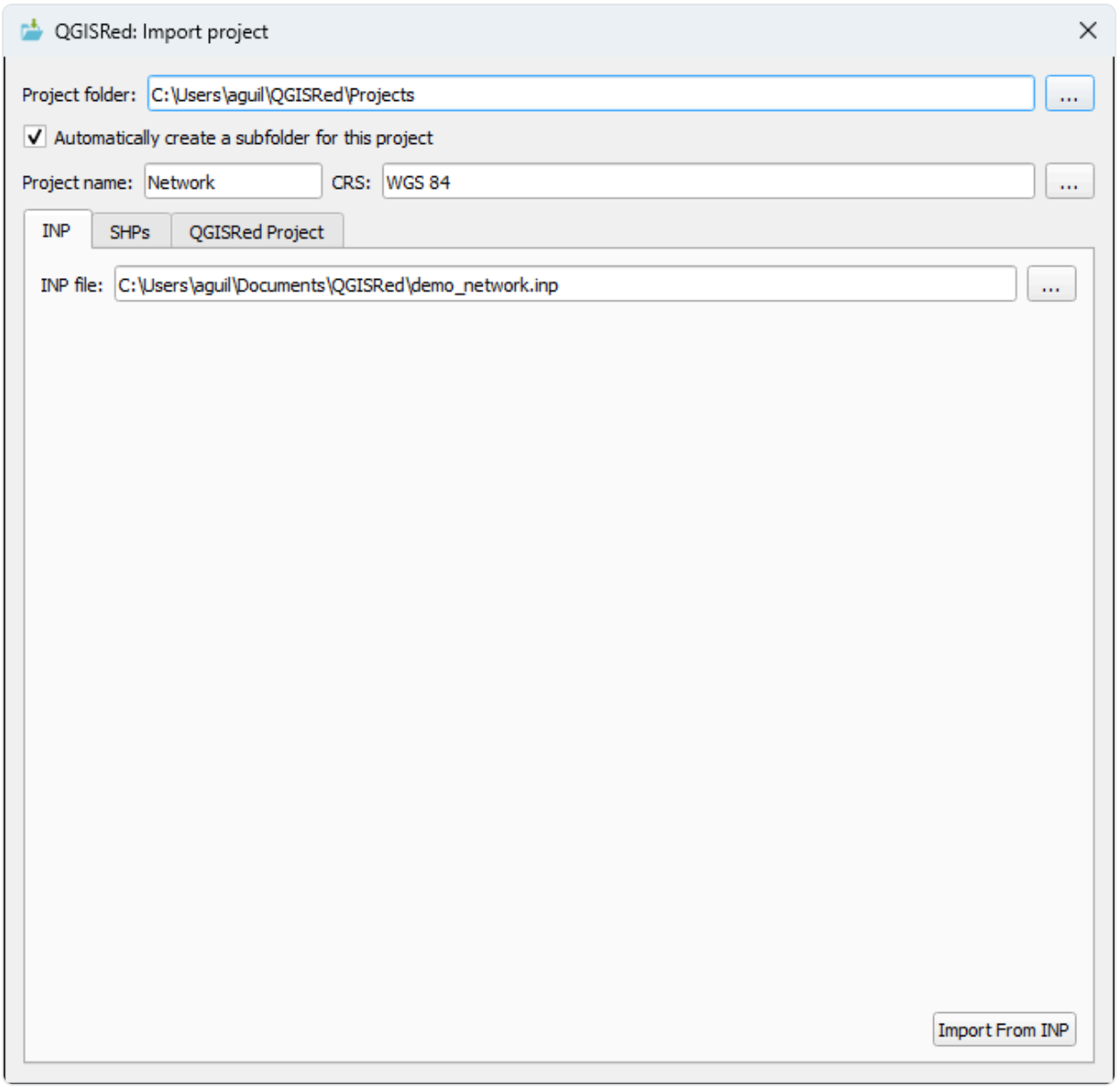
Import project

General Bar → Import project

Convert external data into a QGISRed project, or recover a previously exported one. Supports three input formats:

Import from EPANET (`.inp`)

The most common case: you have an existing EPANET model and you want to work with it in QGISRed.



EPANET INP File Import Dialog

Import dialog: selection of .inp file, network name and destination folder.

1. Select the file `.inp`.
2. Indicates the **name of the network** that the QGISRed project will have (it may be different from the internal name of the INP).
3. Choose the **destination folder** where the SHPs will be created.
4. QGISRed converts all elements (nodes, pipes, valves, pumps, curves, patterns, controls...) to the SHP+DBF structure.
5. If the `.inp` has pumps or valves exported as links whose end nodes share the same coordinates, QGISRed automatically separates them a small distance (2% of the network's average link length) so that no element is lost during import. There is no checkbox to disable this behavior.

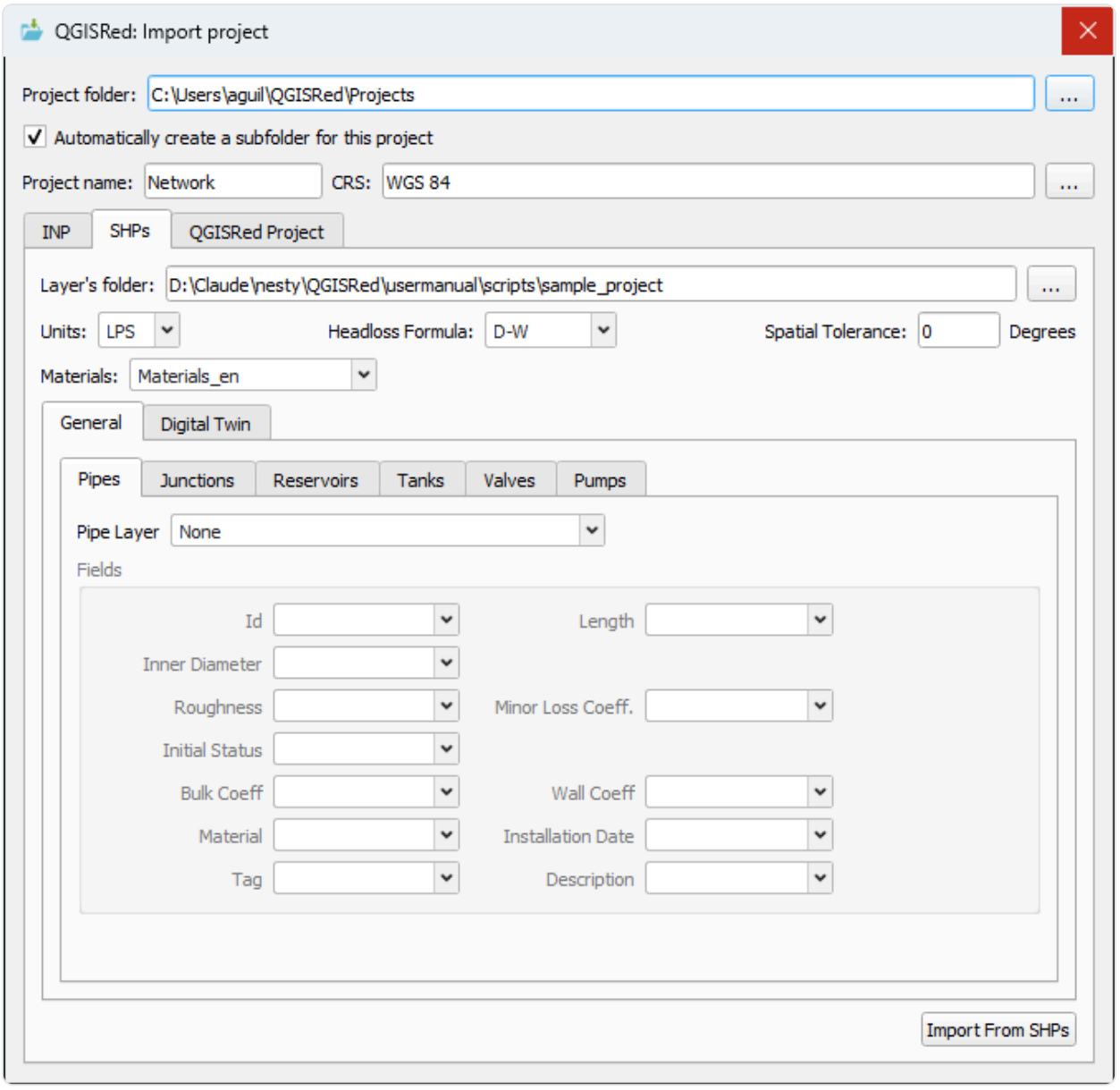
> **Warning**
>
> The coordinates of `.inp` must be in the same CRS that you will use in QGISRed. The plugin does not reproject during import.

What is imported:

- All network elements (junctions, pipes, tanks, reservoirs, valves, pumps)
- Curves (H-Q, efficiency, volume, pressure loss)
- Demand patterns
- Simple controls and rules
- Simulation options (units, formula, times, energy, quality)
- Multiple demands per node

Import from external SHPs

If you have SHP layers with the geometry of the network but without the internal structure of QGISRed, the importer allows you to map the attribute columns of each layer to the fields expected by the plugin.



SHP tab of the import dialog, with the chosen folder and populated layer combos

For each element type you can select the corresponding SHP layer and assign its fields to the model attributes. Automatically recognized fields (if the name matches) are preselected:

Pipes — mappable fields: ID, Length, Diameter, Roughness, Minor loss coeff., **Material**, Installation date, Initial status, Bulk reaction coeff., Wall reaction coeff., Tag, Description.

Services — mappable fields: ID, Length, Diameter, Roughness, **Material**, Base demand, Pattern, Active, Installation date, Tag, Description.

> If the connection layer is **points** (each connection is hooked to the nearest main pipe, instead of already having its own layout), two optional restrictions appear to decide which pipes each connection can be hooked to — combinable with each other:
>
> - **Only pipes with diameters below this value are candidates** (in the project diameter units).
> - **Only pipes currently selected in the Pipes layer are candidates** — only available if you already have pipes selected in the map before opening the importer; The box shows how many are selected.
>
> A connection that does not find any candidate pipes within those constraints is not imported, and QGISRed indicates this in the import summary.

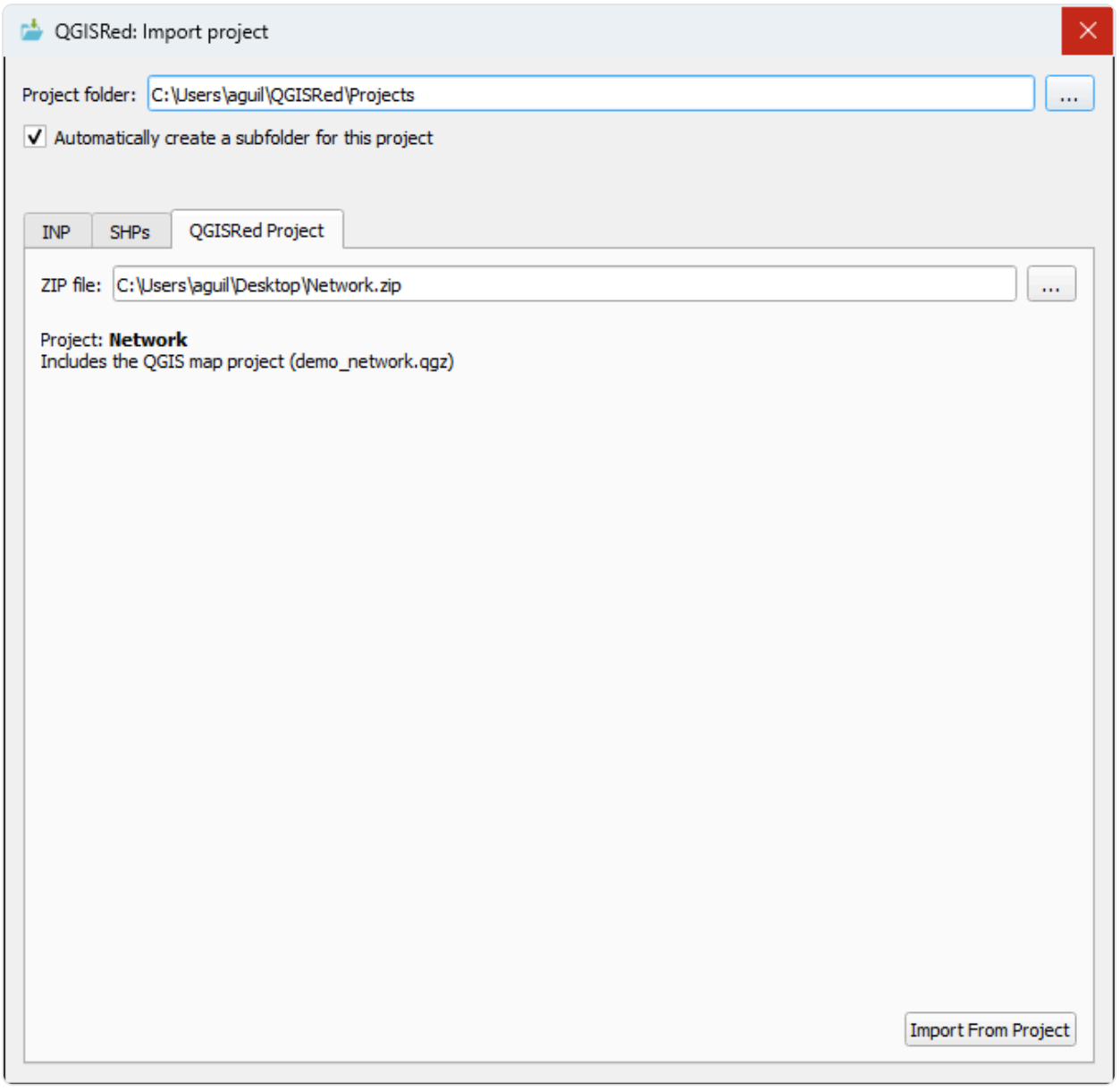
The other elements (valves, pumps, tanks, reservoirs, nodes, isolation valves, meters) have their own sets of mappable fields.

When the import creates a new project, the **materials catalog** (same as when creating a project from scratch) and basic EPANET parameters (units and pressure drop formula) are also requested. If imported over an existing project, these parameters are ignored.

> 💡 The **Material** field of pipes and connections is crossed with the project's materials catalog to automatically estimate the roughness based on the age of the pipe.

Import an exported QGISRed project (ZIP)

Retrieves a project packaged with the **Export** button from Project manager — see Save, export and close project. It also recognizes ZIPs generated by previous versions of the plugin, even if they do not have the internal manifest of the current exports.



QGISRed project tab of the import dialog

1. In the **QGISRed project** tab, press the **...** button next to **ZIP file:** and select the `.zip` file.
2. QGISRed inspects the ZIP content without extracting it yet and displays a summary under the field:

- **Project:** name of the network containing the ZIP (replaces any name you entered before; the project name field is hidden in this tab).
- If the ZIP includes the QGIS map, indicate the file `.qgz` / `.qgs`; If it is not included, it warns that only the data will be imported.
- If the ZIP includes complementary data (background cartography, MDT, etc.), indicate how many elements and their total size.

3. If the ZIP includes complementary data, the **Import the complementary data included in the ZIP file** box appears, checked by default. Uncheck it if you don't want to bring them.
4. The **Automatically create a subfolder for this project** checkbox decides whether the project is placed in a subfolder with the network name within the destination folder:

- If the ZIP already contains its own project folder (it was exported along with supporting data in sister folders), QGISRed automatically unchecks and disables this box — nesting it in another folder would break the relative paths to that data.
- Otherwise, you can freely check or uncheck it.

5. Press **Import From Project**.

If the ZIP is not a valid QGISRed project, QGISRed indicates this without actually importing anything:

Situation	Message
The ZIP does not contain a recognizable QGISRed project	*"ZIP file does not contain a valid QGISRed project"*
The ZIP was generated with a newer version of QGISRed than the one installed	*"This ZIP file was created with a newer version of QGISRed. Please update the plugin."*
The ZIP contains unsafe file paths	*"The ZIP file contains unsafe file paths and will not be imported."*

> **Warning**
>
> If a project with the same name (or files with the same name) already exists in the destination folder, QGISRed asks for confirmation before overwriting them.

> 💡 If the ZIP includes the QGIS map but you decide not to import the complementary data, QGISRed warns that some background layers will not be available and lets QGIS ask you to locate them.

Add data by import

Project bar → Add data by import

Available only when there is a project already open. It allows you to enrich the project with additional data without closing what is loaded.

Typical use cases:

- Incorporate a new network zone designed in a separate `.inp`.
- Add demands for a new database.
- Integrate data from a sector imported from another system.

The process is the same as importing, but the imported items are **added** to the existing project instead of creating a new one. QGISRed verifies that there are no ID conflicts before incorporating the data.

Considerations when changing equipment

If you copy the project folder to another computer:

1. Use **Upload** in Project Manager to add it to local history.
2. If the project has a `.qgz` saved, open it from QGIS normally — QGISRed will recognize it automatically.
3. If the `.qgz` is not there or the paths have changed, use **Open Project** to load it from the SHPs directly.

4 📋 Project

The **Project** bar groups the administration tools of the project that is already open in QGISRed. All of your buttons require a valid project loaded; If there are none, the plugin will warn with the message *"No valid project is opened"*.



QGISRed Project toolbar with its nine buttons

Project Bar: active project management tools.

Project bar buttons

#	Tool	Function
1	**Summary**	Number of elements of each type in the network
2	**Add data by import**	Import additional elements to the open project
3	**Layer Manager**	Control layer visibility and recover deleted layers
4	**Legend Editor**	Customize the symbology of the layers
—	*(separator)*	
5	**Project Options**	EPANET parameters: units, formula, quality, times, energy
6	**Default values**	ID Prefixes, Tolerances and Initial Hydraulic Values
7	**Table of materials**	Roughness and aging rates by material
—	*(separator)*	
8	**Save map**	Save the QGIS file `.qgz`
9	**Close project**	Close the project and clear the QGIS session

> 💡 The old **Backup** button (*Project backup*) has been removed from this bar with no direct replacement. To export the project to a portable ZIP, use the **Export** button on Project manager — see Save, export and close project.

In this section

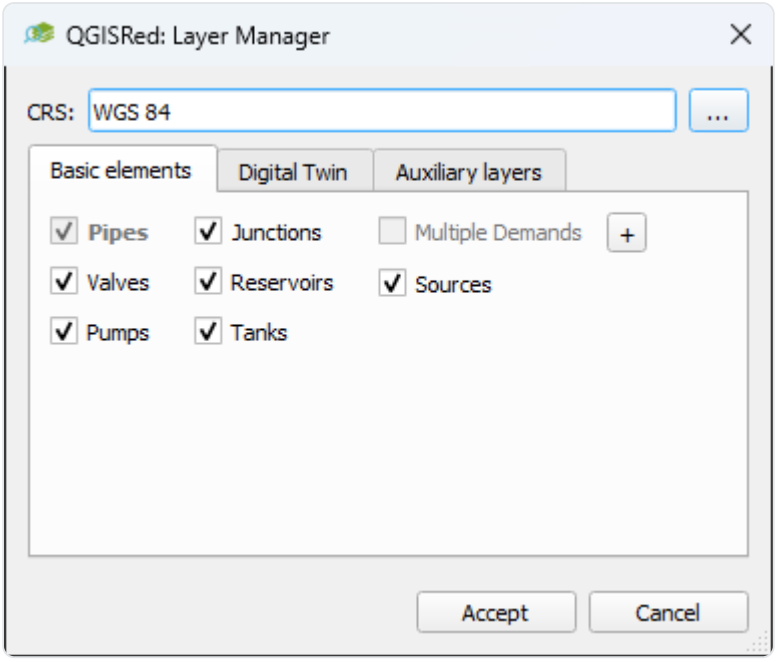
- Overview and layer management — layer visibility, recovery and legend
- Project Settings — EPANET options, default values, materials
- Save, export and close project — save map, export to ZIP and close

4.1 Layer Manager and Legend

Layer Manager

Project bar → **Layer manager** (Layer manager)

Controls which project layers are active in QGIS, allows you to recreate missing base elements, and manages the auxiliary layers of the Nodal demand builder. The dialog organizes its content into three tabs: **Basic elements**, **Digital Twin** and **Auxiliary layers**.



QGISRed Layer Manager Dialog

Layer manager: list of all the layers in the project with their loading status.

Above the tabs the **CRS** field is always visible, with the project coordinate system and a **...** button to change it.

Basic elements and Digital Twin tabs

- **Basic elements** brings together the 6 base elements of EPANET (Pipes, Junctions, Tanks, Reservoirs, Valves, Pumps) plus the complementary layers Multiple Demands and Sources.

- **Digital Twin** brings together the layers of the digital twin: Service Connections, Isolation Valves and Meters.

For each element, the row shows one of two things depending on whether or not its file exists on disk:

- **Box checked/unchecked** → the shapefile already exists; The checkbox decides if the layer is loaded and visible in QGIS. You can check or uncheck any without affecting the data.
- **Button "Create `<Elemento>` Layer"** → the shapefile does not exist yet; the button creates it empty (with the correct field structure) and opens it automatically. Once created, the row now displays the box.

> **Warning**
>
> Pipes is the exception: as soon as she is loaded, her box is locked. It is the layer that holds the rest of the network, so it cannot be downloaded from here without first downloading the rest of the project.

> 💡 When you press **Accept**, the dialog only acts on what has changed: an element that was already marked and remains marked is not closed and reopened, so it preserves its style, its visibility and the selection you had made on the canvas. Changing the CRS is the exception — as it rewrites all shapefiles, it closes and reopens everything managed by the dialog.

Recover a deleted layer

If you have accidentally deleted a layer from the QGIS legend (or its SHP file on disk), the Layer Manager allows you to **recreate it empty**: when you open the dialog, that layer no longer shows the checked box, but rather the **Create `<Elemento>` Layer** button described above. Hit it and QGISRed creates the empty SHP with the correct field structure and loads it into QGIS.

> **Warning**
>
> The recreation creates the empty layer. The data that was on it (if the SHP was erased from the disk) cannot be recovered unless you have a backup copy.

Outdated Layer Notice

In addition to the deleted layer warning icon, the QGIS legend can display a second type of warning icon (⚠) on layers that **do exist** but whose content may have become obsolete.

QGISRed monitors in the background (checking every 5 seconds) the derived layers hanging from the project folders **Issues**, **Queries** and **Results**, whose file name begins with `<Red>_`. If the network's most recent input file (Pipes, Junctions, etc.) has been modified after one of those derived layers was generated, that layer receives the warning icon with the message:

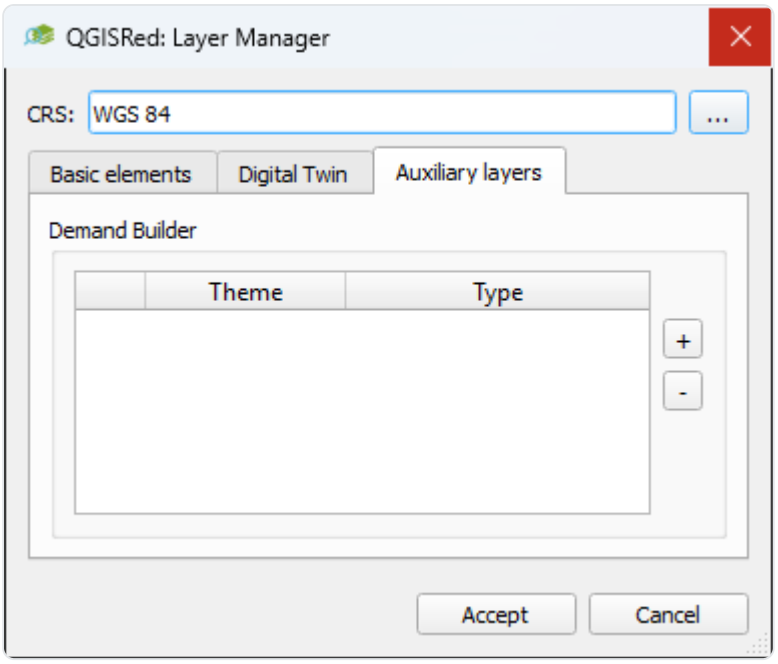
> "Layer may be outdated — inputs have changed since last generation"

- The icon is for informational purposes only: it does not have any action associated with clicking on it.
- To resolve the warning you must **regenerate the layer**, that is, re-launch the analysis or the query that created it (Isolated Segments, Hydraulic Sectors, a property query, etc.).
- The auxiliary layers of the Nodal demand builder (Consumption Points, Demand Links, Demand Sectors) are explicitly excluded from this surveillance: they are your own data that you import or create, not something that QGISRed recalculates from the network, so editing an input does not invalidate them.

> 💡 This notice is different from the icon that appears when a layer has been deleted (see "Recover a deleted layer" above): here the layer still exists and is loaded, its content may simply no longer reflect the current state of the network.

Auxiliary layers tab: Nodal demand builder layers

The **Auxiliary layers** tab contains the **Demand Builder** group, from where the empty work layers used by the tool for assigning demands to nodes (Nodal demand builder) are created and managed: **Consumption Points**, **Demand Links** and **Demand Sectors**.



Auxiliary layers tab of the QGISRed Layer Manager

Each row in the table is a **theme** (theme) — you can have several themes of the same type, for example a different `Sectors` for each demand sectoring campaign. The table shows three columns:

- Upload box (same as the other tabs: checked = uploaded to QGIS).
- **Theme** — name of the theme, or "(default)" for the one the Nodal demand builder itself automatically creates.
- **Type** — Consumption Points / Demand Links / Demand Sectors.

To create a new topic:

1. Press **Create Auxiliary Theme**.
2. In the **New auxiliary theme** dialog, choose the **Type** (Consumption Points, Demand Links or Demand Sectors) and type a **Name**.
3. Press **Accept**. QGISRed creates the empty shapefile with the corresponding fields and adds it already marked and loaded to the table.

To delete a theme, select its row and press **Delete Auxiliary Theme**; You will be asked for confirmation because the operation also deletes the files on the disk.

When you select a **Consumption Points** theme, a **…** button also appears (tooltip "Base demand fields") that opens the **Base demand fields** dialog, where the theme's base demand columns are managed (every field after `DemID` and `Category`):

- The list shows one field per row, with the name editable directly (double-click or keyboard).
- **+** adds a new row with a suggested free name (`BaseDem`, `BaseDem2`…); **-** deletes the selected row. The theme always needs at least one base demand field.
- When you press **Accept**, QGISRed validates the names: they cannot be empty, cannot exceed 10 characters (DBF format limit), must start with a letter and contain only letters, numbers and underscores, and no two fields can share the same name (case-insensitive). If something is not valid, the dialog does not close and shows the reason.
- If an existing field has been removed from the list, applying the changes asks for explicit confirmation because its values are deleted too; renaming a field, on the other hand, keeps the data.

> 💡 The layers that you leave marked in this table are remembered when closing and reopening the project — including projects that do not save a `.qgz` — just like the rest of the layers in the project.

> To know how these layers are used within the Nodal demand builder (import consumption points, generate demand links, aggregate by sectors...), see Demands and scenarios.

Model Summary (Summary)

Project bar → Summary

Generate a quick report with the number of elements of each type present in the project:

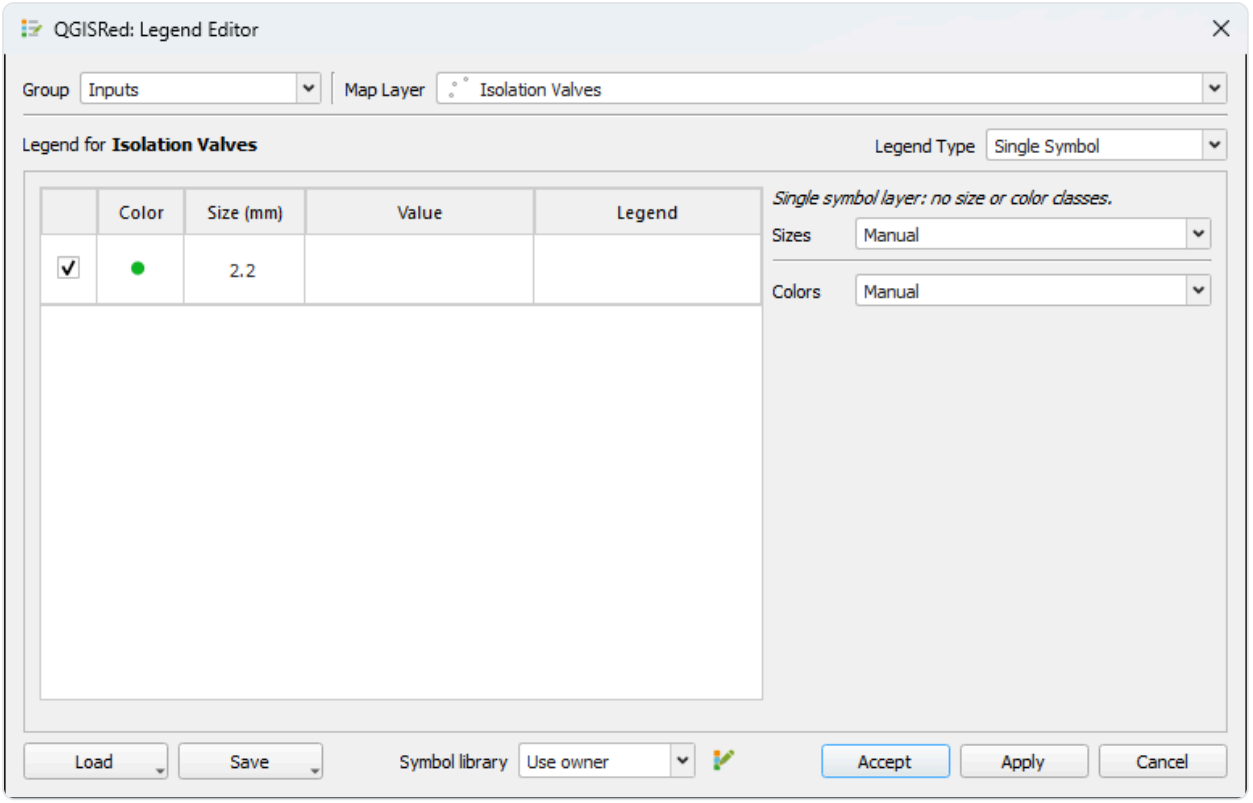
```
Junctions: 1 243
Pipes: 1 876
Tanks: 3
Reservoirs: 2
Valves: 47
Pumps: 8
```

Useful to verify that the import was complete or to document the size of the model.

Legend Editor

Project bar → **Legend editor** (Legend editor)

Opens a floating panel that allows you to build and customize the **symbology** of the project layers without navigating through the QGIS layer properties menu: legend type, automatic classification, sizes, colors, opacity and border on polygon layers, its own ramp/palette library, saving/loading styles and own rules per element type.



QGISRed Legend Editor Panel

Legend Editor panel: predefined styles and customization of colors and sizes.

Choose layer

In the dialog header:

- **Group** — group of the layer tree on which you want to work (Inputs, Results, Queries and their subgroups...).
- **Map Layer** — specific layer within that group. You can also change layers by selecting it directly in the QGIS layers panel; the editor follows the selection automatically.

Variant selector

Several input layers show an additional dropdown that filters the table and the color/size/opacity rules to a subset of the layer instead of all its elements at once:

Layer	Dropdown	Options
Meters	**Meter Type**	"All types" or a specific meter type (the different icons stacked in the symbol)
Junctions	**Demand**	"All", "Outflows (> 0)", "Inflows (< 0)"
Sources	**Source Type**	"All types" or a specific source type
Service Connections	**Component**	"All", "Line", "Demand circle"
Link layers (Pipes and similar)	**Component**	"All", "Line", "Marker"
Connectivity tree nodes (Tree)	**Node**	"All", "Junctions", "Root node"
Layers with their own element types	**Element**	"All" + one type for each possible element of that layer

While the selector is set to "All" (or has no variants), the color/size is applied to all elements at once, unless the layer has fixed style rules (see below).

Legend type and classification

The **Legend Type** dropdown offers, depending on the type of layer, between **Single Symbol**, **Categorized** and **Graduated**. Only the options that make sense for that layer appear (for example, a numeric results layer does not offer Single Symbol); if the layer is Single Symbol with no classes, the panel shows the warning "Single symbol layer: no size or color classes."

The central table lists one row per class, with visibility checkbox, color, size, value/range (or category), and legend label:

- On **graduated** legends, **Classes** is a numeric field editable only when the classification mode supports a variable number of classes (for example, not in

Manual mode); in the rest of cases it appears grayed out, with no arrows, and cannot be typed into. Reclassifying the range is done with **Intervals** (see below).

- On **categorized** legends, that same spot instead shows the **Classes** dropdown (**Current** / **All**): it controls whether the table shows only the classes you already have or one for every unique value of the layer. Set it to **All** and QGISRed automatically adds the classes that are missing; if some can't be added (class limit reached, or you cancel the operation), it drops back to **Current** on its own because they're no longer all there.
- The **+** button next to Classes adds a class below the selection with a single click; the arrow next to it opens a menu with "Add class above the selection" and, on categorical legends, 'Add "Other values" class' (a special class that groups the rest of the unclassified values). The **-** button removes the selected class.
- **Intervals** (`cbMode`) sets the automatic classification method for graduated legends: Manual, Equal Interval, Fixed Interval, Quantile (Equal Count), Natural Breaks (Jenks), Standard Deviation and Pretty Breaks. With **Fixed Interval** the **Interval Range** field appears to indicate the width of each class.
- You can edit the range of a class by hand by **double clicking on its value** (Value column) to open a small dialog with the lower and upper limits.
- **Up / Down** (arrows next to the table) manually reorder the selected class. The **Class Order** dropdown (**Current** / **Ascending** / **Descending**), above the table, automatically reorders all classes by their value at the moment the legend is applied; **Current** keeps the order the table already has.

> 💡 If you change the **Legend Type** after having edited something by hand, QGISRed asks for confirmation before discarding those changes; if you hadn't touched anything, it switches without asking. If you go back to the type the layer already had, it recovers the exact original legend, not a generic one.

Sizes

The **Sizes** block controls the size of the classes, always in millimeters except for the exception below:

- **Sizes** (`cbSizes`): Manual, Equal, Linear, Quadratic, Exponential or Proportional to Value.
- **Equal** uses a single **Value** field for all classes.

- Linear/Quadratic/Exponential/Proportional to Value distribute the size between **Min** and **Max** according to the chosen curve, with the **Invert** box to exchange which end (lower or higher value) receives the minimum size.

> 💡 On layers with a fixed status legend (see "Specific style rules" below) or on a Single Symbol layer with the variant selector set to "All", the column header changes to **Size (%)**: the value is no longer a size in mm but a **percentage of the current sizes** — 100% leaves each element with the size it already has drawn, and the adjustment scales all of them at once instead of setting an absolute size per class.

Colors

The **Colors** block controls the color of each class. The **Colors** dropdown (`cbColors`) offers, in addition to Manual/Equal/Random, the library's ramps and palettes grouped by type:

- **Manual** — each class keeps the color it has been set to by hand.
- **Equal** — a single color (color button next to the dropdown) for all classes.
- **Random** — different random colors per class, with the same "shuffled random colors" criterion that QGIS uses natively. The refresh button next to the dropdown (visible only in this mode) reshuffles the colors without changing anything else.
- **2 colors Ramps / 3 colors Ramps / > 3 colors Ramps** — continuous color ramps, grouped by how many colors define the ramp.
- **Span Palettes** — categorical palette whose colors are spread across the range of classes, keeping the first and last.
- **Sequential Palettes** — categorical palette whose colors are assigned in the order they are declared in the palette.
- **Labeled Palettes** — categorical palette where each class receives the color whose label matches its own value.

The editor itself **recommends an option** based on the legend type (Span Palettes for numeric legends; Labeled Palettes if there is a labeled palette that matches the layer's categories, or Sequential Palettes in any other categorical case): that option appears in bold with the suffix "(recommended)". Options with no ramp/palette of that type in the active library, or Labeled Palettes on a numeric legend, appear disabled with a tooltip explaining why.

The **Invert** box exchanges the direction of the chosen ramp/palette.

> 💡 For the connectivity tree node layer (Tree), the row color does not color the entire symbol: it edits only the **stroke color** of the outer circle of the node, leaving the star and element icons with their own color.

Ramp and palette library

Next to the Colors dropdown, **Symbol library** lets you choose where the ramps and palettes offered by that dropdown come from:

- **Use default** — the library that ships with QGISRed out of the box.
- **Use owner** — your own editable library. Selecting it shows the **Edit owner** button, which opens QGIS's native style manager (Style Manager) on that library to add, edit or delete ramps, palettes and symbols. Changes you make there are reflected immediately in the Colors dropdown, even recalculating already-applied colors if the active ramp changed.

Opacity and border (fill layers)

On layers whose symbol is a polygon fill (for example, Hydraulic and Demand Sectors), the panel adds two controls that apply **to all classes at once**, not class by class:

- **Opacity** (0–100%) — fill opacity; 100% is solid, 0% invisible.
- **Border** — border mode for each class: "No border", "Black", "Fill color" (the border takes the same color as the fill) or "Darker than the fill"; with any option except "No border" the border width in mm also appears.

Specific style rules per layer type

Input elements (Inputs) and some query layers carry style rules with fixed states that the color/size you choose respects, instead of overriding the entire symbol. For example, Pipes/Valves/Pumps keep the "closed" state in red and active Valves in orange no matter what happens with the color you choose for the rest. Among the layers with their own rules:

- **Multiple Demands**: the chosen color only colors the "positive demand" branch of the symbol (the inner marker), just like in Junctions; the negative demand and the rest of the symbol maintain their fixed colors.

- **Junctions**: with the **Demand** selector set to "Outflows (> 0)" or "Inflows (< 0)" you can classify and color each group of nodes separately; negative demands always keep white in automatic range-based legends.
- **Isolation Valves**: the chosen color only replaces the "open, no pressure loss" state; The colors of closed (red), with loss of charge (amber) and not available (gray) are set by the legend itself and cannot be edited from here.
- **Meters**: The color and size are applied depending on what you have selected in **Meter Type** — to all meter types at once, or only to the chosen type, without touching the rest of the stacked icons.
- **Service Connections**: the chosen color is applied to the active connection stroke and to a lighter version of the same color for its fill; The rest of the states retain their own color.
- **Connect_Links** (result of the Connectivity tool, within Queries): unlike the previous ones, it does not have rules by state — the color and size are applied directly to the symbol, as in any Single Symbol layer.
- **Consumption Points / Demand Links** (Nodal demand builder layers): the **Uncategorized** class always stays orange and first in Ascending/Descending order — it is never part of the ramp or color palette you choose; the rest of the categories are colored with it, starting with the first actual category.

Load and save styles

The **Load** and **Save** buttons, at the bottom of the dialog, each open a menu:

Load

- **Default Style** — retrieves the default QGISRed style for that layer type.
- **Global Style** — load a style that you have previously saved at a global level (valid for any project).
- **Project Style** — loads a style saved within this project.
- **Revert to Original Legend** — recovers in the dialog the legend that the layer had at the time of opening the editor (without the need to close and reopen the dialog).

Save

- **To Global...** — saves the current legend as a global style, reusable in any project.
- **To Project...** — saves the current legend inside the `layerStyles` folder of this project.

When saving, a small dialog lets you choose whether you want to save the legend **as seen** or a **strategy** that regenerates automatically the next time you load it (by marking which parts to keep: the class/range structure, the sizes and/or the colors).

> **Warning**
>
> Both **Load** and **Revert to Original Legend** only update the dialogue preview. The project layer doesn't change until you press **Apply** or **Accept**.

Apply, Accept and Cancel

The bottom three buttons have very specific preview semantics:

- **Apply** — applies the changes shown in the dialog to the layer, without closing the editor. Useful to see the result on the canvas while you continue adjusting.
- **Accept** — applies the changes to the layer and closes the dialog (equivalent to Apply + close).
- **Cancel** — closes the dialog and **restores the layer to the legend it had when you selected it** in this editor, also undoing any changes you may have already applied with Apply. If there were changes applied, QGISRed asks for confirmation before discarding them.

> 💡 Since Cancel always returns you to the starting state (even if you've pressed Apply several times while trying things out), it's the safe way to "start over" with a layer without having to rebuild its legend by hand.

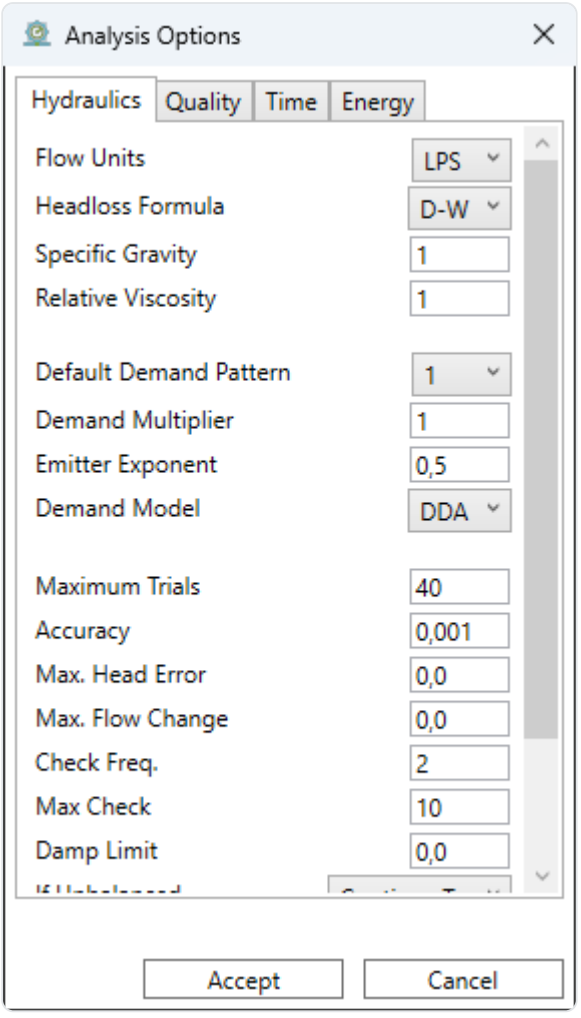
4.2 Project Configuration

This page brings together three configuration dialogs that affect the hydraulic behavior of the model and the default values used when creating new elements: Analysis options (**Analysis** bar) and Default values / Materials table (**Project** bar).

Analysis options

Analysis bar → **Analysis options...** (Analysis options)

Opens the main EPANET options dialog. It is equivalent to section `[OPTIONS]` of file `.inp`.



Analysis Options Dialog: Hydraulics, Quality, Time and Energy tabs

Analysis options dialog with its four tabs.

Hydraulic Tab

Field	Description
Flow units	Defines the system of units of the project. Metric units (LPS, LPM, MLD, CMH, CMD) correspond to SI; gallons and cubic feet (CFS, GPM, MGD, IMGD, AFD) to US
Head loss formula	Darcy-Weisbach (D-W), Hazen-Williams (H-W) or Chezy-Manning (C-M)
Specific gravity	Specific weight of the fluid with respect to pure water (1.0 for standard water)
Relative viscosity	Factor on the kinematic viscosity of water at 20 °C
Precision	Convergence criterion of the hydraulic solver
Demand model	DDA (Demand Driven) or PDA (Pressure Driven) — in PDA, demand is reduced if the pressure drops below a threshold
Minimum / nominal pressure	Thresholds for the PDA model
Max. iterations / ratio	Solver convergence parameters

> 💡 Changing the **flow units** does not convert the values already entered. If the network is set to LPS and you switch to GPM, all demand, flow, and length values will need to be updated manually.

Quality Tab

Field	Description
Type of quality analysis	None (does not simulate quality), Chemical (reagent), Age (water age), Trace (tracer)

Field	Description
Reagent label	Name of the modeled product (e.g. "Chlorine") — will appear in the results
Tracer node	For Trace type analysis, tracer source node ID
Concentration units	mg/L or µg/L
Diffusivity	Relative molecular diffusion coefficient (1.0 for chlorine in water)
Tolerance	Convergence criterion for the quality solver

Time Tab

Field	Description
Simulation duration	Total simulation time. Format `HH:MM:SS` or in hours (e.g. `24:00:00`)
Hydraulic time step	Hydraulic calculation interval (typically 1 h)
Quality time pass	Quality calculation interval (typically 5 min)
Report time step	How often results are saved (determines the number of moments available in the Viewer)
Simulation start time	Clock time corresponding to instant 0 of the simulation
Type of statistician	None (all instants), Average, Minimum, Maximum, Range

> 💡 A 1-h **reporting step** in a 24-h simulation generates 25 result instants (0 h to 24 h). Shorter steps increase the temporal resolution but also the size of the result files.

Energy Tab

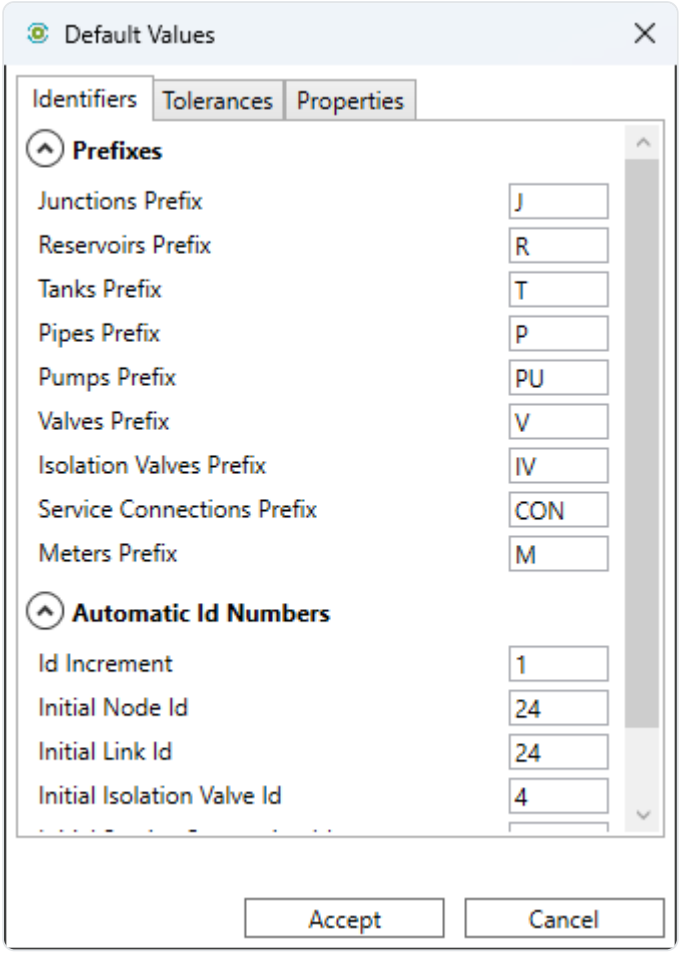
Allows you to define the energy cost of the pumps for consumption analysis:

Field	Description
Global price	Cost per kWh (in defined currency)
Price pattern	Temporal pattern of electricity price variation
Overall efficiency	Average efficiency of the pumps (if they do not have individual efficiency curve)

Default values

Project bar → **Default values** (Default values)

Defines the values that are automatically assigned to new elements when they are created with the editing tools.



Defaults dialog with sections for nodes, pipes and prefixes

Default values dialog: initial parameters for each element type.

ID Prefixes

Each item type has a configurable prefix that is used when automatically generating the ID of new items:

Element	Default prefix	Example of generated ID
Junction	J	J-1, J-2…
Pipe	P	P-1, P-2…
Tank	T	T-1, T-2…
Reservoir	R	R-1, R-2…
Valve	V	V-1, V-2…
Pump	BM	BM-1, BM-2…

The prefixes are configurable. The starting number can also be set.

Initial hydraulic values

Field	Description
Default diameter	Diameter (mm or inches) assigned to the new pipes
Default roughness	Roughness coefficient according to the active formula
Default elevation	Elevation (m or ft) assigned to the new nodes
Default base demand	Initial demand of the new demand nodes
Default pump speed	Initial relative speed factor for pumps

Geometric tolerances

Field	Description
Node Tolerance	Maximum distance (m or ft) to consider two points to be the same node
Minimum length for division	Minimum length of the resulting sections when dividing a pipe
Maximum length for division	Maximum length of the resulting sections when dividing a pipe

---

Materials table

Project bar → **Materials table** (Materials table)

Manage the list of materials available for pipes and their aging properties.

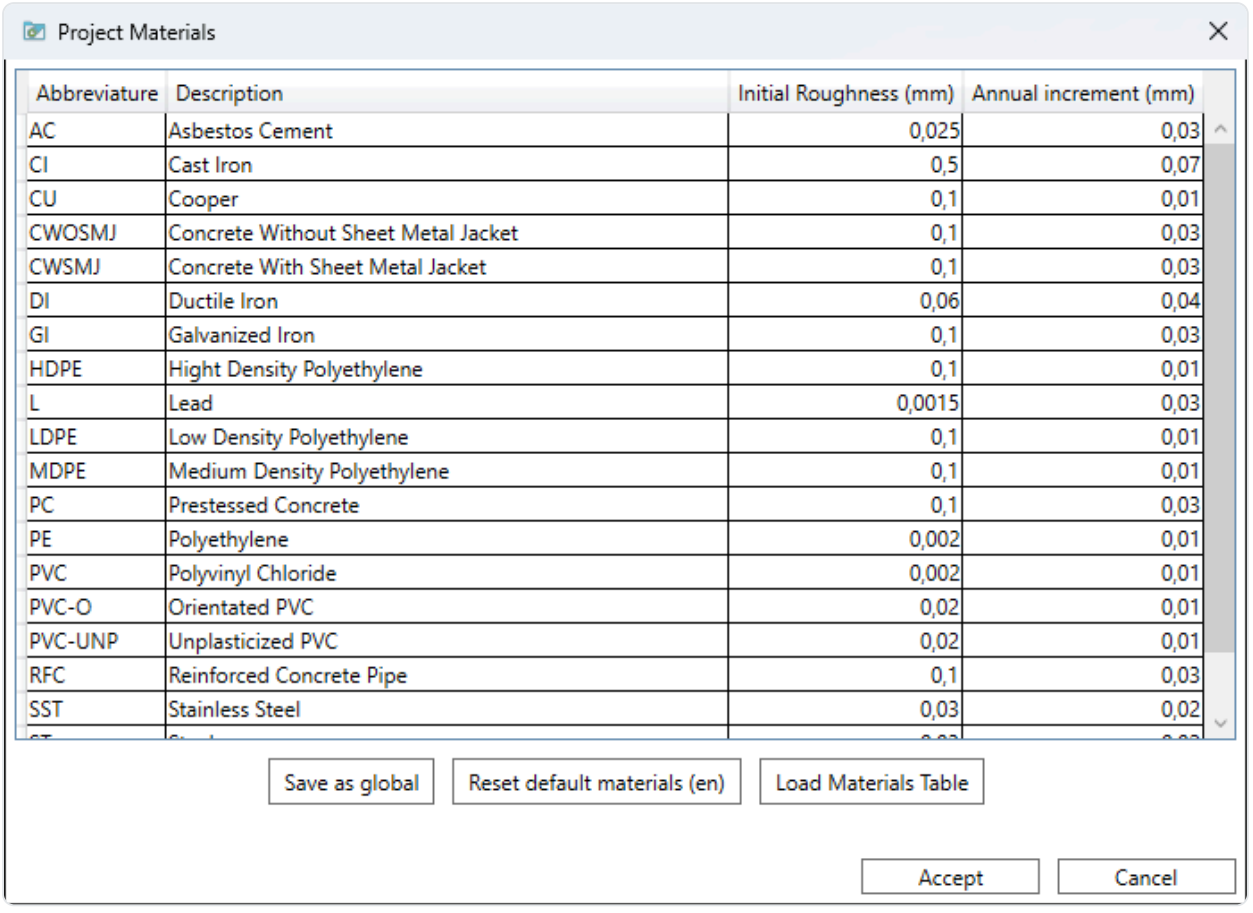


Table of materials: code, name, initial roughness and annual increase

Table of materials with initial roughness and increase per year.

Table fields

Field	Description
Abbreviation	Material short code (e.g. PVC, DI, AC)
Description	Full name (e.g. "Ductile Iron", "Asbestos Cement")
Initial roughness (mm)	D-W roughness coefficient at installation date
Annual increase (mm)	Increase in roughness per year of age

> **Warning**
>
> There cannot be two materials with the same abbreviation — if there is, QGISRed warns you and prevents saving until you correct the repeated one.

Add a material

The table always shows an **empty row** at the end. Write directly in it (abbreviation, description, initial roughness and annual increment) and, as soon as you leave the row, QGISRed registers it as a new material and adds another empty row below it — no separate "Add" button is needed. If you leave the initial roughness or increment blank, they are saved as 0.

Delete a material

Select a row and press **Del** to delete it. If the material is assigned to a pipe or connection, QGISRed notifies how many elements use it and asks for confirmation before deleting it — if you accept, those elements are left without assigned material.

Use with the "Assign Roughness" tool

When you use the **Assign Roughnesses** tool from the Tools bar, QGISRed searches this table for the material of each pipe and calculates:

```
Rugosidad = Rugosidad_inicial + (Año_actual - Año_instalación) × Incre
```

> 💡 You can add custom materials. The materials defined here are also available when creating new pipes from the Edition bar.

Materials included by default

QGISRed includes a predefined material table with the most common ones (FG, FD, ACE, PVC, PE, PE-AD...). You can edit or extend them according to the characteristics of your system.

Save and reuse tables between projects

The materials table is unique to each project, but can be shared with other projects by saving it as a **global** table (saved in the user profile, outside of any project — one `.dbf` per table).

With an active project ("Project Materials" window), the dialog directly edits the project table (without drop-down) and offers these buttons:

Button	Action
Save	Closes the dialog and saves the changes to the project.
Save as global	Saves a copy of the current table as a **new** global table, asking for a name. If a global table with that name already exists, asks for confirmation before overwriting it.
Restore default materials (language)	Replaces the project table with the predefined QGISRed one in the language indicated in parentheses (the one of the interface), discarding the current project materials.
Load Materials Table	Replaces the project table with another one, chosen in a separate dialog that lists both the global tables saved by the user and the predefined QGISRed ones (marked "(default)").
Cancel	Closes the dialog without saving changes.

Warning

There cannot be two materials with the same abbreviation — if there is, QGISRed warns you with a red message under the table and prevents saving until you correct the repeated one. The same check applies when pressing "Save" and "Save as global".

No active project: global table manager

If you open **Material Table** without any active QGISRed project (for example, as soon as you open QGIS, before creating or opening a project), the dialog opens as a separate window ("Global Material Tables") to manage the saved global tables, with the label **"Select the global material table"** next to a drop-down list that lists all the available ones:

- **Global tables saved** by the user (created with "Save" or "Save as..."), editable.
- QGISRed **predefined tables** by language, marked with the suffix **"(default)"** — read-only: the grid cannot be edited while one of these is selected.

Next to the dropdown is a **Delete** button that deletes the selected global table; it is only available for your own tables, not for predefined read-only ones.

The buttons below change depending on the selected table:

Button	When does it appear	Action
Save	Only with own table selected (not predefined)	Saves changes **over the already selected table**, without asking for a new name — unlike **Save As...**.
Save as...	Always	Requests a new name and saves a copy as a global table; if the name already exists, asks for confirmation before overwriting it. If successful, it adds it to the dropdown and selects it next.
Restore default materials (language)	Only with own table selected (not predefined)	Replaces the content of the current table with the predefined one of the interface language.
Cancel	Always	Closes the window.

Warning

If you change tables in the dropdown with unsaved changes, QGISRed asks if you want to save them before changing (Yes/No/Cancel). Closing the window with "Cancel" (or with the X), on the other hand, doesn't ask anything: since there is no final button that confirms all the changes at once (unlike with an active project), only what you have already explicitly saved with "Save" or "Save as..." is kept here.

4.3 Save, Export and Close Project

Save the project map

Project bar → **Save map** (Save project map)

Saves the QGIS file (`.qgz`) that contains the project's visual settings: loaded layers, styles, group visibility, map framing, etc.

First time

If the QGIS project does not already have a `.qgz` file, the plugin opens the standard QGIS dialog **"Save As"** automatically suggesting the QGISRed project folder and the network name as the file name:

```
{CarpetaProyecto}/{NombreRed}.qgz
```

Later Saves

If a `.qgz` already exists, it directly overwrites it (equivalent to `Ctrl+S` in QGIS).

> 💡 **Recommendation**: save the `.qgz` in the same folder as the project's SHPs. Thus, if you copy the folder to another computer, the `.qgz` file will find the SHPs without the need to reconfigure paths.

> **Warning**
>
> Save the `.qgz` **does not save network data**. The data (diameters, dimensions, demands...) are automatically saved in the SHP+DBF when QGISRed modifies them. The `.qgz` only saves the visual presentation.

Export the project

Project Manager → **Export**

> **Warning**
>
> This button is **no longer** on the **Project** bar: the old *Project backup* button has been removed and has no replacement on that bar. The export is now done from Project manager — select the project in the list (it is not necessary to have it open) and press **Export**.

Generates a portable ZIP file with the project: the SHP/DBF of the network, the QGIS map (`.qgz`) if it exists, and optionally the content groups and complementary data (background cartography, MDT, orthophotos...) referenced by that `.qgz`.

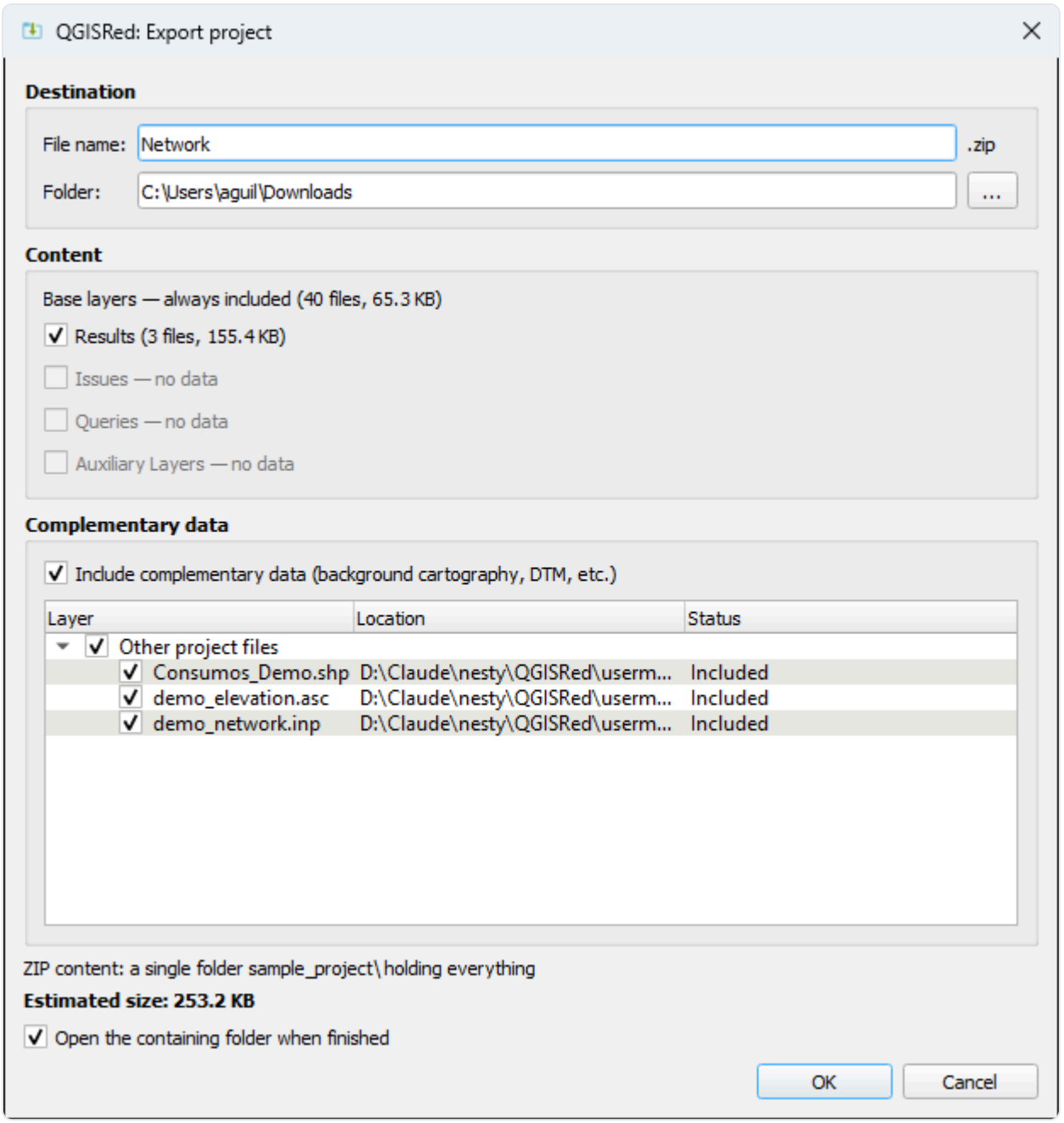
Before exporting

If the project you export is the one you have open in QGIS and its `.qgz` has unsaved changes, QGISRed asks first:

> *"The QGIS project has unsaved changes. Do you want to save it before exporting?"*

- **Yes**: save the `.qgz` and export that newly saved version.
- **No**: exports the `.qgz` as it was in the last save (pending changes do not travel in the ZIP).
- **Cancel**: The export dialog does not open.

The export dialog



QGISRed export project dialog

Field	Function
File name:	ZIP name (without extension); by default, the network name
Folder:	Destination folder; by default, the user's Downloads folder
Content	Optional groups to include (see below)

Field	Function
Complementary data	External data referenced by `.qgz`, selectable one by one
Open the containing folder when finished	Open the file explorer in the destination folder when finished (enabled by default)

What is always included

- The SHP+DBF+PRJ of the network in the root of the project folder (Pipes, Junctions, Valves, Pumps, Tanks, Reservoirs, Demands, Sources...) and the options and metadata files (`_Options.dbf`, `_Title.dbf`).
- The map file `.qgz`, if QGISRed finds it in the project folder or in its parent folder. If there is no `.qgz` saved, the dialog warns that the map display will not be exported.

What's optionally included

Four content groups, each with its own box in the **Content** section (checked by default if the group has data from this network; if empty, the box is disabled):

Box	Content
Results	Simulation results saved in `Results/`
Issues	Incidents detected by verifications, in `Issues/`
Queries	Queries saved, in `Queries/`
Auxiliary Layers	Auxiliary layers (for example, of the Nodal demand builder), in `Auxiliary Layers/`

If the `.qgz` references complementary data, the dialog adds a **Complementary data** table with one row per layer (name, location, and state), each with its own checkbox — so you can leave out, for example, a multi-GB MDT without giving up the rest.

If the project folder also contains other files that aren't part of the network (a stray `.inp`, notes, an unrelated SHP, or even another complete QGISRed project sharing the folder), the dialog groups them under **Other project files** — with a subgroup for

each other QGISRed project detected — each with its own checkbox, just like the complementary data.

What is not included

- Content groups that you leave unchecked.
- The complementary data that is outside the project folder and its parent folder: the dialog marks them as *"Not exportable"* and warns before exporting. To include them, move them with the file explorer to the project folder (or next to it) and reopen the project so that QGISRed relinks them.
- Remote background layers (WMS services, XYZ, databases): there is nothing to copy, so they never block the export or appear in the table.

> **Warning**
>
> If you leave out a content group or complementary layer that `.qgz` is still using, QGISRed warns you before exporting. Press **OK** a second time if you want to continue anyway.

Where is it saved

```
{CarpetaDestino}/{NombreArchivo}.zip
```

By default `{CarpetaDestino}` is the user's Downloads folder and `{NombreArchivo}` is the network name, but both are editable in the dialog. If a ZIP with that name already exists, QGISRed asks if you want to overwrite it.

Upon completion, QGISRed shows the full path of the created ZIP in the message bar.

> 💡 **Best Practices**: Export the project before operations that modify many elements at once (bulk imports, CRS changes, roughness conversions) and before updating the plugin version. To recover an exported project, use **Import project → "QGISRed project" tab** — see Open and import projects.

Close project

Project bar → **Close project** (Close project)

Close the current QGISRed project and clean the QGIS session: delete all loaded layers and restore the initial state.

It is equivalent to using *Project* → *New*, *Project* → *Close* or *Project* → *Open* in the native QGIS menu, and also to closing the QGIS window directly: QGISRed intercepts all four actions to ask with its own dialog, instead of letting QGIS do it.

> **Warning**
>
> If there are unsaved changes in the `.qgz` file of a QGISRed project, the dialog **"Do you want to save the map of the current project?"** appears with three options: **Yes** saves and continues (if saving fails, the action is cancelled), **No** discards the changes and continues, **Cancel** aborts the action (closing, new project or opening another one) and the current project stays open as it was. This dialog only appears when there is an active QGISRed project; in a QGIS session without a QGISRed project, QGIS's native behavior does not change.

Summary: what each option saves

Operation	What keeps	Where
Editing Tools	Attributes and geometry	SHP/DBF on disk, immediately
Save map	Styles, visible layers, framing	File `.qgz`
Export project (Project Manager → Export)	Network SHP/DBF, `.qgz` and optionally supplementary data and content groups	File `.zip` in the folder of your choice

5 ✏️ Edition

The **Edition** bar contains all the tools to build and edit the network directly on the QGIS map. Work on the layers of the active project without having to open attribute tables or external files.



QGISRed Edition Toolbar

Bar Edition: creation of elements, geometric and topological editing, properties and operation data.

> All buttons require a valid project uploaded. If there are none, the plugin displays *"No valid project is opened"*.

Edition Bar Tools

Group 1 — Creation of elements

#	Tool	Function
1	**Add pipe**	Draw pipes by clicking on the map; automatically creates nodes at the ends
2	**Add tank**	Place a Tank on an existing node
3	**Add reservoir**	Place a reservoir or feed point (Reservoir) at an existing node
4	**Insert valve in pipe**	Insert a valve into an existing pipe, splitting it
5	**Insert pump in pipe**	Insert a pump into an existing pipe, splitting it

Group 2 — Geometric and topological editing

#	Tool	Function
6	**Select multiple elements**	Multi-layer selection by rectangular area on the map
7	**Move nodes**	Move nodes by dragging all connected elements
8	**Edit link vertices**	Add, move and delete intermediate pipe vertices

#	Tool	Function
9	**Reverse elements**	Reverses the direction of orientation of pipes or service connections
10	**Split/Join pipes**	Split a pipe at the indicated point or join two adjacent sections
11	**Merge/Dissolve junctions**	Merge two nodes into one or separate one node into several
12	**Create/Remove T connections**	Create or delete a T-joint between a node and a nearby pipe
13	**Create/Remove crossings**	Creates or deletes a junction (shared node) between intersecting pipes
14	**Move valves/pumps**	Move a valve or pump from one pipe to another
15	**Change element status**	Toggles the Open/Closed status of pipes and valves
16	**Delete elements**	Delete the highlighted item or selected items

Group 3 — Properties and operation data

#	Tool	Function
17	**Edit element properties…**	Opens the properties dialog of the clicked element
18	**Edit patterns and curves…**	Demand Pattern and Pump/Tank Curve Editor
19	**Edit controls…**	Simple controls and operating rules editor

---

In this section

- Creation of elements — pipes, tanks, reservoirs, valves, pumps
- Geometric and topological manipulation — move, split, reverse, cross, delete
- Element properties — editing dialog with integrated browser
- Patterns and curves — demand patterns, H-Q curves, efficiency and volume
- Controls and rules — simple controls and automatic operating rules

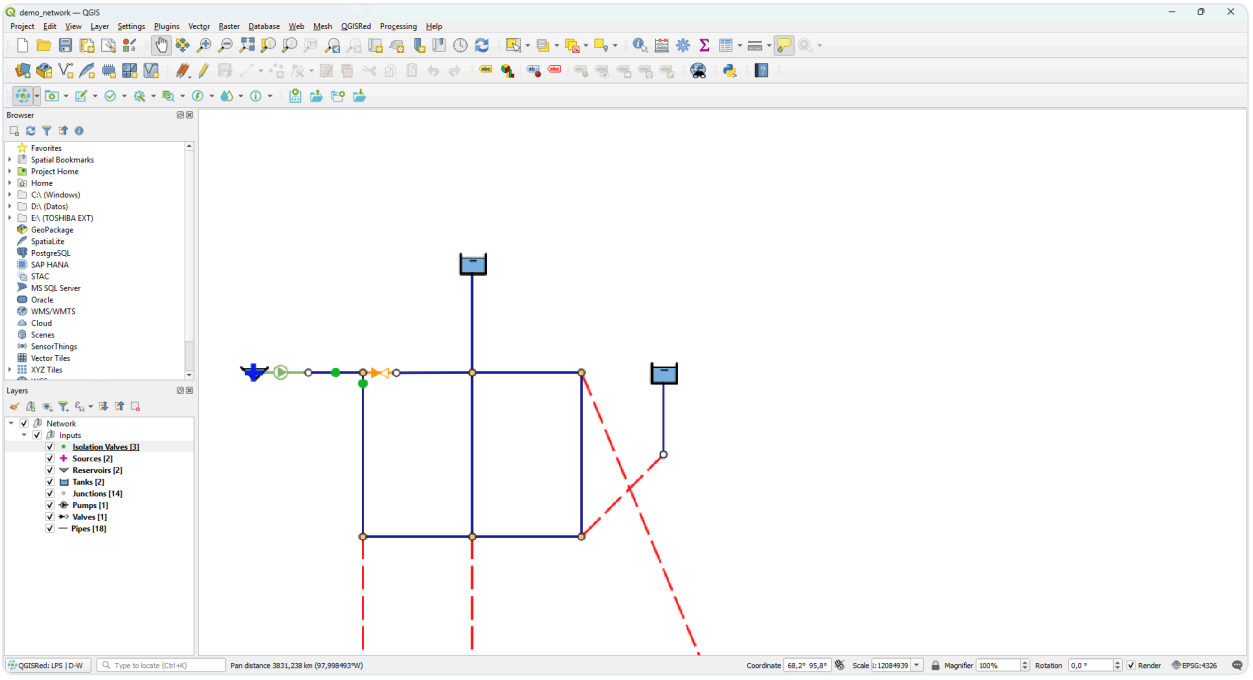
5.1 Element Creation

The first five tools on the Edition bar allow you to add elements to the network. They all activate an **interactive editing mode**: the cursor changes and the plugin waits for an action on the map. To cancel without creating anything, press the same button again or press `Esc`.

Add pipe

Edition bar → Add pipe

Line drawing mode: Each click adds a vertex to the pipe. The tool remains active until you finish the layout.



Add pipe tool in action on the QGIS map

Drawing a pipe: The temporary red line follows the cursor until the next click.

Process

1. Activate the tool. The cursor changes to drawing mode.
2. Click to set the **start point**. QGISRed automatically creates a junction at that point if none exists within the tolerance radius.
3. Click to add **intermediate vertices** (path break points).

4. **double click** or press the **right button** to finish the pipeline. QGISRed creates a second node at the end point.

What QGISRed creates when confirming

- A record in `{Red}_Pipes.shp` with the geometry drawn.
- Up to two new nodes in `{Red}_Junctions.shp` (one per end), if a node did not already exist within the configured tolerance.
- The diameter, roughness and demand values are taken from the **Default Values** of the project.

Connect to existing elements

If the start or end point falls within the tolerance of an existing node, valve, pump, tank or reservoir, the new pipe **connects to that element** instead of creating a new node.

> Setting to the nearest node uses the tolerance configured in **Project Bar → Defaults → Node Tolerance**. You can review or change it before drawing dense networks.

Add tank

Edition bar → Add tank

Place a Tank on the map. Tanks have a variable level and participate in the hydraulic simulation.

Process

1. Activate the tool. The cursor shows the tank icon.
2. Click on an **existing node** or on an empty point on the map.

- If you click on an existing node, that node **becomes** a Tank.
- If you click on an empty point, QGISRed creates a new Tank (no initial connection; you will need to connect it with a pipe).

3. The reservoir is created with the default values; use **Edit properties of the elements...** to enter the data (background dimension, initial level, minimum level,

maximum level, diameter).

Main tank parameters

Parameter	Description
Elevation	Tank bottom elevation (m or ft)
InitLevel	Initial water level above bottom
MinLevel	Minimum operating level
MaxLevel	Maximum operating level
Diameter	Tank diameter (for circular section); if you use volume curve, put 0
MinVol	Minimum volume (optional)
VolCurve	Volume curve ID (for non-cylindrical geometry)

Add reservoir

Edition bar → Add reservoir

Place an external reservoir or feeding point (Reservoir). Unlike the Tank, the Reservoir has **fixed level** (constant piezometric head) and represents a water source of unlimited capacity.

The process is identical to that of the tank. The parameters are simpler:

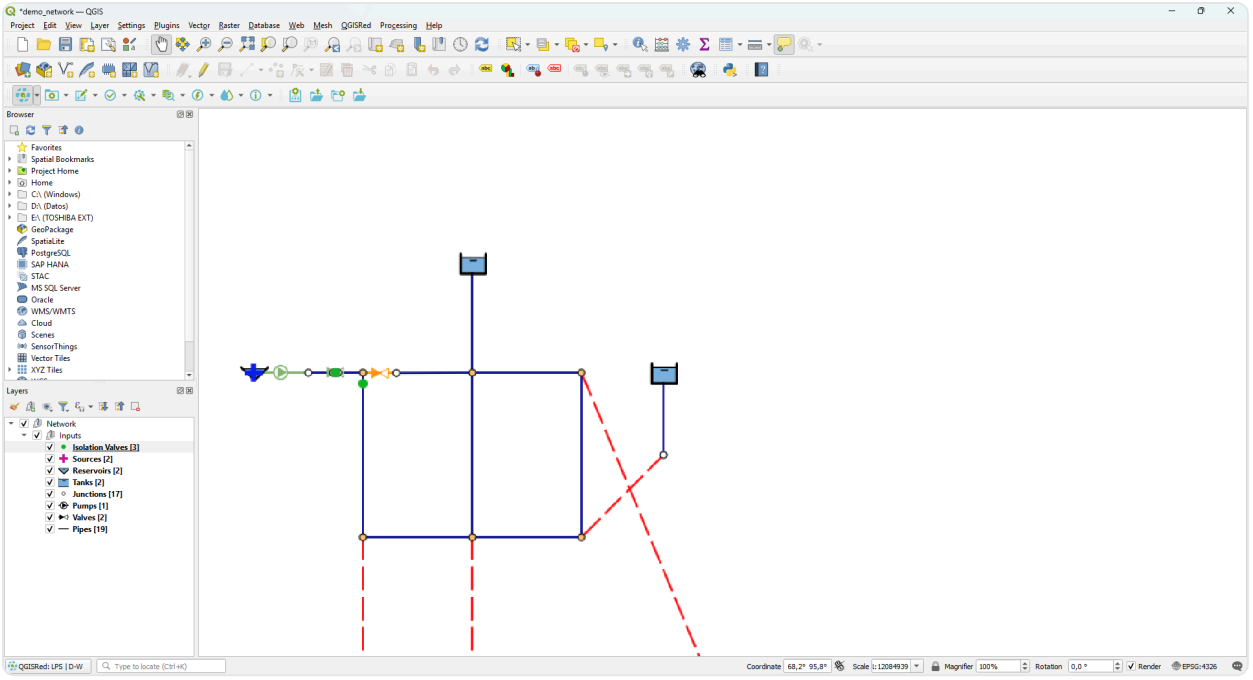
Parameter	Description
Head	Fixed piezometric load (free water level elevation, m or ft)
Pattern	Load variation pattern over time (optional)

> Use reservoirs to represent high water delivery points (connections with external systems) or constant flow supply points.

Insert valve in pipe

Edition bar → Insert valve in pipe

Insert a valve into an existing pipe. The original pipe is **divided into two sections** that are connected through the valve.



Result of inserting a valve: the original pipe is divided into two

The original P-12 pipe is divided into P-12 and P-13, with valve V-1 between them.

Process

1. Activate the tool. The cursor changes to the valve icon.
2. Click on the pipe where you want to insert the valve.
3. QGISRed determines the exact insertion point (projection of the click on the axis of the pipe) and:

   - Create a node at that point.
   - Divides the original pipe into two sections with the same diameter and material attributes.
   - Create the valve between the two new ends.

4. The valve is created with the default type and setting; use **Edit Element Properties...** to configure its type and setting.

Available valve types

Type	Name	Function
PRV	Pressure Reducing Valve	Reduces downstream pressure to setpoint
PSV	Pressure Sustaining Valve	Maintains upstream pressure at setpoint
PBV	Pressure Breaker Valve	Produces a fixed head loss
FCV	Flow Control Valve	Limits the flow to the setpoint
TCV	Throttle Control Valve	Simulates a partially closed valve using a loss coefficient
GPV	General Purpose Valve	Head loss defined by a custom curve

---

Insert pump in pipe

Edition bar → Insert pump in pipe

Insert a pump into an existing pipe, splitting it exactly the same as with valves.

Process

1. Activate the tool and click on the pipe.
2. QGISRed divides the pipe and creates the pump between the two resulting sections.
3. The pump is created with the default values; use **Edit Element Properties...** to set the H-Q curve and initial speed.

Pump parameters

Parameter	Description
Curve	H-Q Curve ID (required to simulate)
Speed	Initial speed factor (1.0 = nominal speed)

Parameter	Description
Pattern	Speed variation pattern
Power	Constant power (alternative to H-Q curve)

> If the pump requires an efficiency curve for energy calculation, define it in the **Pattern and Curve Editor** and reference it from the pump properties.

5.2 Geometric and Topological Manipulation

The tools in the second group of the Edition bar allow you to modify the geometry and topology of the network without breaking connectivity. QGISRed maintains consistency between spatial geometry and model data at all times.

> All the tools on this page that are activated by clicking on the map (Move nodes, Reverse elements, Merge/Dissolve junctions, Create/Remove T connections, Create/Remove crossings...) resolve the click against the **closest** element within the configured tolerance, not against the first one they find — important when there are several nodes very close to each other.

Multiple selection (Select multiple elements)

Edition bar → Select multiple elements

Simultaneous selection tool on several layers. Activate it and draw a rectangle on the map: all elements of all the project layers that fall within the area are selected.

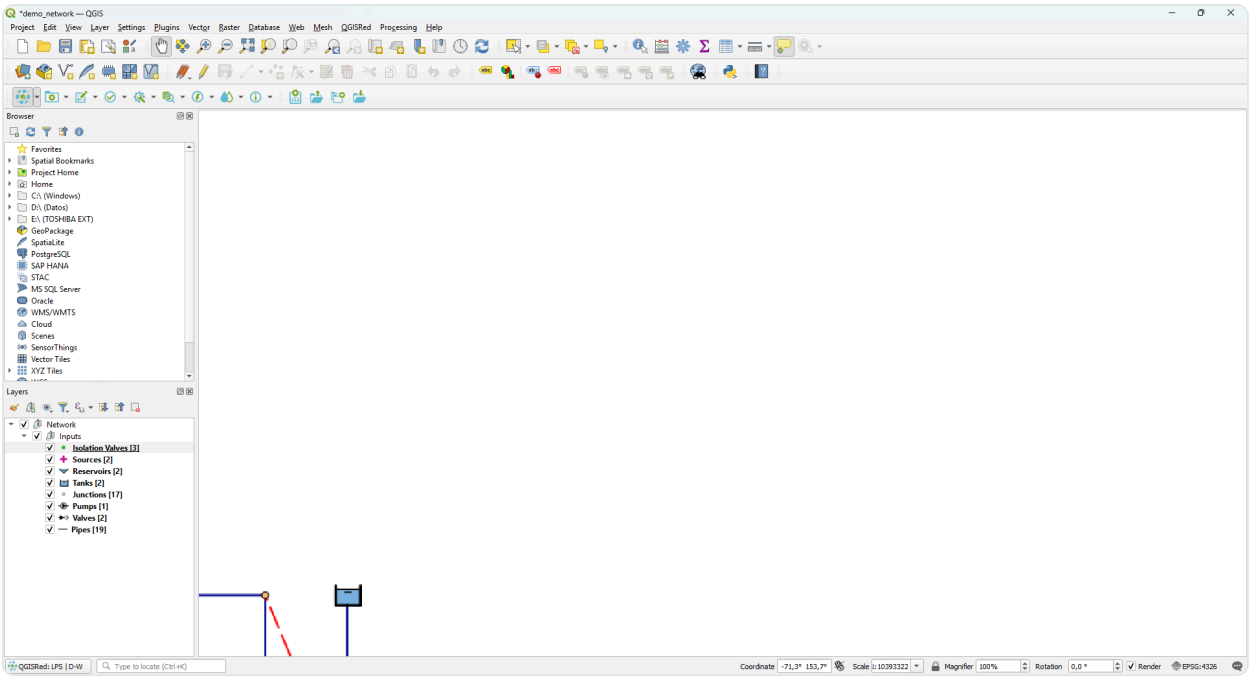
The selection is used as **input** for other tools: Reverse elements and Delete elements operate on the selected elements if there are any, or ask you to click on the map if there is no previous selection.

> To deselect, press the button again or use `Ctrl+Shift+A` (QGIS global deselect).

Move nodes

Edition bar → Move nodes

Moves one or more nodes (Junctions, Tanks, Reservoirs) dragging with it **all connected linear elements** (pipes, valves, pumps). The network remains connected after the movement.



Move a node and its connected pipes on the map

When you drag a node, all connected pipes follow the movement.

How to use it

1. Activate the tool.
2. Click on the node you want to move (or on a node area in the Junctions layer).
3. Drag to the new position.
4. Release the mouse button to confirm.

> This tool does **not** move intermediate pipe vertices. For that, use **Edit link vertices**.

> 📝 The starting point of the drag snaps to the nearest node within **10 screen pixels**, not a fixed distance in map units — so the tolerance stays the same regardless of the zoom level or the project's coordinate system.

Edit link vertices

Edition bar → Edit link vertices

Allows you to adjust the visual layout of pipes and other linear elements by manipulating their intermediate vertices. It does not affect the end nodes or the topology.

Available operations

Action	Gesture
Move vertex	Click on an existing vertex (blue circle) and drag it
Add vertex	Click on the segment between two vertices to insert a new one
Delete vertex	Right click on a vertex to delete it

Reverse elements

Barra Edition → Reverse elements

Reverses the **orientation** of pipes and service connections. The orientation determines the positive direction of flow in the simulation results.

Two ways to use it

1. **Over selection**: Select one or more pipes with the multiple selection tool and press Reverse. They all reverse their orientation.
2. **By click**: Without prior selection, press Reverse and click on the pipe you want to reverse.

> The inversion only affects the sign convention of the flow rate in the results. It does not modify the hydraulic behavior in the simulation (EPANET always calculates the real direction of flow, regardless of the stored orientation).

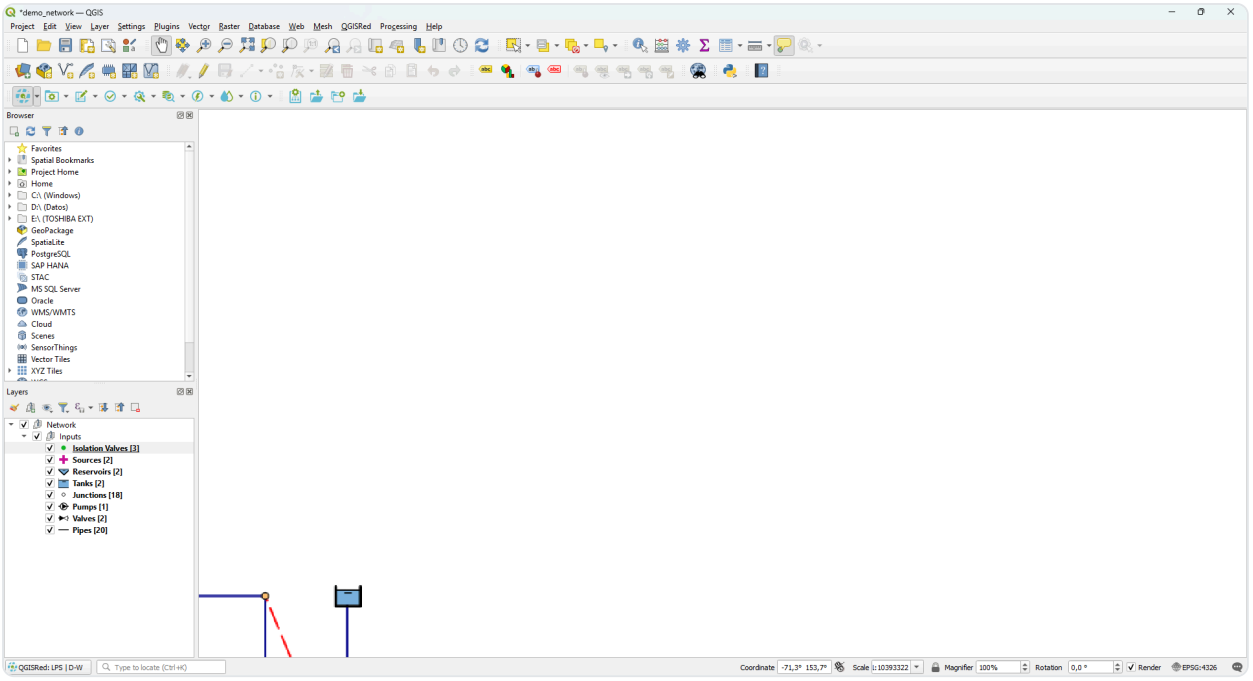
Split/Join pipes

Barra Edition → Split/Join pipes

Click on a pipe to **split** it at the indicated point: QGISRed creates a new junction at that point and two sections with the same diameter, material and InstallYear attributes as the

original.

To **join** two pipes, click on the intermediate node they share: if that node has exactly two connected pipes and the diameter, material, roughness coefficient and InstallYear properties are the same, QGISRed merges them into a single section and eliminates the node.



Split a pipe: an intermediate node and two sections are created

Click on P-5 creates node J-42 and divides the pipe into P-5 and P-45.

> If the two pipes have a different diameter, material, roughness coefficient or year of installation, the connection is not made and the plugin shows a warning.

Merge/Dissolve junctions

Barra Edition → Merge/Dissolve junctions

This tool operates with **two clicks**:

- **A single click** (click and without a second point): **Separates** the indicated node into as many independent nodes as there are pipes connected to it — you need at least two pipes connected to the node, otherwise QGISRed warns that there is

nothing to dissolve. Useful when a node groups together several pipes that should not be topologically connected.
- **Two clicks** (origin → destination): **Merges** the origin node with the destination node. All pipes connected to the origin node are reconnected to the destination node. The origin node disappears. If the two nodes chosen are already the two ends of the same pipe, the merge is not performed (it would create a loop) and QGISRed displays a warning.

Common use cases:

- Merge two very close nodes that were separated when importing from `.inp`.
- Separate a node at a junction where the pipes are not actually connected.

What happens to the properties of the origin node when merging

QGISRed does not simply discard the data of the disappearing node — it combines it with that of the destination node:

Property	Behavior
Base demand	If the two nodes have a single demand with the same pattern, the base flows are added. In any other case, the demand(s) of the origin node are added as additional categories of the destination node (see Demands and scenarios).
Quality source	If only one of the two nodes has a quality source, that one is kept. If both have it with the same type and pattern, their intensities are added. If both have it but with a different type or pattern, the one from the destination node is kept and the one from the origin is discarded, with a warning.
Emitter coefficient	The coefficients of the two nodes are added.

Create/Remove T connections

Barra Edition → Create/Remove T connections

Manages T-joints: points where a node is very close to a pipe but **not** connected to it.

Create a T

1. Click on the node you want to connect.
2. Click on the pipe to which it should be connected.
3. QGISRed divides the pipe at the point closest to the node and connects both with a short pipe, or moves the node to the pipe if the distance is less than the tolerance.

Delete a T

Click on the existing T connection. QGISRed checks that the two pipes on either side of the node are actually **collinear** (form a straight line, within an angular tolerance): if they are, it removes the intermediate node and restores the original pipe; if not, it rejects the operation and shows how much the most aligned pair deviates from that straight line, so you know if it really was a T connection or a real junction/branch.

Create/Remove crossings

Edition bar → Create/Remove crossings

Manages crossings between pipes that intersect on the map:

- **Create junction**: Click on the intersection point between two pipes that do not have a shared node. QGISRed divides both pipes and creates a common node at the intersection.
- **Delete junction**: Click on a junction node that has exactly four connected pipes. QGISRed checks that those four pipes form two **collinear** pairs (two straight lines that intersect, within an angular tolerance); If the best possible match deviates further from the tolerance, it rejects the operation and displays the deviation angle instead of undoing a match that was not actually a match. If the check passes, remove the knot and replace the two original pipes that pass over it.

> This tool does not apply snapping to avoid false positives. The crossover detection tolerance uses the value configured in **Default Values**.

Move valves and pumps

Barra Edition → Move valves/pumps

Moves a valve or pump from one pipe to another maintaining all its properties (type, adjustment, curve...).

Process

1. Activate the tool. The cursor asks for the first click.
2. Click on the **source pipe** (the one containing the current valve/pump).
3. Click on the **destination pipe** (where the element will be inserted).
4. QGISRed removes the element from the original position, restores the original pipe, and inserts it into the new position.

Change element status

Edition bar → Change element status

Toggles the operating state (Open/Closed) of pipes and manual valves without opening the properties dialog.

- **Single click**: Toggle between Open and Closed.
- **Ctrl + Click**: Cycle through all available states: Open → Closed → CV (Check Valve) → Open.

The **Isolation Valves** layer can also be managed with this tool if it is loaded.

> The state is stored in the `InitStatus` field of the corresponding layer and exported to the `.inp` of EPANET.

Delete elements

Edition bar → Delete elements

Delete one or more elements from the project. It works in two ways:

1. **Over selection**: Select items with the multiple selection tool and press Delete. All selected items are removed.

2. **By click**: Without selection, activate the tool and click on the element to delete.

Behavior when deleting

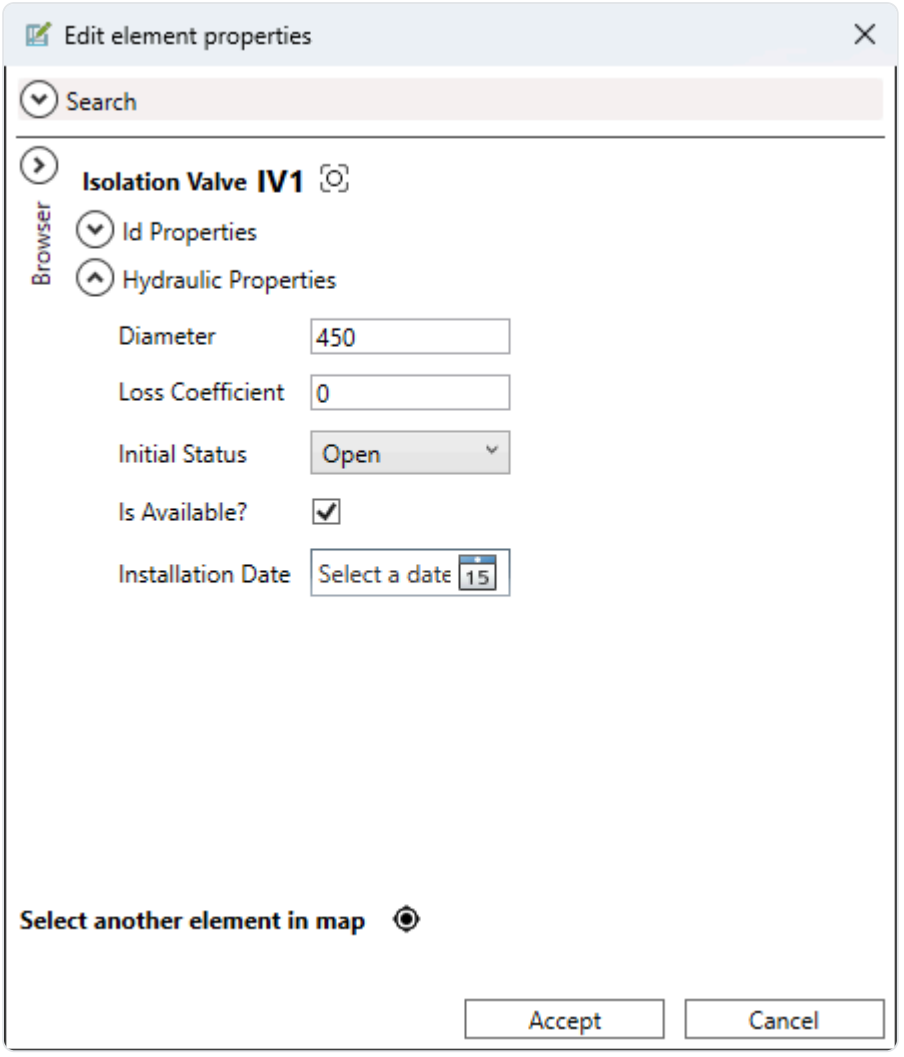
Situation	What happens
Delete a pipe	The pipe is removed. End nodes remain if they have other connections; They are eliminated if they become isolated.
Remove a node with connected pipes	All connected pipes are also removed.
Remove a valve or pump	The two sections of pipe into which it was divided are automatically merged into one.
Delete a Tank or Reservoir	The element is converted to a Junction or removed if it has no connections.

> Deletion cannot be undone with `Ctrl+Z`. QGISRed automatically saves the previous state of the project to the temporary folder before running the operation, but the only way to recover deleted data is to use a previous **backup**.

5.3 Element Properties

Edition bar → Edit element properties…

The properties dialog is the central tool for viewing and editing all attributes of any network element. It works as a smart form that loads the data of the clicked element and allows you to navigate between elements without closing it.



Properties dialog of a pipe with all its fields

Properties dialog: element attributes, connected elements navigator and centering button.

How to open the dialog

1. Activate the tool by pressing the **Edit element properties…** button (pencil/edit icon).
2. Click on any network element on the map: pipe, node, valve, pump, tank or reservoir.
3. The dialog opens showing all the attributes of the selected element.

> The tool remains active as long as the button is pressed. You can click on different elements without activating it again.

Pipe fields

Field	Description
ID	Unique pipe identifier
Length	Length automatically calculated from geometry (m or ft)
Diameter	Inner diameter (mm or inches)
Roughness Coeff	Roughness for the configured head loss formula
MinorLoss	Minor loss coefficient (0 if not applicable)
InitStatus	Initial status: Open, Closed or CV (Check Valve)
Material	Material code (referenced in the Materials Table)
InstallYear	Year of installation (`YYYY` format), used to calculate aging roughness
BulkCoeff	Bulk reaction coefficient (for Chemical type quality models)
WallCoeff	Wall reaction coefficient (for Chemical type quality models)

Node fields (Junctions)

Field	Description
ID	Unique node identifier
Elevation	Node elevation (m or ft)
Demand	Base demand (in project flow units)
Pattern	ID of the applied demand pattern
EmitterCoeff	Emitter coefficient (to model pressure-dependent leaks)
InitQuality	Initial water concentration or age (only if the quality model is active)

Multiple demands

The nodes can have more than one demand (user categories: residential, industrial, etc.). If the project has the optional layer `{Red}_MultipleDemands.shp`, the dialog shows an additional section where you can add, edit and delete demands by category:

Field	Description
Demand	Demand value for this category
Pattern	Category Specific Demand Pattern
Name	Category label (informational)

Tank fields

Field	Description
ID	Unique identifier
Elevation	Tank bottom level
InitLevel	Initial water level on the background
MinLevel	Minimum operating level
MaxLevel	Maximum operating level

Field	Description
Diameter	Tank diameter (0 if using volume curve)
MinVol	Minimum volume (m^3)
VolCurve	Volume curve ID (for non-cylindrical geometry)
MixModel	Mixing model: MIXED, 2COMP, FIFO, LIFO. Defaults to MIXED on a new tank
MixFraction	Fraction of the first compartment (only visible if MixModel = 2COMP)

> Both fields are only shown if the project has an active quality model (Chemical, Age or Trace); without a quality model, EPANET does not mix anything and the fields provide no information.

Reservoir fields

Field	Description
ID	Unique identifier
Head	Fixed piezometric head (m or ft)
Pattern	Load variation pattern over time

Valve fields

Field	Description
ID	Unique identifier
Diameter	Diameter (mm or inches)
Valve Type	Valve type: PRV, PSV, PBV, FCV, TCV, GPV

Field	Description
Setting	Regulation setpoint (pressure, flow or pressure loss depending on the type)
MinorLoss	Minor loss coefficient
InitStatus	Initial status: Open, Closed, Active

Pump fields

Field	Description
ID	Unique identifier
Curve	Pump H-Q Curve ID
Speed	Turning speed factor (1.0 = nominal)
Pattern	Speed variation pattern
Power	Constant power (alternative to H-Q curve)
EfficiencyCurve	Efficiency curve ID (for energy analysis)
EnergyPrice	Specific energy price for this pump
PricePattern	Energy price variation pattern
InitStatus	Initial status: Open or Closed

Navigation between elements

The dialog includes a **browser** (Browser) that allows:

- **Go to connected element**: lists the nodes and elements connected to the current element to jump to them. On a pipe/valve/pump, its two end nodes are listed; on a node, the links that reach it. In both cases, isolation valves, meters and service

connections are added, but only if their location matches the element (within the project's node tolerance) — being merely close by is not enough.
- **History**: Previous / Next buttons to return to previously visited items without closing the dialog.
- **Center on map**: button to move the map to the currently displayed element.

> When navigating to another element from the dialog, QGISRed saves the changes from the previous element before loading the new one. It is not necessary to click "Accept" explicitly after each modification.

QGISRed exclusive fields

These fields are not part of the EPANET standard but are used by the plugin:

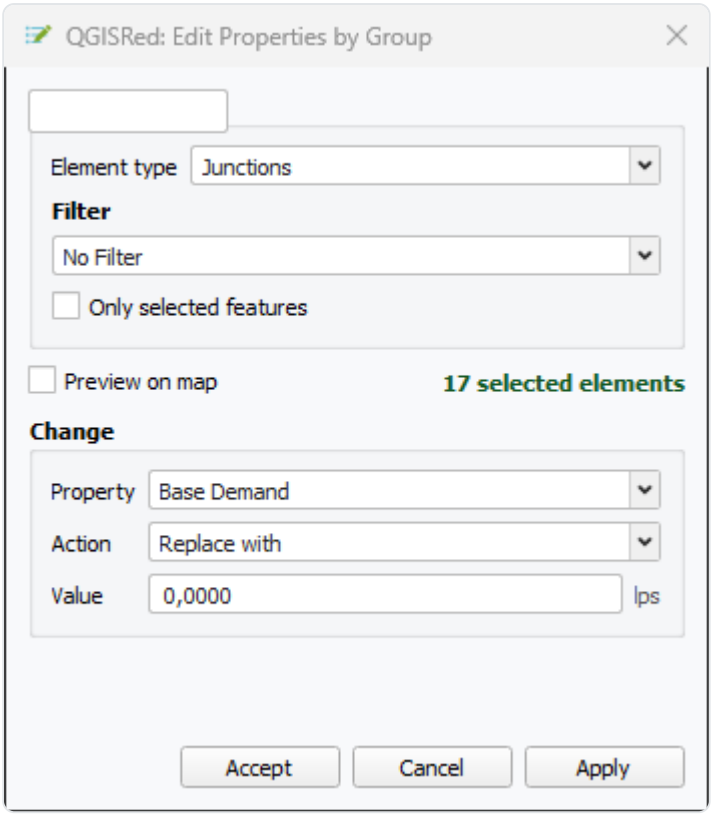
Field	Layer	Description
Material	Pipes	Material code referenced in the Materials Table
InstallYear	Pipes	Year of installation for calculation of roughness due to aging
IsActive	Various	Enable/disable the element in the Digital Twin
Tag	All	Free tag (equivalent to the EPANET TAG field)

5.4 Edit by Group

Edition bar → Edit properties by group…

The **Edit properties by group** tool allows you to modify an attribute of multiple network elements in bulk. Combine an optional filter with an edit action and apply the result to all elements that meet the condition, accumulating the changes in a QGIS edit buffer until the user commits or discards them.

The dialog is **modeless**: you can still interact with the map while it is open.



Edit properties by group dialog with configured filter and action

Edit dialog by group: filter by numeric field and Multiply by action on pipes.

Available item types

Element	Description
Junctions	Network nodes

Element	Description
Multiple Demands	Multiple demands by category
Pipes	Pipes
Tanks	Tanks
Reservoirs	Reservoirs
Pumps	Pumps
Valves	Valves
Sources	Quality sources
Service Connections	Service connections
Isolation Valves	Isolation valves
Meters	Flowmeters

> 🧪 **Chemical Quality Fields:** The BulkCoeff and WallCoeff (pipes) and ReactCoef and InitQuality (tanks, reservoirs, and nodes) fields only appear in the field selectors when the project's quality model is set to **Chemical**.

Select elements

The **Select Elements** section of the dialog groups the field filter, map preview, and scope.

Field filter

The field dropdown starts with the **No Filter** option. While that selection is held, the operator and value controls remain hidden and the action affects all elements of the chosen type.

When you select a specific field, the operator and value controls appear:

- The **operator** determines the type of comparison (see table below).

- The **value** is automatically filled with the unique values present in the layer. The list includes **NULL** as the first option:
- Operator `=` with NULL generates an **IS NULL** filter.
- Operator `≠` with NULL generates an **IS NOT NULL** filter.
- The value field has a **×** button to quickly delete it. Additionally, the field is **editable**: the user can enter a custom value that is not listed in the drop-down list.

Operators available by field type

Field type	Operators
Numeric	`>=`, `<=`, `=`, `>`, `<`, `≠`
List of values	`=`
Free text	`=`, `≠`, `ILIKE`, `NOT ILIKE`, `LIKE`, `NOT LIKE`
Date	`=` (calendar selector)

Preview on the map

The **Preview on map** checkbox highlights in **orange** the elements that meet the active filter, updating in real time when any filter parameter changes. Next to this checkbox is the **number of elements** that match the filter at that moment.

Selected items only

By checking **Only selected features**, the action affects only the elements that are selected on the map at the time you press **Apply**. The selection can be made before opening the dialog or while it is open.

Unchecked (default), the action is applied to all elements of the chosen type that meet the filter.

Edit action (“Do…” section)

Defines which attribute to modify and with what value or transformation.

Actions for numeric fields

Action	Formula
Replace with	`operando`
Multiply by	`valor_actual × operando`
Add	`valor_actual + operando`
Subtract	`valor_actual − operando`
Divide by	`valor_actual / operando`
Clamp minimum to	`max(valor_actual, operando)`
Clamp maximum to	`min(valor_actual, operando)`

Actions for text fields

Action	Result
Set to	Replaces the entire value
Prepend	Prepends the text to the current value
Append	Adds the text to the end of the current value
Find and replace	Search and replace (case sensitive)

Actions for enumerated fields

Just **Replace with**, selecting the new value from a list. The available options depend on the type of field:

Field	Options Source
`InitStatus`	Fixed EPANET list (Open, Closed, CV, Active…)
`Material`	Project Materials Table
`Curve`	Project curves filtered by type (pump, volume, efficiency, headloss)
`Pattern`	Project patterns filtered by type (demand, quality, head, speed, price)

Field	Options Source
`ValveType` (Valves only)	Fixed EPANET list (PRV, PSV, PBV, FCV, TCV, GPV), shown in the combo with its long descriptive name (e.g. "Pressure Reducing" for PRV)

Date fields

Set to action: The date is selected from the existing date combo on the layer or via the calendar button.

Dialog buttons

Button	Behavior
Apply	Displays a pre-commit dialog detailing the changes to be temporarily applied (item type, field, and number of items affected) and requests confirmation before writing to the QGIS edit buffer. It can be called multiple times to accumulate changes on different attributes. The modified elements are selected on the map and their attribute table is opened or reactivated.
Accept	It shows a simple confirmation and, after accepting, permanently saves all changes accumulated in the buffer to disk. Close the dialogue; the attribute tables remain open.
Cancel	Discards **all** the changes accumulated in the buffer (full rollback) and closes the dialog. Clears the selection on the map, but the attribute tables remain open.

> Changes are only written to disk when you press **Accept**. While working with **Apply**, the data is in the QGIS edit buffer and can be undone en masse with **Cancel** at any time.

Attribute table

After each **Apply**, the tool opens or reactivates the attribute table of the affected layer—whether it is docked or floating—without duplicating it. Modified elements appear ordered at the beginning. If multiple layers are edited in successive **Apply**, each table is managed independently.

When you press **Cancel** or **Accept**, the attribute tables remain open; only the selection on the map is cleared.

Automatic dialog update

When layers are added or removed while the dialog is open, it automatically updates and restores the previous element type, field, and filter selections. If the project is closed or a different project is loaded, the dialog closes automatically.

Usage examples

Change material to pipes of a specific diameter Element: Pipes — Filter: `Diameter = 200` — Do: `Material → Replace with → PVC`

Increase the roughness of cast iron pipes by 10% Filter: `Material = FD` — Do: `Roughness → Multiply by → 1.1`

Close all isolation valves Element: Isolation Valves — Filter: No Filter — Do: `InitStatus → Replace with → CLOSED`

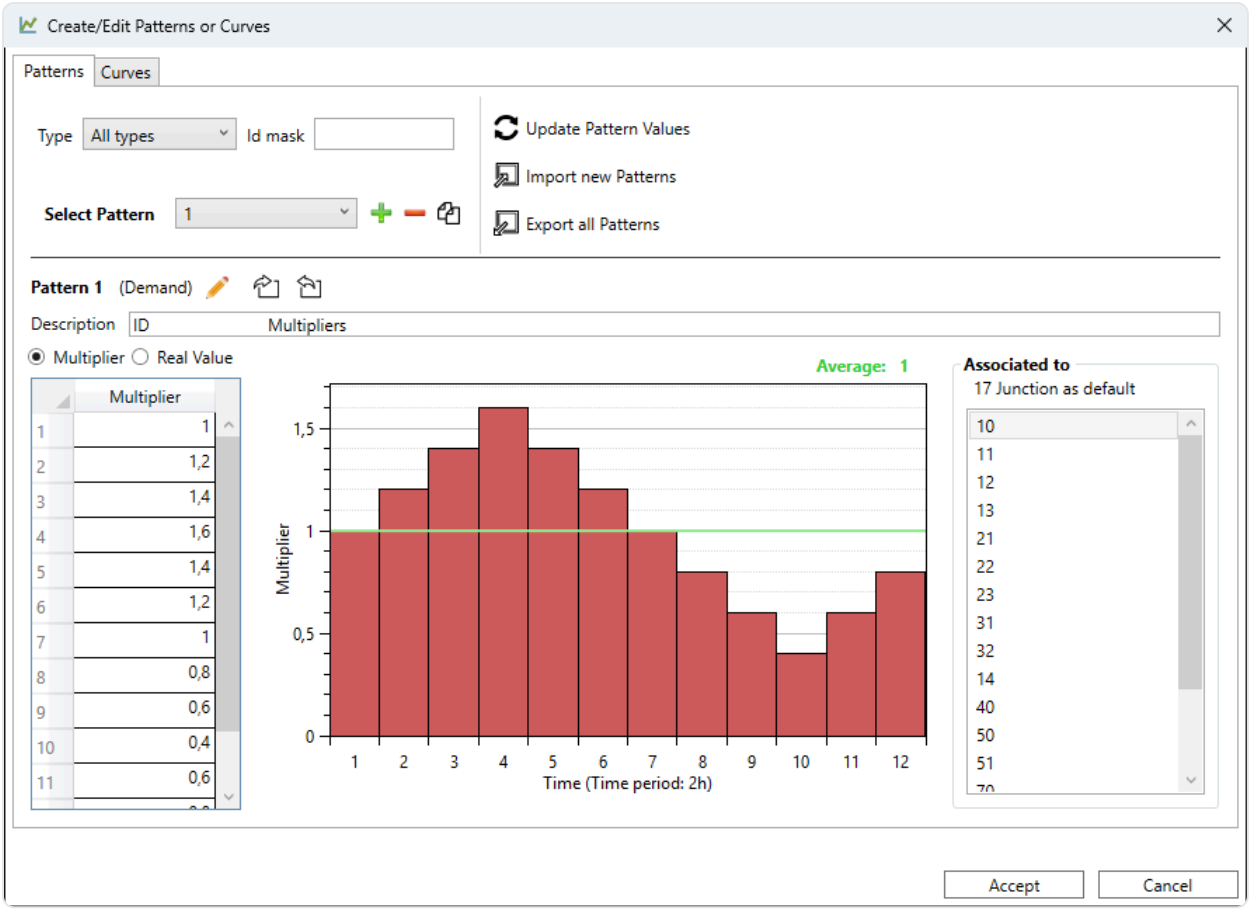
Assign pattern to a selected node set Check "Only selected features" — Element: Junctions — Do: `Pattern → Replace with → PAT_RESIDENCIAL`

Replace text in labels Element: Junctions — Do: `Tag → Find and replace → Buscar: "SEC" / Reemplazar: "ZN"`

5.5 Patterns and Curves

Edition bar → Edit patterns and curves…

The patterns and curves editor centralizes the management of temporal and functional data that control the dynamic behavior of the model: how demand varies throughout the day, how a pump behaves according to its flow rate, or what is the volume of an irregular tank.



QGISRed Pattern and Curve Editor

Pattern and curve editor: list of elements on the left, graph and data table on the right.

Demand Patterns

A pattern defines how you multiply a node's base demand (or other parameter) at each simulation time interval.

Structure of a pattern

Each pattern has:

- A unique **ID** (referenced from the nodes or pumps).
- A list of **multiplier factors**, one per time interval.
- The **time step of the pattern** is defined in the simulation options; If the pattern has fewer factors than simulation intervals, the values are repeated cyclically.

Example

A pattern of 24 time factors for a 24-h simulation:

```
ID: DomResidential
Factores: 0.4  0.3  0.3  0.3  0.4  0.7  1.1  1.3  1.2  1.0  0.9  0.9
          1.0  1.1  1.0  0.9  1.0  1.2  1.3  1.2  1.0  0.8  0.6  0.4
```

The node with base demand 2.0 L/s and pattern `DomResidential` consumes 0.8 L/s at 0 h (2.0 × 0.4) and 2.6 L/s at 7 h (2.0 × 1.3).

Editing in dialog

1. Select an existing pattern from the list or press **New** to create one.
2. Enter the factors in the table (one row per interval).
3. The graph updates in real time.
4. You can **import factors from CSV** (a column of numeric values) using the import button.

Behavior curves

The curves relate two physical quantities. EPANET uses four types:

Pump H-Q curve

It relates the **Manometric Height** (Head, Y axis) to the **Flow** (Flow, X axis). Defines the working point of the pump at nominal speed.

Number of points	Adjustment method
1 point	QGISRed fits the EPANET standard curve: H_0 = 133% of point, given Q_0, Hmax = 0 to 2×Q_0
3 points	Second degree polynomial fit passing through the three points
N points	Linear interpolation between points (free curve)

> The H-Q curve must have **negative slope** (higher head at lower flow). EPANET will warn if the curve has a positive slope in any section.

Efficiency curve

Relates **Efficiency** (%) to **Flow** (Flow). It is used for energy consumption analysis. If not defined, EPANET uses the overall project efficiency.

Volume curve

Relates the **Level** of the tank (m or ft, X axis) to the **Volume** stored (m^3 or gallons, Y axis). Necessary for tanks with non-cylindrical geometry (conical basins, irregularly shaped tanks).

GPV head loss curve

For **GPV** (General Purpose Valve) type valves, relate the **Head loss** (m or ft) to the **Flow** (Flow). It allows modeling any hydraulic control device for which the characteristic curve is known.

Create and edit curves

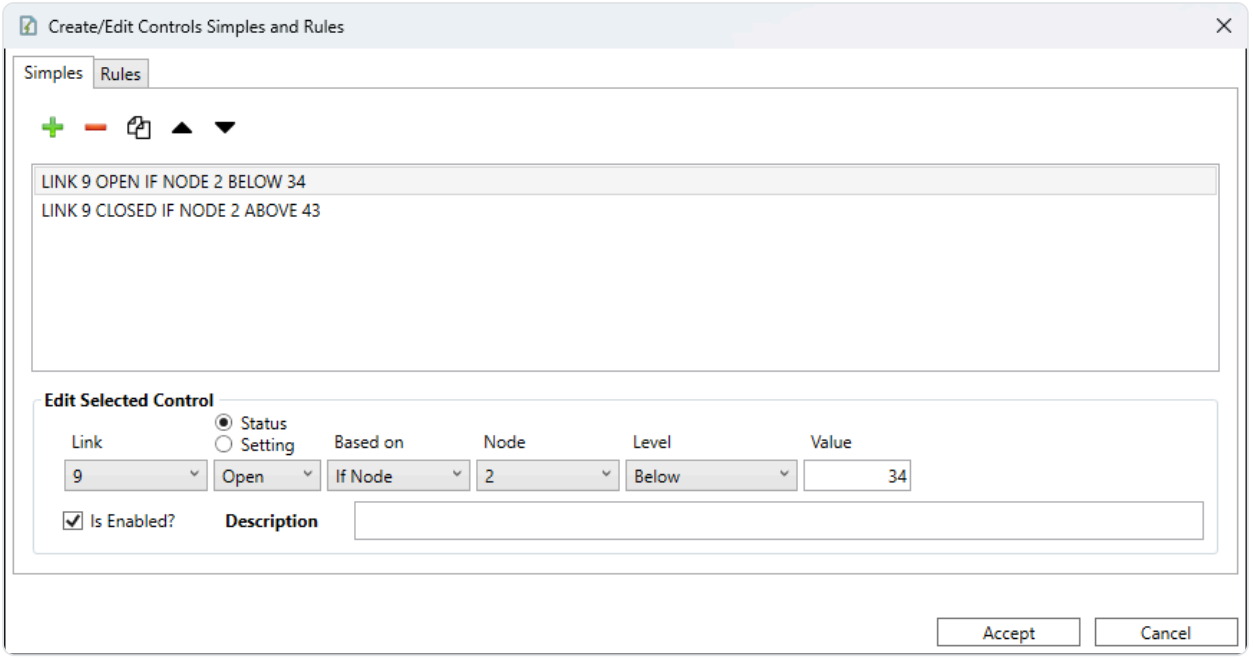
1. Select the type of curve in the upper selector.
2. Choose an existing curve from the list or press **New**.
3. Enter the pairs of points (X, Y) in the table.
4. The graph shows the resulting curve with the corresponding interpolation or adjustment.
5. Press **OK** to save. The curves are stored in `{Red}_Options.dbf`.

> To reference a curve from a pump or tank, copy its exact **ID** into the corresponding field of the element properties dialog.

5.6 Controls and Rules

Edition bar → Edit controls…

The controls editor defines the **operating logic** of the network: when a valve opens, when a pump starts, or what sequence of actions triggers a certain system state. EPANET supports two levels of control with different complexity.



QGISRed Rules and Controls Editor

Controls editor: Simple Controls and Rules tabs, element and condition selector.

Simple Controls

A simple control defines a **single action** that is executed when a **single condition** is met. They are sufficient for most basic automations.

Structure

```
IF [elemento] [condición]  THEN [acción]
```

Condition Types

Type	Usage example
Tank level	If the level of Tank T-1 exceeds 4.5 m → close pump BM-1
Node pressure	If the pressure in J-120 drops below 10 m → open valve V-3
Simulation time	At 6 hours of simulation → turn on pump BM-2
Clock	At 23:00 (clock time) → close pipe P-55

Available actions

Action	Applies to
OPEN	Pipes, valves, pumps
CLOSED	Pipes, valves, pumps
Setting = value	Valves (changes the regulation setpoint)
Speed = value	Pumps (changes relative speed)

Complete example

```
; Start pump when tank is low
IF TANK T-DEPOSITO1 LEVEL BELOW 1.5
THEN PUMP BM-ELEVADORA OPEN

; Stop pump when tank is full
IF TANK T-DEPOSITO1 LEVEL ABOVE 4.0
THEN PUMP BM-ELEVADORA CLOSED

; Turn on booster pump during peak hour
IF CLOCKTIME 7:00 AM
THEN PUMP BM-REFUERZO OPEN

IF CLOCKTIME 10:00 AM
THEN PUMP BM-REFUERZO CLOSED
```

Operating rules

The rules allow you to combine **multiple conditions** with logical operators, as well as define alternative actions and priorities. They are equivalent to the `[RULES]` of the EPANET file `.inp`.

General structure

```
RULE [ID]
IF   [condición 1]
AND  [condición 2]          (opcional)
OR   [condición alternativa] (opcional)
THEN [acción principal]
ELSE [acción alternativa]   (opcional)
PRIORITY [número]           (opcional)
```

Logical operators

Operator	Usage
AND	All conditions must be met simultaneously
OR	It is enough that any of the conditions is met

PRIORITY

When two rules with conflicting conditions are activated at the same time, the one with the **higher priority number** wins. The default value is 0.

Complete example

```
RULE R-01
IF   TANK T-DEP1 LEVEL BELOW 2.0
AND  PUMP BM-ELEV STATUS = CLOSED
THEN PUMP BM-ELEV OPEN
PRIORITY 2

RULE R-02
```

```
IF   NODE J-SALIDARED PRESSURE BELOW 8.0
OR   TANK T-DEP1 LEVEL BELOW 1.0
THEN PUMP BM-REFUERZO OPEN
ELSE PUMP BM-REFUERZO CLOSED
PRIORITY 1
```

Editing in QGISRed

The QGISRed dialog presents the rules in directly editable text format, equivalent to the `[CONTROLS]` and `[RULES]` section of the `.inp` file. You can:

- **Write** controls and rules directly in the text area.
- **Activate or deactivate** a rule by putting a `;` at the beginning (converts the line into a comment).
- **Check syntax** with the validation button before saving.

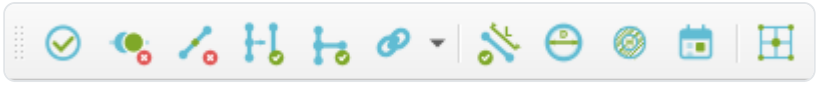
> The controls are exported exactly as they appear when generating the `.inp` from the Tools bar. If the syntax is incorrect, EPANET will reject the file in simulation.

Modeling Tips

- For a system with a pump and tank, always define **two controls per pump**: one to start (low level) and one to stop (high level). Without the stop control, the pump runs indefinitely.
- Simple controls are processed **before** rules at each time step. If you have a simple control and a rule that act on the same element, the result can be contradictory.
- The order of simple controls **does not matter**; neither does that of the rules, because priority orders them. But if two rules have the same priority and contradictory conditions, the result is indeterminate.
- Avoid creating control loops (rule A activates B, rule B deactivates A in the same time step): EPANET may not converge.

6 ✅ Debug

The **Debug** bar groups together the model verification and debugging tools. Its objective is to detect and correct topological errors, attribute inconsistencies and connectivity problems **before launching the simulation**, thus avoiding errors that are difficult to diagnose in EPANET.



QGISRed Debug Toolbar

Debug bar: data validation, topological debugging, review of attributes and hydraulic sectors.

Debug Bar Tools

Group 1 — Topology and coherence

#	Tool	Function
1	**Check && commit data**	Validates all model data and flags elements with errors
2	**Remove overlapping elements**	Detect and remove duplicate nodes or pipes in the same position
3	**Simplify link vertices**	Eliminates intermediate vertices aligned in straight sections
4	**Join consecutive pipes**	Merge adjacent pipes with identical diameter, material and year
5	**Create T connections**	Detects end nodes on pipes and creates the topological join
6	**Check connectivity**	Identifies areas isolated from supply sources
—	*Delete isolated subzones*	(Sub-option) Eliminates subzones with fewer pipes than the defined threshold

Group 2 — Attribute verification

#	Tool	Function
7	**Check pipe lengths**	Compare attribute lengths vs. geometry and points out differences
8	**Check diameters**	Detects diameters outside the usual range of the project
9	**Check pipe materials**	Detects undefined materials in the project's materials table
10	**Check pipe installation dates**	Detect incorrectly formatted or inconsistent installation dates

Group 3 — Hydraulic sectors

#	Tool	Function
11	**Check hydraulic sectors**	Classifies the areas of the network according to their supply capacity (types A–D)

In this section

- Topology and connectivity — commit, overlapping, simplification, join, T-connections, connectivity
- Attribute verification — lengths, diameters, materials, installation dates
- Hydraulic sectors — classification of sectors type A, B, C and D

6.1 Topology and Connectivity

The tools in the first group of the Debug bar detect and correct the most common structural errors: duplicate elements, unnecessary vertices, fragmented pipes and disconnected areas. It is advisable to run them in the order they appear on the bar before simulating for the first time.

Check && commit data

Debug bar → Check && commit data

It is the main validation tool. It goes through all the elements of the project, checks the consistency of the data (dimensions, diameters, duplicate IDs, references to non-existent curves and patterns, etc.) and **consolidates pending changes**.

What is valid

- Duplicate IDs on any layer.
- Pipes without valid end nodes (broken connectivity).
- References to curves or patterns that do not exist in the project.
- Empty mandatory values (null diameter, empty dimension...).
- Internal consistency of file `_Options.dbf`.

Result

- If everything is valid: message *"Input data is valid"* in green.
- If there are errors: list of problems with the ID and type of the affected element. Items with errors are automatically selected on the map to make them easier to locate.

> Run **Check && commit data** whenever you have edited the attribute table manually (outside of the properties dialog), since those changes do not go through the plugin's automatic validation.

Remove overlapping elements

Debug bar → Remove overlapping elements

Detects elements that share exactly the same geographic position: nodes on nodes, pipes on pipes, or nodes on the end of another layer.

When duplicates appear

- When importing from a `.inp` with rounded coordinates.
- When combining data from different GIS sources.
- When copy-pasting elements without checking overlap.

Operation

The tool operates on the current selection or on the entire network if there is no selection. Eliminates the duplicate element, keeping the one with the most connections or, in case of a tie, the one with the lowest ID. The attributes of the removed element are discarded.

> Run this tool **before Create T connections** and **before Check connectivity** to avoid false connectivity positives caused by duplicate nodes.

Simplify link vertices

Debug bar → Simplify link vertices

Removes intermediate vertices that are aligned (within an angular tolerance threshold) with adjacent segments. These vertices do not provide geometric information but increase the size of the SHP and slow down the rendering.

When is it useful

- After importing from AutoCAD or municipal GIS where the lines have vertices every few centimeters.
- After using external smoothing tools that add unnecessary points.

What preserves

Vertices at actual break points (change of direction) are not removed. Only those that fall on the extension of the anterior segment, within the internal tolerance angle of the plugin, are eliminated.

Join consecutive pipes

Debug bar → Join consecutive pipes (= diameter, material and year)

Merge adjacent pipes when they share **all three attributes**: diameter, material and year of installation. The intermediate node is removed if it is not in demand or connected to other layers.

Result

Pipes that were previously fragmented (by import from GIS, by previous divisions or by incremental design) are merged into a single section. This:

- Reduces the number of elements in the model.
- Simplifies the attribute table.
- Improves simulation performance.

> If the intermediate node has non-zero assigned demand, the pipeline is **not** merged. QGISRed preserves the node so as not to lose consumption data.

Create T connections

Debug bar → Create T connections

Automatically detects situations where the end of a pipe (or a demand node) falls on the route of another pipe, without being connected to it. In those cases, the plugin splits the pipe and creates the joining node.

Problem it solves

When digitizing networks by hand, it is common for a branch to be left "floating" above the main without connecting topologically. Visually it seems correct, but in the simulation that branch has no real connection. This tool detects and fixes it automatically.

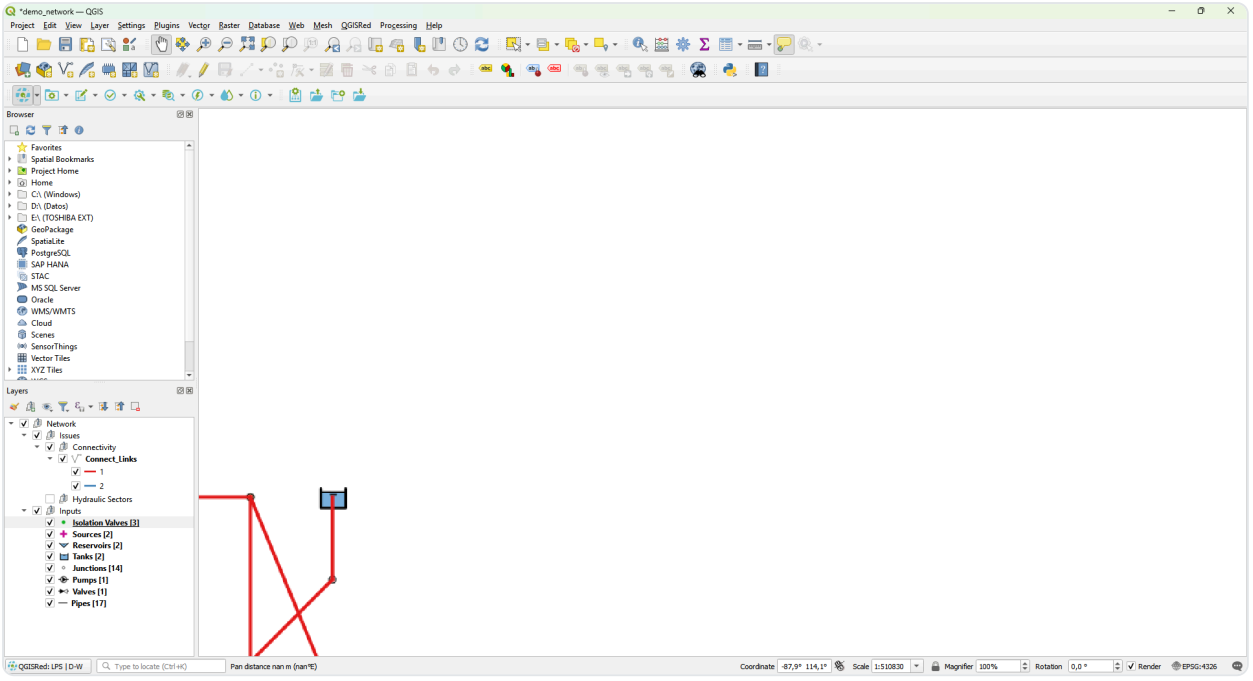
Tolerance

Uses the node tolerance configured in **Project Bar → Default Values**. If the end of the pipe is less than that distance from the axis of another pipe, it is considered a tee to solve.

Check connectivity

Debug bar → Check connectivity *(with Delete isolated subzones sub-option)*

Analyzes the connectivity of the entire network from the supply sources (Reservoirs and Tanks). Identify which pipes and nodes are **not connected** to any source.



Check connectivity result: isolated areas colored in red on the map

Isolated areas identified: in red the elements without connection to any source.

Option 1: Check connectivity (display only)

Color the elements according to their connectivity zone. Items not connected to any source are highlighted. It does not modify the network.

Option 2: Delete isolated subzones

Opens a dialog that asks for the **maximum number of pipes** in a subzone to delete. Subzones with that number of pipes or less are automatically deleted. The largest ones are preserved even if they are isolated (they may be valid sectors not yet connected).

This threshold is useful for cleaning up topological "junk" — fragments of 1-3 pipes left loose after an import.

> Always run **Remove overlapping elements** before **Check connectivity** to prevent duplicate nodes from generating false isolations.

6.2 Attribute Check

The four tools in the second group of the Debug bar audit the **alphanumeric data** of the pipes to detect transcription errors, inconsistent values or empty fields that would prevent a correct simulation or the calculation of aging roughness.

They all operate on the current selection or on the entire network if there is no previous selection.

Check pipe lengths

Debug bar → Check pipe lengths

Compares the **length stored in the** `Length` attribute of each pipe with the **actual geometric length** calculated from the SHP vertices.

Tolerance Dialogue

When you activate the tool, a dialog opens where you define:

Field	Description
Tolerance (%)	Maximum acceptable percentage difference between attribute length and geometric length
Update lengths	If checked, replaces the attribute value with the geometric length on all pipes that exceed the tolerance

When differences appear

- Pipes imported from a `.inp` where `Length` was calculated with a different scale.
- Pipes whose geometry was modified (moved vertices) without updating the attribute.
- Networks in projected CRS vs. geographic: if the coordinates of `.inp` are in degrees and used as meters, the longitudes are incorrect.

> QGISRed calculates the geometric length always in the CRS units of the project. If the project uses geographic coordinates (degrees), the longitudes will be incorrect.

> Always use a projected metric CRS.

Check diameters

Debug bar → Check diameters

Review the diameters of all selected pipes (or the entire network) and point out those that are outside the usual range or are zero.

What it detects

- Pipes with **zero or negative** diameter (import error or manual editing).
- Pipes with diameters that are statistically atypical compared to the rest of the model (extremely high or low values).
- Pipes without assigned diameter (empty field).

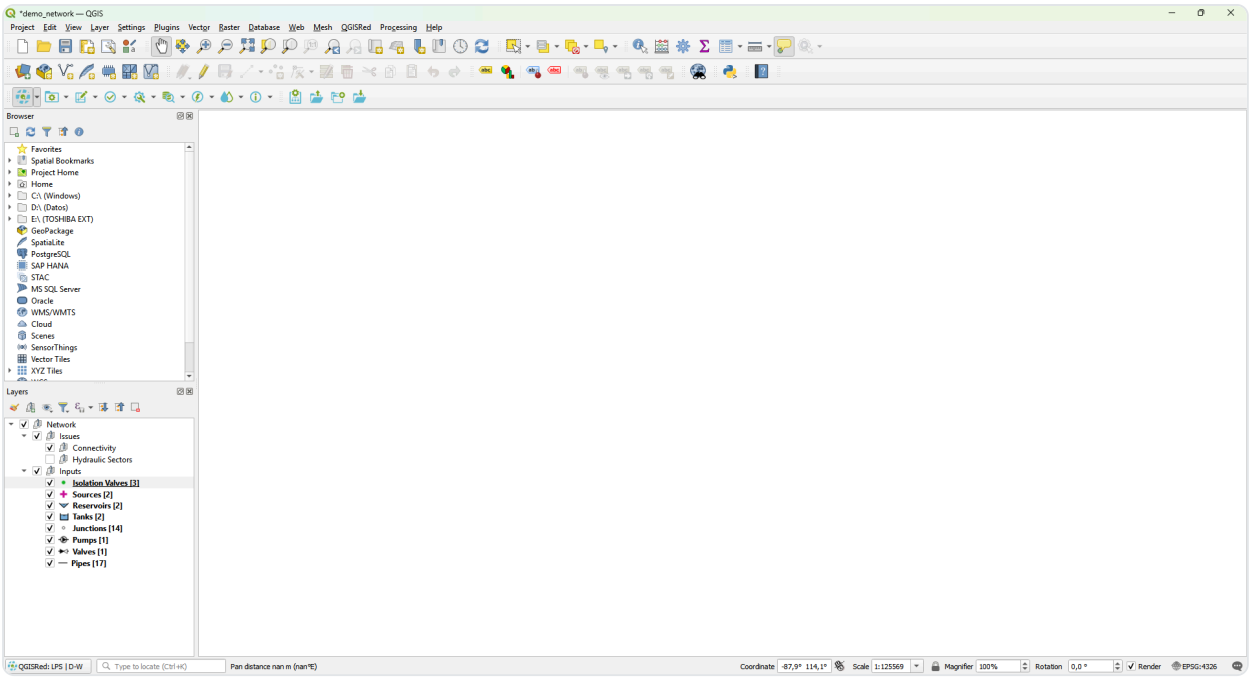
Result

Features with problematic diameters are selected on the map and a summary is displayed in the message panel. It does not automatically modify any values: the correction must be done manually from the properties dialog or attribute table.

Check pipe materials

Debug bar → Check pipe materials

Check that the value of the `Material` field of each pipe is defined in the **Project Materials Table** (Project Bar → Materials Table).



Check pipe materials result: pipes with invalid material selected on the map

It does not display any dialog of its own: it selects directly on the map the items with problems and summarizes the result in the QGIS message pane.

What it detects

- Pipes with empty or no material.
- Pipes with a material code that does not exist in the project table (for example, a code inherited from another GIS system).
- Pipes with the value `UNKNOWN` (default value when the material is not known).

Why it is important

The material is essential for the **Assign Roughnesses** tool (Tools Bar), which calculates the aging roughness based on the material and the installation date. If the material is invalid, the roughness cannot be calculated.

Check pipe installation dates

Debug bar → Check pipe installation dates

Checks the pipes `InstallYear` field, which stores the year of installation in numerical format (`YYYY`).

What it detects

Problem	Description
Empty date	Field `InstallYear` null or zero
Future date	Year greater than current year
Incorrect format	Non-numeric values or values outside reasonable range (before 1800 or after current year)

Why it is important

The installation date, combined with the material, allows the **current roughness** of each pipe to be calculated using the aging formula:

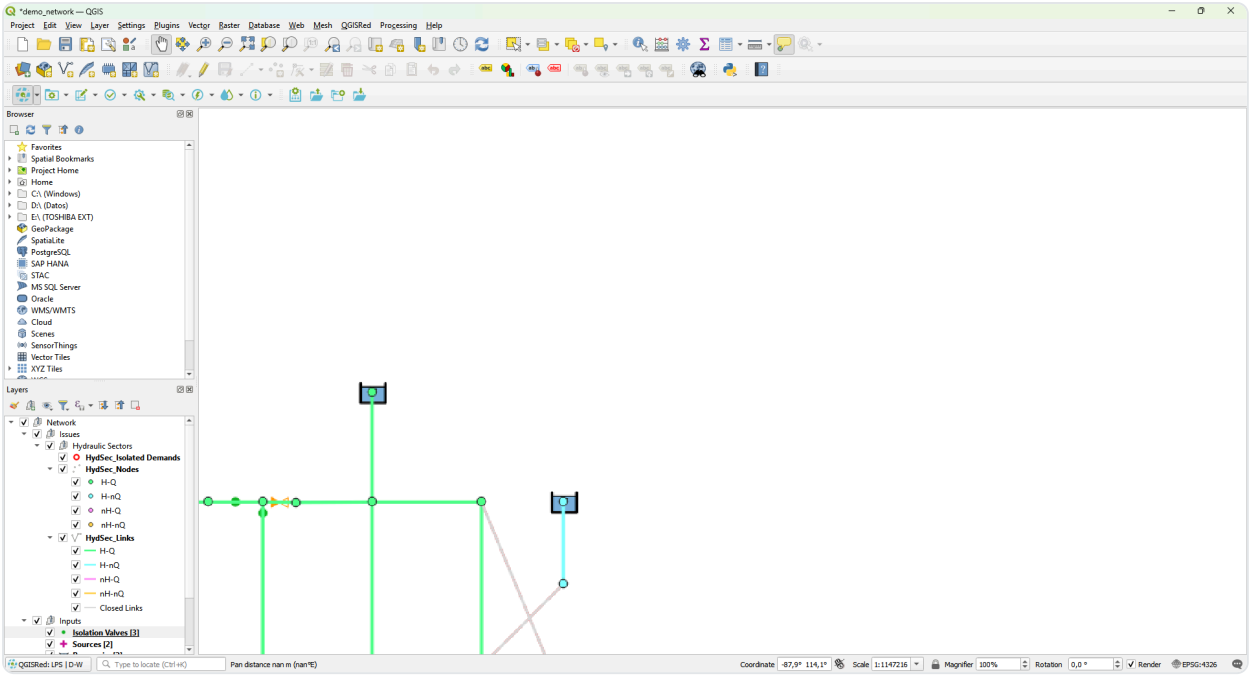
```
Rugosidad = Rugosidad_inicial + (Año_actual − InstallYear) × Incremento
```

If the date is incorrect, the calculated roughness will be wrong and the hydraulic simulation will produce results that are far from reality.

6.3 Hydraulic Sectors

Debug bar → Check hydraulic sectors

The hydraulic sectors tool scans the network using a BFS (breadth-first search) algorithm from all supply sources and classifies each connected subnetwork according to whether or not it has a hydraulic source (H) and whether or not it has demand (Q). The result is dumped into SHP layers and into a CSV report.



Map of hydraulic sectors: areas colored by type H-Q, H-nQ, nH-Q and nH-nQ

Hydraulic sectors: each color represents a type of classification. Sectors nH-Q (no source with demand) appear in red.

Sector classification

The tool assigns each sector one of these four types. These are the **actual tags** that appear in the SHP layer and in the CSV report:

Tag	Source (H)	Demand (Q)	Meaning
H-Q	✅ Yes	✅ Yes	Functional sector: has a supply source and nodes with demand. It can be simulated correctly.

Tag	Source (H)	Demand (Q)	Meaning
H-nQ	✅ Yes	❌ No	Latent sector: has a source but no nodes with demand > 0. It can be simulated but without real flow.
nH-Q	❌ No	✅ Yes	**Critical sector**: nodes with demand but without any connected source. EPANET will not converge.
nH-nQ	❌ No	❌ No	Passive sector: neither source nor demand. It does not cause an error in the simulation but it is disconnected.

> **H** = presence of at least one Tank or Reservoir in the sector. **Q** = presence of at least one Junction with base demand > 0. **n** = negation (absence of that condition).

There is also a special pseudo-sector called **ClosedLinks** that groups pipes with status `Closed` that are outside any connected sector. It does not count in the total number of sectors in the report.

Outputs generated

The tool produces three outputs that are automatically added to the project:

Output	Type	Content
`HydraulicSectors`	SHP layer	Geometry of all elements colored by sector type
`HydraulicSectors_IsolatedDemands`	SHP layer	Nodes and connections of the **nH-Q** type with their isolated demand
`{Red}_HydraulicSectors_Report.csv`	CSV	Table with sector ID, number of elements and classification

The CSV has the format:

```
SectorID; NumElements; Classification
S1; 1 243; H-Q
S2; 47; H-nQ
S3; 12; nH-Q
S4; 3; nH-nQ
```

How to interpret each type

H-Q — Functional

Correct status. Every sector that is going to be simulated must be H-Q. A properly constructed network will have a single large H-Q sector (or several if there is actual hydraulic sectoring with closed valves between them).

H-nQ — Latent

There is a connected source but all nodes in that sector have demand = 0. Common causes:

- Imported network zone with no demand data assigned yet.
- Bypass or reserve branch without consumers (may be correct by design).

In the first case, demands must be assigned before the simulation is realistic.

nH-Q — Critical (the most important to correct)

It is the only type that prevents simulation. There are nodes with demand that do not have any path to a Tank or Reservoir.

Frequent causes:

- There is a missing pipe that should link this sector with the main network.
- There is a closed valve between this sector and the source (operationally correct, but it must be modeled this way on purpose).
- Topological error: The connecting pipe exists visually but there is a connectivity break — detected with **Check connectivity**.

The `HydraulicSectors_IsolatedDemands` layer shows exactly which nodes and connections have demand without a source, making it easier to locate the problem.

nH-nQ — Passive

Disconnected fragments without consumption. They are usually imported remains or incomplete project branches. They do not cause simulation error, but they dirty the model. If they are not part of the layout, delete them with **Delete elements** or the **Delete isolated subzones** option of **Check connectivity**.

Recommended Workflow

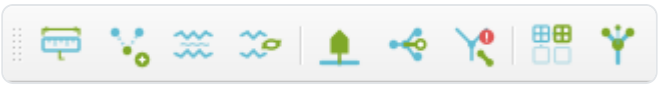
Before simulating for the first time, or after importing a new network:

1. **Check && commit data** — ensures that the basic topology and attributes are consistent.
2. **Remove overlapping elements** — eliminates nodes and duplicate pipes that could generate artificial sectors.
3. **Check connectivity** — identifies isolated zones visually and, if there is topological "junk", uses **Delete isolated subzones**.
4. **Check hydraulic sectors** — get the full ranking. Write down how many nH-Q sectors there are.
5. **Correct nH-Q sectors** — add pipes or correct topological errors until they disappear.
6. Rerun **Check hydraulic sectors** — confirm that all sectors are H-Q, H-nQ, or nH-nQ (no nH-Q).

> Only when there are no **nH-Q** sectors can the EPANET simulation run without convergence errors.

7 🔧 Tools

The **Tools** bar groups the massive processing tools: automatic calculation of hydraulic properties, assignment of demands from external sources, scenario management and topological analysis. Unlike the Edition tools, these act on the entire network or on large selections, not element by element.



QGISRed Tools toolbar

Tools bar: hydraulic properties, demands and scenarios, topological analysis.

Tools from the Tools bar

Group 1 — Hydraulic properties

#	Tool	Function
1	**Automatically calculate pipe lengths**	Recalculate the length of each pipe from its geometry
2	**Interpolate elevation from .asc files…**	Assign heights to nodes by interpolating from an MDT in ASC format
3	**Set roughness coefficients (from Material and Date)**	Calculate the current roughness of each pipe due to aging
4	**Convert roughness coefficients…**	Convert roughness between H-W, D-W and C-M formulas

Group 2 — Demands and scenarios

#	Tool	Function
5	**Nodal demand builder…**	Assign demands to nodes from external SHP layers (points or polygons)
6	**Scenario builder…**	Export and import model parameters in bulk to manage scenarios
7	**Isolated segments…**	Identify which valves to close to isolate a section and which areas are left without service

Group 3 — Topological analysis

#	Tool	Function
8	**Obtain demand sectors**	Generates demand sectors delimited by flowmeters
9	**Minimum Cost Tree…**	Calculate the minimum cost tree from a selected node

---

In this section

- Hydraulic properties — lengths, elevations, aging roughness and conversion between formulas
- Demands and scenarios — mass assignment of demands, management of scenarios and isolated segments
- Demand sectors and tree — sectorization by flowmeters and minimum cost tree

7.1 Hydraulic Properties

The first four tools in the Tools bar calculate or update hydraulic properties of pipes and nodes in bulk: length, elevation and roughness. They work on the current selection or on the entire network if there is no selection.

Automatically calculate pipe lengths

Tools bar → Automatically calculate pipe lengths

Recalculates the `Length` field of each pipe using the actual geometric length measured over the SHP vertices in the project's CRS units.

When to use it

- After moving vertices or nodes with the Edition tools without having updated the attribute.
- After importing from a `.inp` whose lengths differ from the real geometry (coordinates on a different scale or different projection).
- As a previous step to **Check pipe lengths** (Debug Bar) to leave all values synchronized before the audit.

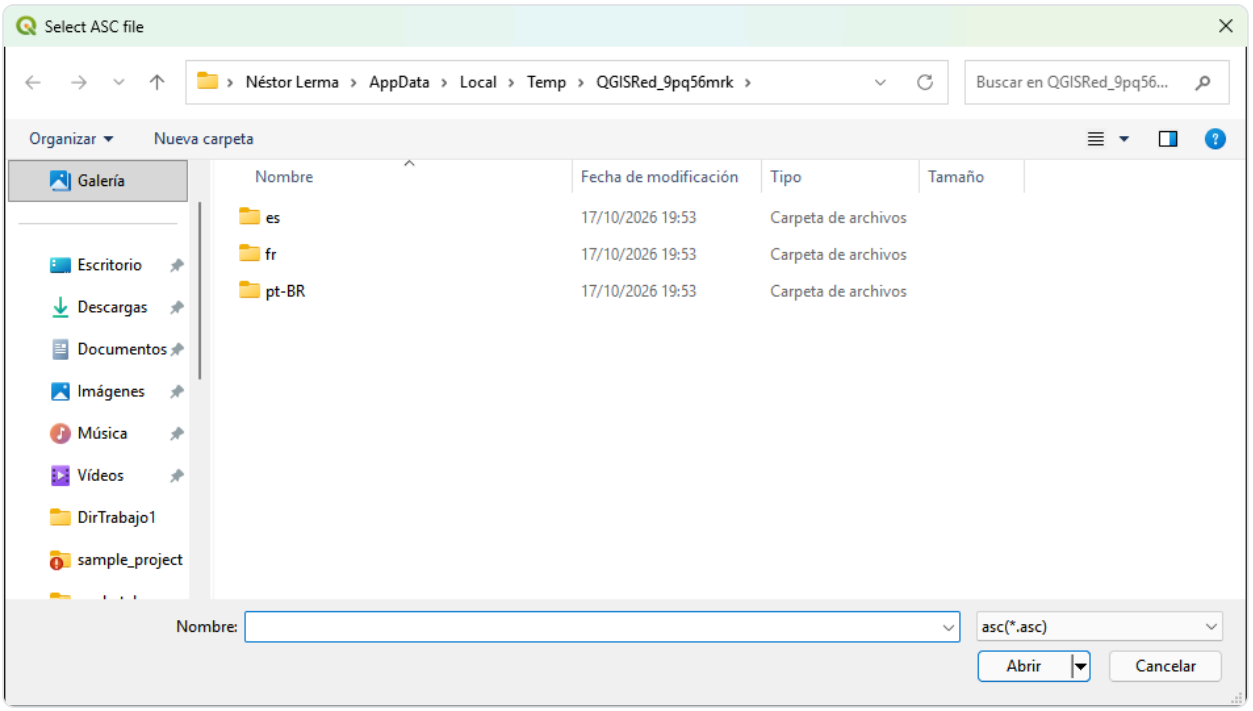
The tool overwrites the value of `Length` unconditionally on all pipes in the selection scope. It does not ask for confirmation or filter for tolerance.

> Always use a projected metric CRS (UTM, LCC, etc.). If the project uses geographic coordinates (decimal degrees), the calculated length will be in degrees, not meters, and will be useless for the simulation.

Interpolate elevation from .asc files…

Tools Bar → Interpolate elevation from .asc files…

Assigns the elevation (field `Elevation`) to the nodes, tanks and reservoirs of the project by interpolating their value from one or more Digital Terrain Models (DTM) in ASC format.



ASC file selector for elevation interpolation

MDT File Selector: You can upload multiple ASC files to cover the entire network area.

ASC format supported

```
ncols         500
nrows         400
xllcenter     450000.0
yllcenter     4400000.0
cellsize      5.0
nodata_value  -9999
230.4 231.1 231.8 ...
```

Header	Meaning
`ncols` / `nrows`	Number of columns and rows in the mesh
`xllcenter` / `yllcenter`	Coordinates of the center of the bottom-left cell (`xllcorner` / `yllcorner` is also accepted)
`cellsize`	Cell size in CRS units
`nodata_value`	Value that the plugin ignores (cell without data)

Assignment process

1. Open the selector and choose one or more `.asc` files. You can combine multiple MDTs to cover the entire network area.
2. QGISRed projects the coordinate of each node onto the mesh and obtains the elevation by bilinear interpolation between the four neighboring cells.
3. Only nodes whose current `Elevation` is equal to the default value (typically 0) are updated. Nodes with an elevation already assigned manually are not modified.
4. Nodes that fall outside the range of all loaded MDTs are marked as an incident on the message board.

> The CRS of the ASC file must match the CRS of the project. If they do not match, the coordinates are not projected and the nodes will be outside the mesh.

Set roughness coefficients (from Material and Date)

Tools bar → Set roughness coefficients (from Material and Date)

Calculates and assigns the current roughness coefficient of each pipe based on its material, its year of installation and the parameters of the project's **Materials Table**.

Calculation formula

```
Rugosidad_actual = Rugosidad_inicial + (Año_actual − InstallYear) × Inc
```

Where `Rugosidad_inicial` and `Incremento_anual` are obtained from the Material Table row that matches the `Material` field of the pipe.

Prerequisites

Before using this tool, verify with the Debug Bar that:

1. All pipes have a valid `Material` (**Check pipe materials**).
2. All pipes have a correct `InstallYear` (**Check pipe installation dates**).

If any of these fields are empty or invalid for a pipe, its roughness is not updated and is recorded as an issue.

Roughness is written in the units of the active project formula:

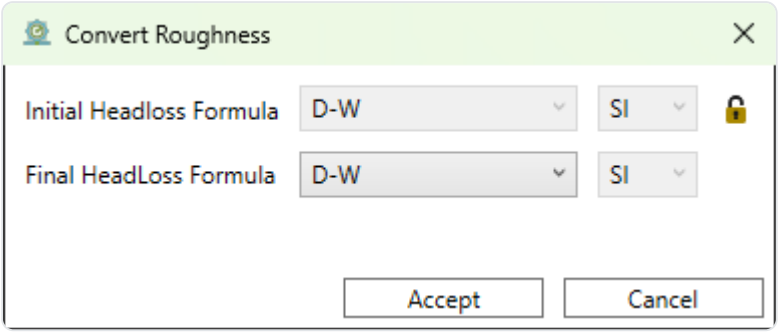
Formula	Roughness unit
Darcy-Weisbach (D-W)	mm (absolute wall roughness)
Hazen-Williams (H-W)	Dimensionless C coefficient (typical 100–150)
Chezy-Manning (C-M)	Coefficient n (typical 0.010–0.020)

> The Material Table stores the initial roughness in D-W units (mm). If the project uses H-W or C-M, the calculated value is automatically converted to the active system.

Convert roughness coefficients…

Tools bar → Convert roughness coefficients…

Converts the values of the `Roughness` field of all pipes between the three pressure loss formulas. It is necessary when you change the hydraulic formula of the project and want the existing values to maintain their physical meaning.



Roughness Conversion Dialogue Between Formulas

Available conversions

Origin	Destination
Hazen-Williams (H-W)	Darcy-Weisbach (D-W)

Origin	Destination
Darcy-Weisbach (D-W)	Hazen-Williams (H-W)
Chezy-Manning (C-M)	Darcy-Weisbach (D-W)
Darcy-Weisbach (D-W)	Chezy-Manning (C-M)

When changing the hydraulic formula in **Project Options**, QGISRed detects the change and offers to run this tool automatically. If you reject at that time, you can launch it manually from here.

> The D-W ↔ H-W conversion uses the diameter and a reference flow rate to find the C that produces the same loss as the D-W roughness at that flow rate. The result may differ from a direct calibration because the three formulas are not mathematically equivalent for all flow regimes.

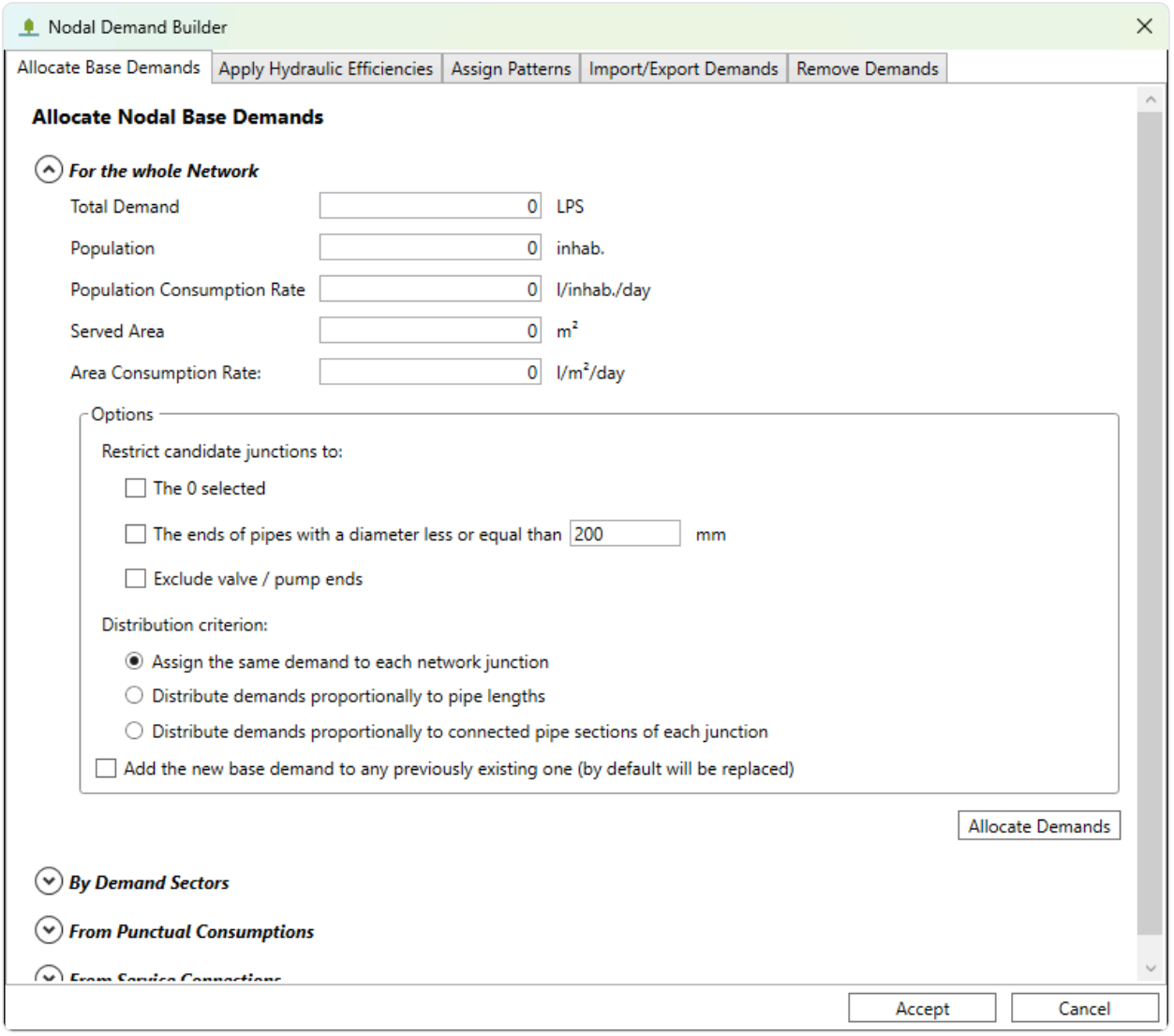
7.2 Demands and Scenarios

The three tools in the second group of the Tools bar manage mass demand assignment, simulation scenarios, and identification of operational isolation segments.

Nodal demand builder…

Tools Bar → Nodal demand builder…

Assign consumption to network nodes in bulk from external SHP layers loaded in QGIS. It is the main tool for integrating billing data, user censuses or polygon estimates into the EPANET model.



Nodal demand builder dialog with source and assignment method options

Nodal demand builder: automatically detected source layers, field configuration and distribution method.

Supported data sources

Geometry type	Assignment method
Points	Each point is assigned to the nearest node. The demand value is read from a configurable field in the layer.
Polygons	The total demand of the polygon is distributed among all the nodes that fall within it.
Lines	The demand for each section is distributed among the closest nodes along the axis.

Process

1. Load the external SHP layer with the consumption data into QGIS before opening the manager.
2. Activate **Nodal demand builder**. The dialog automatically detects and lists external layers.
3. Set for each layer:

- **Demand field**: column with the consumption value.
- **Category field**: to create multiple requests by type of user (residential, industrial, etc.).
- **Pattern field**: ID of the demand pattern to apply (optional).

4. Optionally select nodes on the map to limit the assignment to that area.
5. Confirm. QGISRed writes the values to `Junctions` or `{Red}_MultipleDemands.shp` if there are categories.

Restriction to selected candidates

The dialog offers two constraint options that can be combined:

Option	Effect
Restrict demand candidates to selected	Only **nodes (Junctions) currently selected** on the map are considered as candidates to receive demand. The other nodes are ignored even if they fall within the influence zone of a consumption point.
Restrict service connection candidates to selected	Only currently selected Service Connections on the map are considered candidate service points. Useful for reallocating demand to specific connections without affecting the rest.

Both options are independent and can be activated simultaneously.

Custom Demand Units

By default, the Builder interprets demand values in the project's flow units. If your source data uses different units, turn on **Custom demand units** and enter:

- **Units label**: descriptive label of the source units (e.g., `m³/mes`).
- **Conversion factor**: multiplier factor to convert to project units (e.g., if the project uses L/s and the data comes in m³/month: `1000 / 86400 / 30 ≈ 0.000386`).

The Builder automatically applies the factor to all consumption values before assigning them to the nodes.

Result on the map

The resulting layer is displayed with colors per category and labels with the demand value. Nodes with no assigned category appear in orange under the **Uncategorized** group.

When you hover over a point on the map, the tooltip shows its category and the base demand value with the project's flow unit (for example, "Residential - 1.2345 l/s"); on older themes without a `Category` column, the tooltip only shows the value and unit.

> 💡 The auxiliary layers of the Nodal demand builder (ConsumptionPoints, DemandLinks, Sectors...) can also be created empty from the Layer Manager, without the need to first run an analysis (see Overview and layer management).

Lawsuit Cleanup

The Builder allows you to delete existing demands before assigning new ones:

- **Delete demands from selected nodes**: eliminates values of `Demand` and entries of `MultipleDemands`.
- **Delete orphan patterns**: delete patterns that are no longer referenced by any nodes.

Demand assignment from segment layer

When a segment layer (line geometry) is used to distribute demands using the `%Dem` field, records without that field filled in automatically receive the remaining percentage up to 100%, distributed proportionally between them.

Patterns by sectors

The sector patterns section allows you to assign a demand pattern to each sector of the network. It has **two exclusive modes**:

Mode	Description
Import patterns from a sector theme	Select the polygon layer with the sectors from a drop-down combo that lists the polygon layers already loaded in QGIS (or import it with the `...` button if it is not already loaded). Then choose the **Sector Id (optional)**, **Id demand pattern** and **Priority (optional)** fields from the corresponding combos. The Sector Id field is optional: if not identified, QGISRed generates internal identifiers automatically. Optionally, save the result as an internal layer of the project with the **Import and save** button. Once saved, this option is locked.
Use patterns from a project sector theme	Select a slice layer already loaded in the project. A list is displayed with the sectors and, next to each one, an **editable** combo to choose the pattern: you can select an existing pattern from the list or directly write the Id of a new pattern. Nodes without a sector are grouped into an extra sector.

Efficiency by sectors

The hydraulic efficiency section by sectors also presents **two exclusive modes**:

Mode	Description
Import efficiencies from a sector theme	Select the polygon layer with the sectors from a drop-down combo that lists the polygon layers already loaded in QGIS (or import it with the `...` button), and choose the **Sector Id (optional)**, **Efficiency** and **Priority (optional)** fields. The Sector ID field is optional. Optionally, save the result as an internal layer of the project with the **Import and save** button. Once saved, the import option is blocked.
Use efficiencies from a project sector theme	Select an existing slice layer; The plugin automatically identifies efficiency fields.

Efficiency and pattern fixes

After defining the efficiencies by sectors, the Builder offers additional correction options:

- **Correct category efficiencies to meet sector efficiency**: proportionally adjusts the efficiencies of each demand category so that the resulting efficiency in each sector matches the stated objective. Exclusive with the correction towards global efficiency.
- **Correct sector patterns to comply with the global pattern**: after assigning sector patterns, correct these patterns so that their combination complies with the previously declared global pattern. Remediation options are broken down by pattern scope (global or category).

Layer of isolated connections with demand

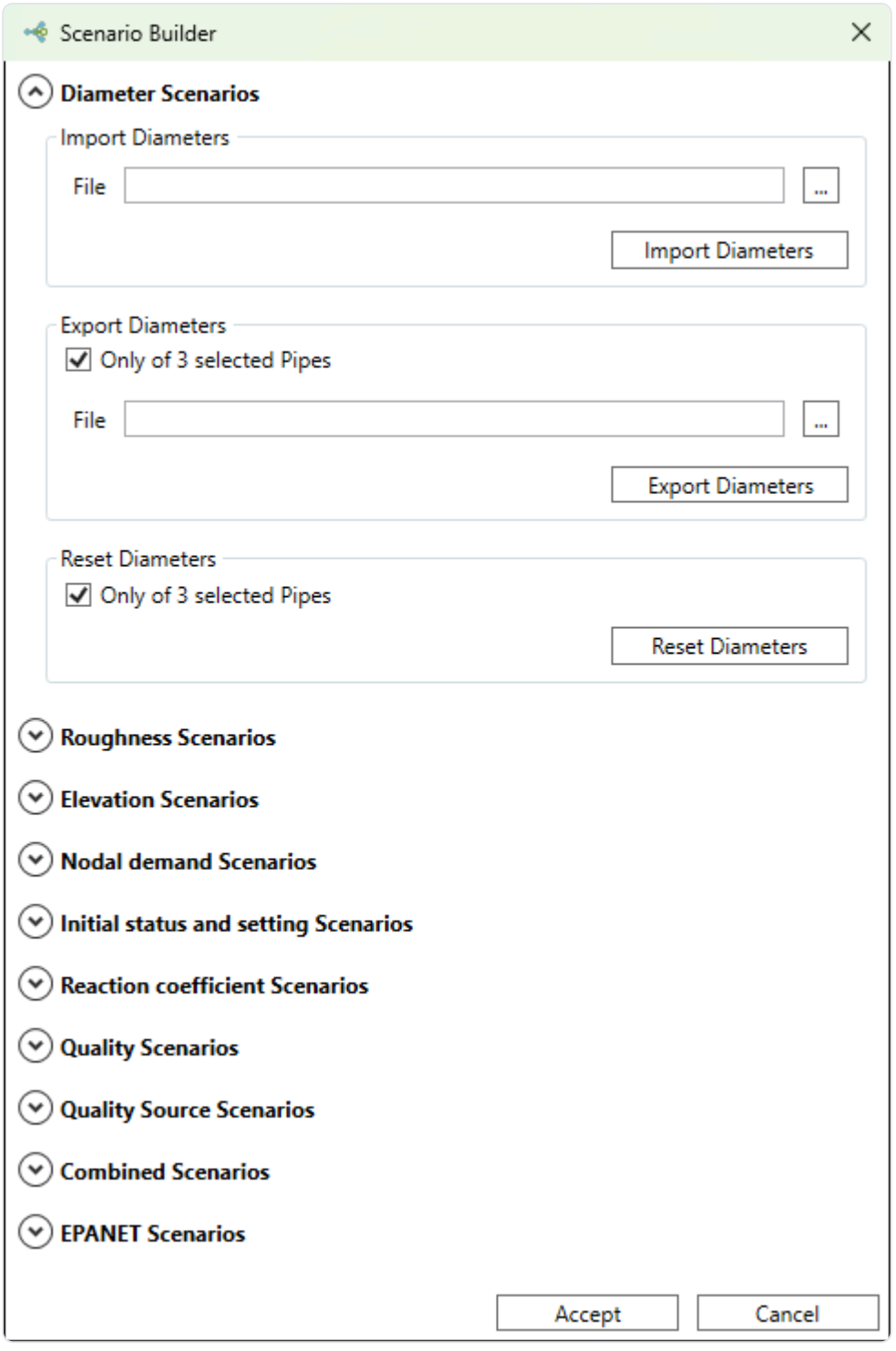
When executing the analysis of isolated segments or hydraulic sectors, the plugin generates an additional layer with **connections that have assigned demand but belong to isolated hydraulic sectors** (without supply). This layer is represented by red outlined circular markers and includes the fields `Id`, `BaseDemand`, and `Category`.

Scenario builder…

Tools bar → Scenario builder…

Bulk export and import model parameters, creating “snapshots” of the network state that can be restored at any time. It is the tool to manage model variants without duplicating

projects.



Scenario builder dialog with network parameter table

> 💡 The table is only populated with elements previously selected on the map (pipes and/or junctions). If you open the tool without any selection, the table appears empty.

Parameters managed

Parameter	Description
Roughness	Roughness coefficients of all pipes
InitStatus	Open/close states of pipes and valves
Demands	Base demands of all nodes
InitQuality	Initial qualities of nodes and pipes
Elevations	Levels of nodes, tanks and reservoirs

Typical workflow

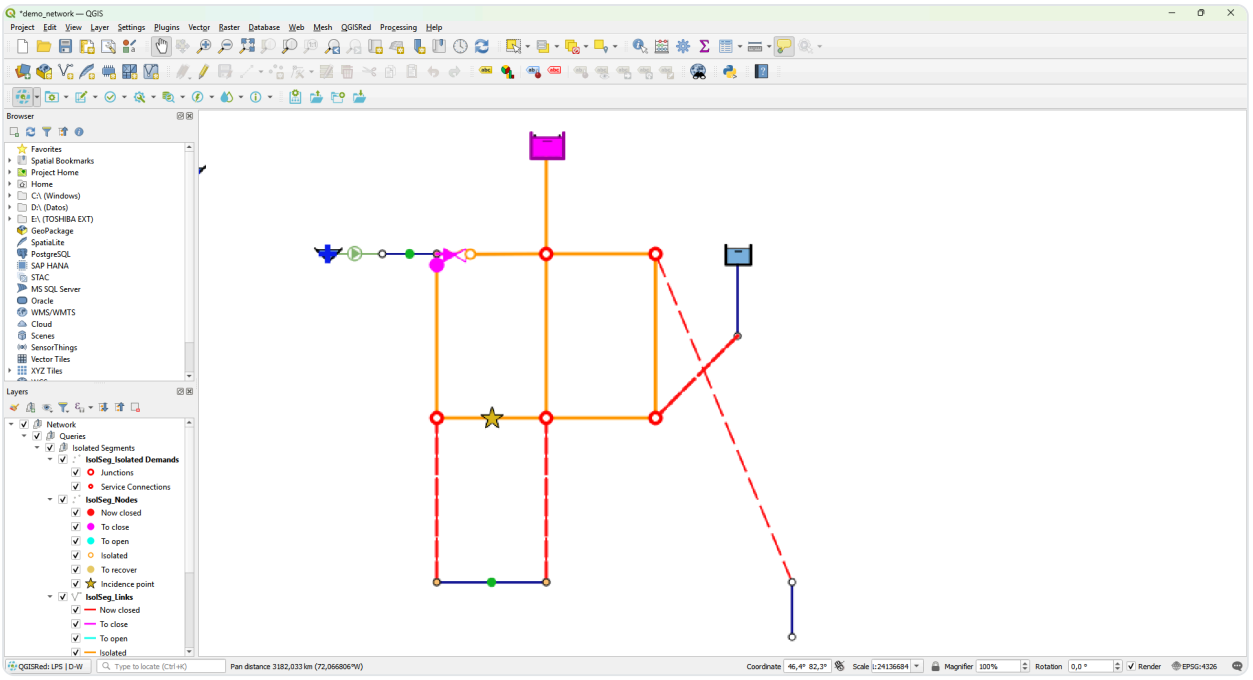
1. Build the model in the current state (base year).
2. Export the base scenario with **Scenario builder → Export**.
3. Modify the model for the future horizon (new demands, aging pipes, etc.).
4. Export the future scenario with another name.
5. To compare or restore, use **Scenario builder → Import** and select the desired scenario.

The scenario files are saved as CSV in the project folder.

Isolated segments…

Tools Bar → Isolated segments…

Answers the operational question: **"What valves should I close to repair this pipeline, and which users will be left without service?"**



Result of Isolated segments: affected pipe, shut-off valves and zone without service

In red the pipe to be repaired, in yellow the valves to close and in blue the area without service.

Process

1. Activate the tool and click on the pipe to be repaired or isolated.
2. QGISRed calculates the **minimum segment** that would be isolated when closing the closest manual valves and identifies the affected collaterals.
3. The result is displayed on the map:

- **Target pipe**: in red.
- **Valves to close**: in yellow.
- **Zone without service** (collateral affected people): in blue.

4. You can click on more pipes within the same session to accumulate the analysis.

The auxiliary layer `IsolatedSegments` is generated with all the information. Does not modify the model.

Nodes with **negative demand** (a water inflow, such as a lift station or a transfer) are treated as a supply point: they are closed just like a tank or a reservoir, but the analysis keeps exploring the network beyond them instead of stopping there. In the results summary they are counted as **Junctions**, alongside valves, pumps, tanks and reservoirs.

7.3 Demand Sectors and Tree

The last two tools in the Tools bar perform topological analyzes on the network: sectorization by flowmeters and calculation of the minimum cost tree from an origin node.

Obtain demand sectors

Tools Bar → Obtain demand sectors (formerly "Demand sector builder…")

It generates a sectorization of the network based on the presence of **flowmeters** (flow meters). Each demand sector is the subnetwork supplied by a single flowmeter, without crossing other flowmeters.

Difference with hydraulic sectors

	Hydraulic sectors (Debug Bar)	**Demand sectors (Barra Tools)**
Base	Presence of Tank or Reservoir	Presence of flowmeters
Question	Where does the water come from?	What does each flow meter measure?
Classification	H-Q / H-nQ / nH-Q / nH-nQ	No type, only colored by sector
Use	Diagnosis before simulating	Water balance by sector

Result

The tool generates the `DemandSectors` layer on the map, with each sector in a different color. If the network does not have flowmeters loaded, the result is a single sector that spans the entire network.

No configuration required: launches directly without dialog.

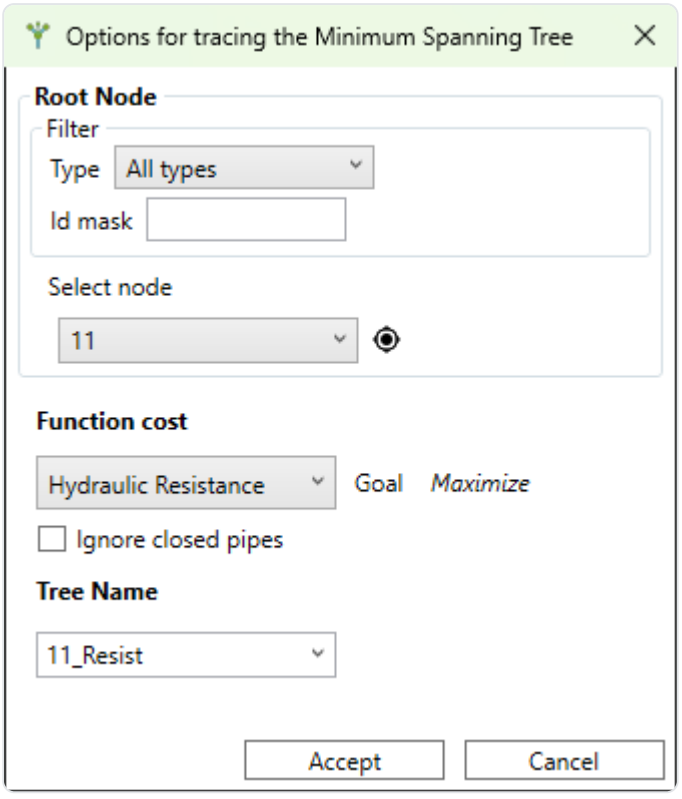
Minimum Cost Tree…

Tools Bar → Minimum Cost Tree…

Calculates the **minimum cost spanning tree** of the network from a selected node. It shows the most hydraulically efficient path (least cumulative resistance) from that node to all other reachable points in the network.

Process

1. Activate the tool.
2. Click on the source node (for example, a supply source or a high water delivery point).
3. QGISRed suggests a name for the tree (by default, the node ID followed by the chosen cost function, e.g. `J5_R`); you can edit it before calculating.
4. QGISRed calculates the tree and generates its own **Tree_<name>** group on the map, with the accumulated distance from the origin labeled on each reach.

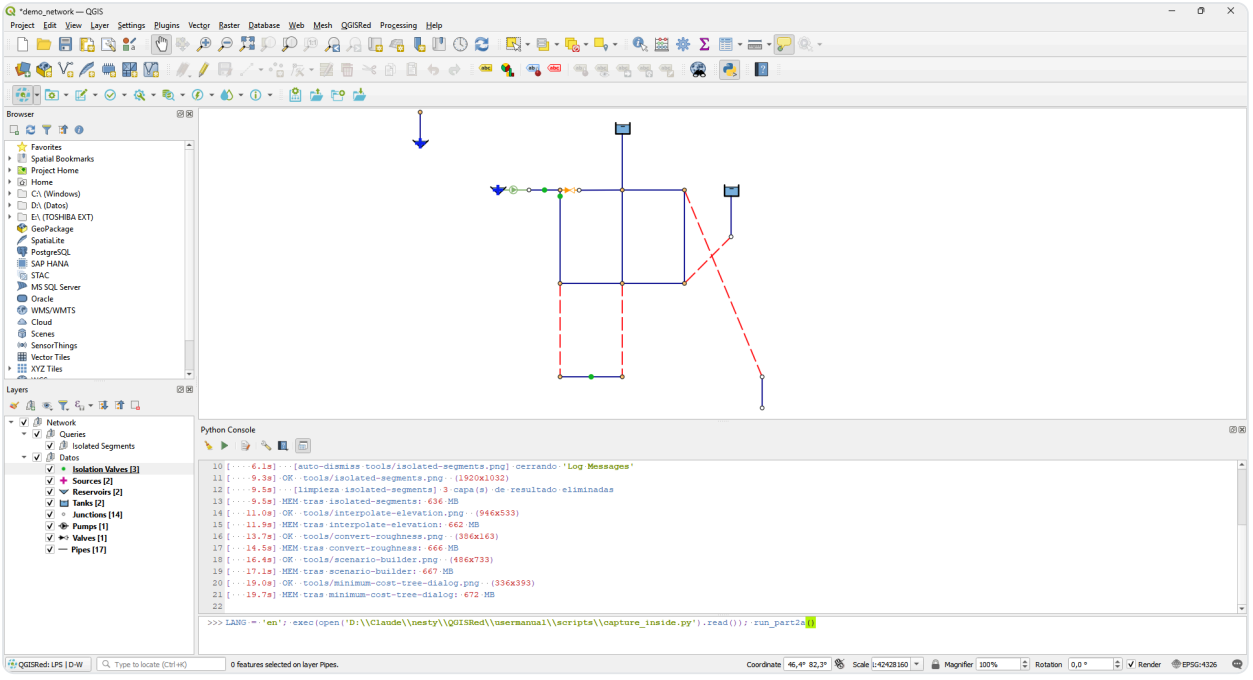


Minimum Cost Tree dialog with source node already selected

> 📝 You can have **several trees open at once**, each with its own independent name, group and pair of layers (nodes and reaches) — they don't replace each

> other. The tool's own dialog lists the trees already calculated for the project and lets you delete any of them individually, without affecting the rest.

Interpretation of the result



Calculated minimum cost tree, with the accumulated distance labeled in each section

The resulting tree shows which path the water would follow from the source node if the network were purely branched (no loops). It is useful for:

- Identify pipes that always work in a single direction of flow.
- Detect redundant pipes in the topology (they do not appear in the tree because there is a shorter path).
- Analyze the supply structure in emergency conditions with part of the network closed.
- Plan pressure sectorization schemes.

Root node ID

In the node layer generated by the tree, the origin (root) node is identified with the value **"ROOT"** in the `NodeType` field. The rest of the nodes have their usual EPANET type (Junction, Tank, Reservoir...). This allows you to create specific symbology rules for the root node directly in QGIS.

The root node also stores, only in its own row, the parameters the tree was generated with: the `CostFn` field indicates the cost function used (hydraulic resistance, diameter or length) and `IgnClosed` whether closed pipes were ignored. Useful for checking how an already generated tree was calculated without having to repeat the process.

8 🗺️ Queries

The **Queries** bar groups the interactive model query and inspection tools: search for elements by ID, exploration of individual properties, thematic maps, queries by conditions on attributes and network statistics. Unlike editing or analysis bars, these tools do not modify the model: they only interrogate and visualize what already exists.



QGISRed Queries Toolbar

Queries Bar: the five query and inspection buttons.

Queries Bar Tools

All buttons belong to a single group without separators.

#	Tool	Function
1	**Find elements by ID…**	Locate one or more elements on the map by searching by their identifier
2	**Element properties…**	Shows in a floating panel all the properties of the element you click on
3	**Thematic maps…**	Generates a time-lapse colored layer of any hydraulic attribute of the pipes
4	**Queries by properties…**	Highlights on the map all elements that meet a condition on their attributes
5	**Statistics…**	Calculates statistical distributions and histograms of network attributes

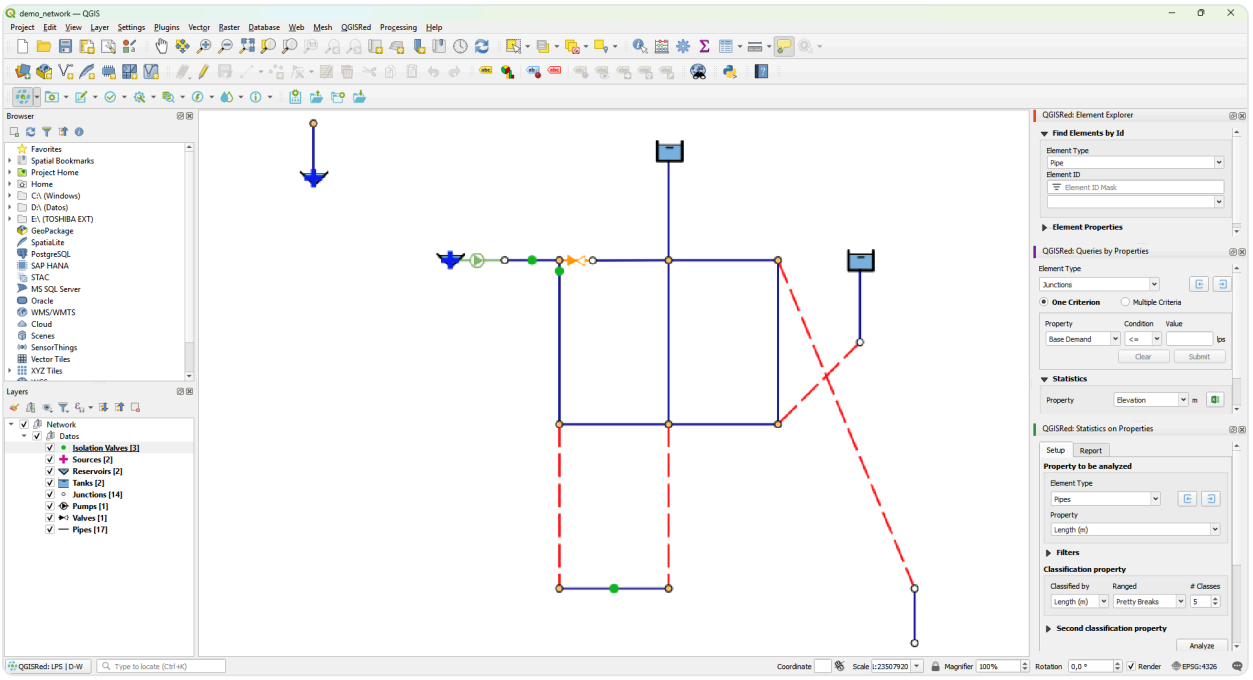
---

In this section

- Element Explorer — floating panel with element search by ID and properties of the selected element, in two tabs
- Thematic maps — interval visual representation of pipe and node attributes
- Property inquiries — filtering and highlighting elements based on conditions on attributes
- Statistics — distributions, histograms and statistical classification of the network

8.1 Element Explorer

The **Element Explorer** is a floating panel (dock) that QGISRed maintains as a single instance. It groups two related functionalities into two drop-down sections, stacked vertically (not in side-by-side tabs): search for elements by ID and display of properties of the selected element on the map.



Element Explorer panel with Search Elements by Id and Element Properties sections expanded

* Element Explorer panel: "Search Elements by Id" section (top) and "Element Properties" section (bottom).*

The **Find elements by ID** and **Element properties** buttons in the Queries bar open this same pane and expand the corresponding section — but **automatically collapse the other**, as only one section remains expanded at a time by default. If you need to view both at once (for example, for captures or to compare results), you can manually re-expand the collapsed section by clicking on its header; this does not close any functionality.

"Search Items by Id" section

Queries Bar → Find elements by ID…

Locates any element on the network by writing its ID and highlights it on the map.

Searchable items

- Pipes, Junctions, Demands, Reservoirs, Tanks, Pumps, Valves, Sources

Process

1. Activate **Find elements by ID**. The panel opens or is brought to the front.
2. Select the element type from the layer dropdown.
3. Type the ID in the text field and press **Find** or Enter.
4. QGISRed centers the map on the element and highlights it. The result appears on the panel with a light yellow background.

Multiple search

Separate multiple IDs with a comma or semicolon to highlight them all simultaneously.

If the ID does not exist

The panel displays a warning and the map does not change.

"Element Properties" section

Queries bar → Element properties…

Activate an interactive identification tool: when you click on any element of the map, the panel displays all its attributes in this section.

Process

1. Activate **Element properties**. The cursor changes to identification mode.
2. Click on any element on the network.
3. The panel shows the fields of the clicked element. You can continue clicking on other elements without deactivating the tool.

Information displayed

Attributes are organized by element type. For a typical **pipe**:

Field	Description
`Id`	Unique identifier
`Length`	Length (m)
`Diameter`	Diameter (mm)
`Roughness`	Roughness coefficient
`Material`	Materials
`InstallYear`	Year of installation
`Status`	Status (Open / Closed / CV)
`Tag`	Free label

For **nodes** `Elevation`, `Demand`, `Pattern`, `InitQuality`, etc. are shown. Each item type has its own set of fields.

For **valves**, the `Type` / `ValveType` field is shown as the plain EPANET code (PRV, PSV, PBV, FCV, TCV, GPV, CV) — English has no separate localized abbreviation.

If the project has simulation results loaded, the panel adds a section with the calculated values (pressure, flow, velocity...) for the active period in the results viewer. The simulated time is indicated by the prefix **Time:** followed by the bold value in the format `HH:MM:SS`.

> **Warning**
>
> **Conditional quality fields.** The `Quality` field only appears when the project quality model is not *None*. The `ReactRate` field is only visible when the quality model is *Chemical*; remains hidden for *None*, *Age* and *Trace* models. These fields are only displayed when the project's quality model supports them.

Usage Notes

- Deactivating the button returns the cursor to the standard QGIS navigation mode.
- If you click in an area without elements, the panel retains the last selection.

- The background of the panel has a light yellow tint to differentiate it from the rest of QGIS panels.
- Clicks on layers that do not belong to the active QGISRed project (background layers, external auxiliary layers, etc.) are ignored: the panel does not update its content.

ID field resolution per layer

QGISRed automatically resolves the **identifier field name** of each network layer using the internal function `getIdFieldName(layer)`. This allows the plugin to correctly detect the ID on layers with different naming conventions:

Layer type	Typical ID field
Pipes	`PipeID`
Junctions	`JunctionID`
Tanks	`TankID`
Reservoirs	`ReservoirID`
Pumps	`PumpID`
Valves	`ValveID`

If your project uses custom naming conventions, automatic resolution prevents search or identification errors. There is no need to configure anything manually: the scanner detects the correct field when activated on any layer of the network.

Additional field aliases automatically recognized

The panel automatically recognizes the following field aliases and presents them with correct labels, units, and decimals without any additional configuration:

Alias	Description
`DemPattID`	Demand pattern in nodes; is suppressed when multiple requests are active and is grouped correctly
`HedPattID`	Pump height curve pattern

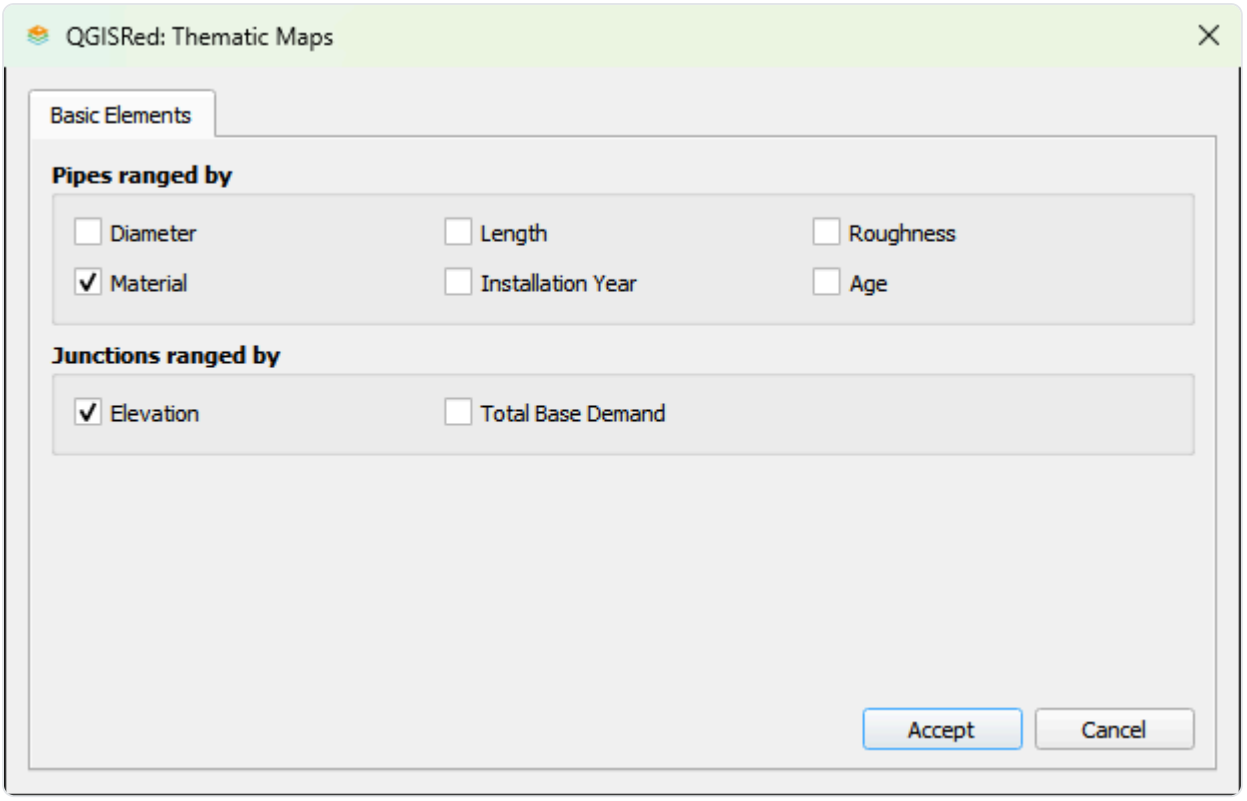
Alias	Description
`QualPattID`	Quality pattern in fonts
`NodeID`	Node identifier in derived layers
`NodeType`	Node type
`LinkID`	Link identifier in derived layers
`LinkType`	Link type

> **Note**
>
> Recognition is automatic: the browser detects the correct alias when activated on any layer of the network, without the need to configure anything manually.

8.2 Thematic Maps

Queries Bar → Thematic maps…

Opens the **Thematic Maps** dialog, which generates layers that color pipes and nodes by intervals of a hydraulic attribute. Unlike other QGISRed dialogs, you don't have to choose a "field and confirm": each available attribute has its own box, and you can check as many at once as you want — each one generates its own layer, and they all live on the map simultaneously.



Thematic Maps dialog with the Material (pipes) and Elevation (junctions) boxes marked

---

Active elements: pipes and nodes

In the current version, **Thematic Maps works on the Pipes and Junctions layers**. The options for other types of elements (valves, pumps, tanks, reservoirs) are present in the interface but are automatically hidden because they are not yet implemented. The groups **Service connections**, **Isolation valves** and **Meters** are visible, but their only checkbox ("Temporary") is also not operational yet — do not check it.

Process

1. Open **Thematic maps** from the Queries bar.
2. Check the boxes of the attributes you want to represent (you can check several pipes and nodes at the same time).
3. Press **Accept**. QGISRed creates a layer for each checked box, within the **Queries → Thematic Maps** group of the QGIS layers panel.
4. To remove an already generated map, reopen the dialog, uncheck its box and press **Accept** — QGISRed deletes that specific layer without touching the rest. The boxes on the already generated maps appear pre-marked.

> 💡 You can have multiple thematic maps open at once (e.g. Pipe Material and Year of Installation along with Node Base Demand) — each is a separate layer, they do not replace each other as was the case before.

Available fields for pipes

Field	Description
`Diameter`	Pipe diameter
`Length`	Length
`Material`	Pipe material, colored with QGISRed's fixed palette (see table below)
`Roughness`	Roughness coefficient — classes and style file depend on the **pressure loss formula** active in the project (Hazen-Williams, Colebrook-White or Darcy-Weisbach)
`Age`	Age, calculated from the year of installation; classes are labeled with "yrs" suffix
`Installation Year`	Year of installation

> The **Age** and **Installation Year** maps add three columns together to the layer's attribute table: the raw installation date (`InstalDate`), the extracted year (`InstYear`), and the calculated age (`Age`) — seeing them all at once is useful even if you've only marked one of the two maps. Pipes with no installation date are grouped under an **Unknown** class, translated to the language you open the project in.

Available fields for nodes

Field	Description
`Elevation`	Knot level. Classes are automatically calculated from the actual project values (there are no standard ranges) — the legend shows the cuts with the project length unit (e.g. "< 120 m", "120 < 180 m", ">= 180 m").
`Total Base Demand`	Total base demand of the node. The circles are **sized proportionally** to the demand (non-linear, so that very large values do not visually dominate the map), in classes also calculated from the actual data, labeled on the project's active flow unit. If the node has multiple demand categories (see Demands and scenarios), the layer reflects the aggregate sum; nodes with zero demand are not shown.

Material palette

The **Material** map colors each pipe based on the value of its `Material` field, comparing it (case insensitive) against the abbreviation or name in this fixed table — a material that does not appear here receives a random color instead:

Abbreviated	Materials	Abbreviated	Materials
FG	Gray Cast Iron	Pb	Lead
FD	Ductile Casting	PVC	Polyvinyl Chloride
ACE	Steel	PE	Polyethylene

Abbreviated	Materials	Abbreviated	Materials
STAINLESS STEEL	Stainless Steel	PVC-O	Oriented PVC
FC	Fiber cement	PVC-R	Rigid PVC
AGal	Galvanized Steel	Cu	Copper
HCCC	Concrete with sheet metal jacket	PE-AD	High Density Polyethylene
HSCC	Concrete without sheet metal jacket	PE-BD	Low Density Polyethylene
HAr	Reinforced Concrete	PE-MD	Medium Density Polyethylene
HPr	Prestressed Concrete	GRP	Fiberglass Reinforced Polyester

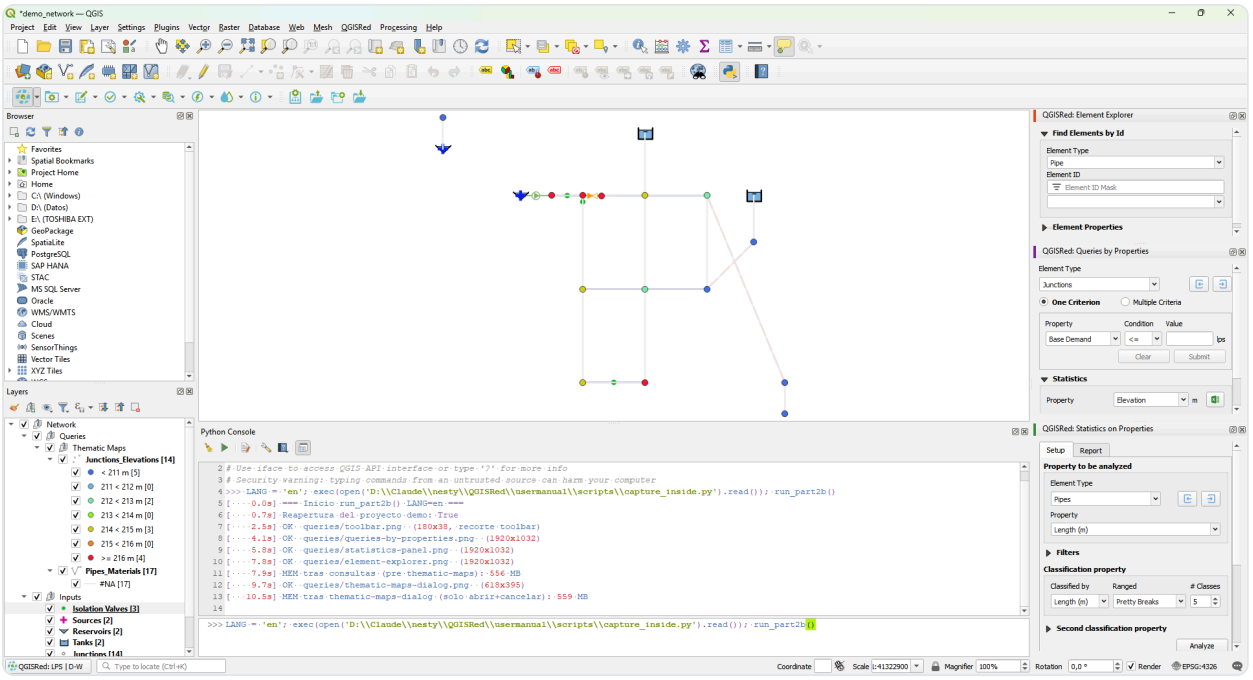
> This color table only applies to the **default** style that QGISRed comes with. If you save your own Material legend from the legend editor (see Overview and layer management), your colors take precedence over this palette when you regenerate the map.

Outdated map notice

If you change the project's **units**, **head loss formula** or **flow units** after generating a thematic map that depends on them (Diameter, Length, Roughness, Base Demand...), QGISRed marks that layer with a warning icon ⚠ in the layers panel — the same icon it already uses to warn of outdated simulation results.

- Mouse over the icon to see the reason.
- Click on the icon to rebuild that layer with the current configuration, without having to reopen the dialog.

Result on the map



Network colored by Pipe Material and Junction Elevation after generating the thematic maps

Each checked box generates its own layer (for example `Pipes_Materials`, `Junctions_Elevations` — always `Element_Property`, both in plural except "Installation Year", which stays singular) within the **Queries** → **Thematic Maps** group. The layers are read-only and update themselves when you edit the source pipe or node (there is no need to regenerate the map by hand after a specific change) — the legend of each one also shows how many elements each class has.

If you check and confirm an already generated box again, QGISRed replaces that specific layer with the new configuration, without touching the rest of the active maps.

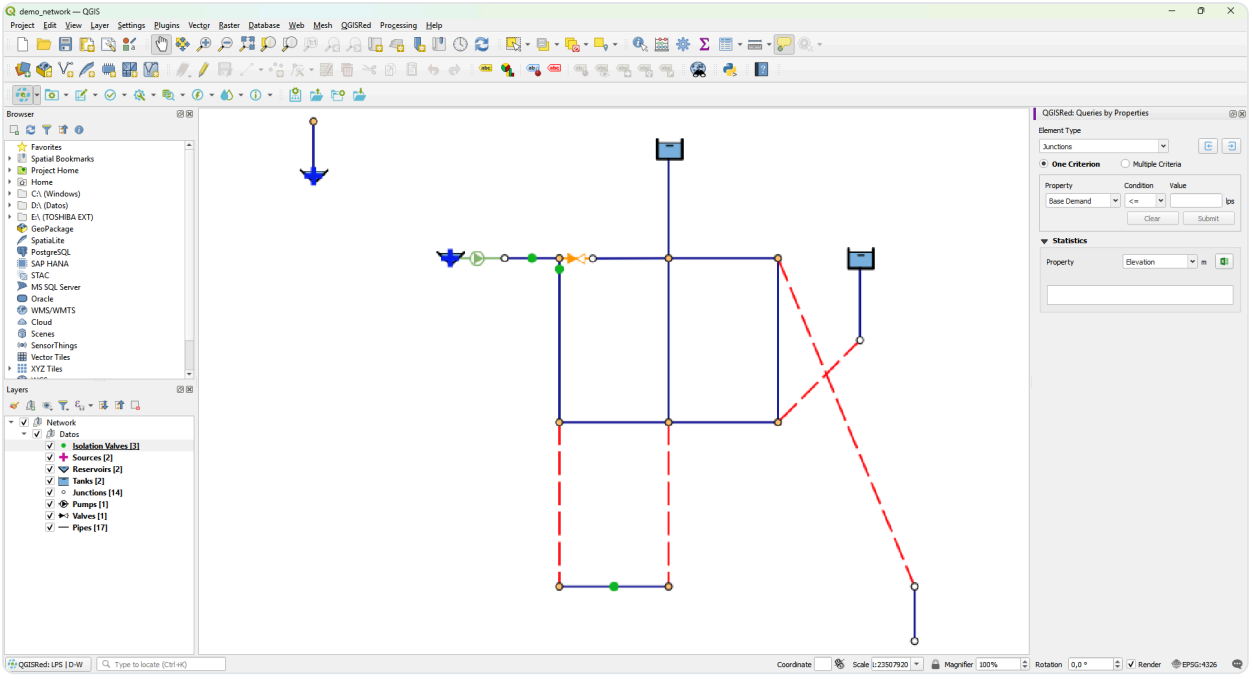
Usage Notes

- The generation of thematic maps does not modify any model data; it only creates new layers with the corresponding symbology.
- To remove a map, uncheck it in the dialog (see "Process" above) or delete its layer directly from the QGIS layers panel.
- The **Total Base Demand** map requires nodes with assigned demand to exist; If the project has no demands loaded, the layer is generated empty.

8.3 Property Inquiries

Queries bar → Queries by properties…

Opens the **Queries by Properties** panel, a filtering tool that highlights on the map all elements that meet one or more conditions on their attributes. It is the fastest way to find, for example, all pipes with a diameter less than 80 mm, all nodes with pressure below a threshold, or all valves in a closed state.



Queries by Properties panel with configured conditions and result highlighted in magenta

Queries by Properties Panel: conditions configured on pipe attributes. Items that meet the condition are highlighted in magenta on the map.

Dashboard interface

The panel has an identifying color **purple** (`#7B1FA2`) in its header to distinguish it from the rest of the QGISRed panels. Contains:

- **Element type selector**: Pipes, Junctions, Tanks, Reservoirs, Pumps, Valves
- **Criterion mode**: two options, **One Criterion** (a single active condition) and **Multiple Criteria** (a list of combinable conditions, see below)
- **Conditions area**: one or more rows with field, operator and value
- **Run button**: applies the query and highlights the result

- **Clear Button**: removes the map highlight
- **Statistics panel**: property selector and table with the numeric results of the query (see below)
- **Time label**: When simulation results are loaded, displays the active instant with the prefix "Time:" followed by the bold value in `HH:MM:SS` format. The statistics label for the result is also shown in bold.

Types of conditions

The operator available for each field depends on the data type:

Numeric fields

Operator	Meaning
`All`	No filter (all values)
`>=`	Greater than or equal to
`<=`	Less than or equal to
`=`	Equals
`>`	Greater than
`<`	Less than
`≠`	Other than
`Range`	Between two values (closed interval)

List fields (enumerated)

Fields like `Status` that have a finite set of possible values:

Operator	Meaning
`All`	No filter
`=`	Equal to selected value

> **Note**
>
> For `Type` / `ValveType` on valves, the value selector shows the type's abbreviation (PRV, PSV, PBV, FCV, TCV, GPV, CV) instead of its long descriptive name.

Free text fields

Fields like `Tag` or `Id`:

Operator	Meaning
`All`	No filter
`=`	Exact same
`≠`	Different
`ILIKE`	Contains (case-insensitive)
`NOT ILIKE`	Does not contain (case-insensitive)
`LIKE`	Contains (case sensitive)
`NOT LIKE`	Does not contain (case sensitive)

Process

1. Open **Queries by properties** from the Queries bar.
2. Select the **item type** you want to filter on.
3. Add one or more conditions: choose the field, the operator and write the value.
4. Press **Run**. QGISRed evaluates the query and highlights in **magenta** the elements that meet it — in Multiple Criteria mode, according to the inclusion/exclusion logic explained below.
5. Highlighted items remain visible while the panel is active. Press **Clear** to remove the highlight.

Single or multiple criterion mode

The **One Criterion** radio button limits the panel to a single active condition at a time: changing the field, the operator or the value replaces the previous condition. It is the simplest mode for one-off queries.

The **Multiple Criteria** radio button opens a list of independent conditions that can be combined with each other:

- **Add**: adds the condition configured above to the list, marked as an **inclusion** condition (`+`).
- **Subtract**: adds the condition configured above to the list, marked as an **exclusion** condition (`-`).
- Each row in the list can be **reordered** (up/down arrows), **edited** (double-click or the edit button), **deleted**, or **enabled/disabled** temporarily without deleting it (the "Enable/disable selected criterion" button) to try out combinations without losing the conditions already defined.

Switching from **Multiple Criteria** to **One Criterion** with more than one condition in the list, QGISRed asks for confirmation: only the first one is kept, the rest are discarded.

Combination logic

Inclusion conditions (`+`) are combined with each other using **OR**: an element is highlighted if it meets **any** of them. Exclusion conditions (`-`) are combined with each other using **AND** and the result is **subtracted** from the previous one. In summary:

> *(any inclusion condition)* **AND NOT** *(all exclusion conditions)*

For example, to find all pipes with a diameter ≥ 300 mm that are **not** cast iron: a `Diameter >= 300` condition marked with **Add**, and a `Material = Cast Iron` condition marked with **Subtract**.

In **One Criterion** mode there is only one condition, so this combination does not apply.

Simulation results

If the project has simulation results loaded, the result fields (pressure, flow, velocity...) also appear in the field selector, allowing you to filter, for example, pipes with a velocity less than 0.5 m/s or nodes with negative pressure.

> **Warning**
>
> **Conditional quality fields.** The result fields `Quality` and `ReactRate` only appear when the project's quality model allows it: `Quality` is hidden with *None* model and `ReactRate` is only visible with *Chemical* model. Static quality fields (`BulkCoeff`, `WallCoeff`, `ReactCoef`, `IniQuality`) are hidden when the quality model is *None*, *Age*, or *Trace*.

Statistics table

The panel calculates numeric statistics on the highlighted elements without needing to export anything. Select the property to calculate in the **Statistics of... for selected Elements** dropdown — any numeric field of the active element type, or one of the result variables if a simulation is loaded — and the table updates automatically.

The columns depend on the type of property:

Property	Columns
Text or list field	**Count** (number of elements)
Numeric field	**Count**, **Avg**, **Min**, **Max**, and **Sum** or **StdD** depending on the property (flows and demands show the sum; the rest, the standard deviation)
None (no property)	only **Count**

In **One Criterion** mode the table shows a single row with the result of the active condition. In **Multiple Criteria** mode with several conditions enabled, it shows one row per condition (labeled `Cr1`, `Cr2`...) and a final **All** row in yellow with the combined result (the same inclusion/exclusion logic as the map highlight) — this lets you compare how many elements each condition contributes on its own versus the combined total.

Exporting criteria and statistics

The panel's export buttons (query criteria and statistics table) save by default to the project's `Queries/Queries by properties` subfolder, instead of the root folder.

> 📝 When exporting several combined criteria to text or CSV, each line is numbered as `Cr1:`, `Cr2:` ... instead of starting directly with the condition's operator — this way a spreadsheet doesn't mistakenly interpret a criterion that starts with `+` or `-` as a formula.

The statistics CSV includes, before the table of values, header lines with the project, the scenario, the element type, the applied query or queries, and the exported magnitude.

Usage Notes

- The query does not modify any model data or create new layers: it only changes the temporal symbology.
- Magenta highlighting is visible on any map background.
- When you close the panel, the highlight disappears and the symbology returns to the previous state.

ID field resolution

The panel uses the same automatic identifier field resolution logic as the Element Explorer (`getIdFieldName(layer)`). Query fields by ID (`PipeID` , `TankID` , etc.) are automatically detected based on the layer type, so queries on the `Id` field work correctly regardless of the actual name of the field in the project shapefile. See Element Explorer for more details.

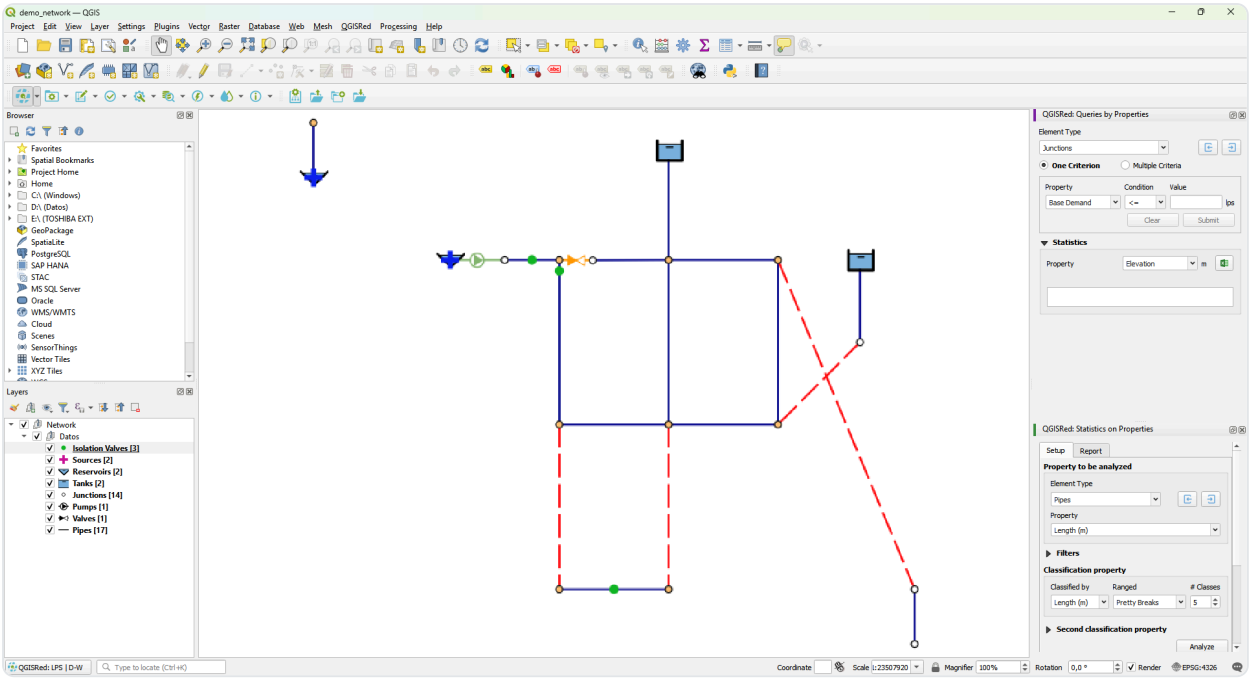
The aliases `PumpCurvID` , `BaseDem` and `SourceQual` are automatically recognized as numeric type fields for pumps, demands and sources respectively. The data type of each field (numeric, list or free text) is determined automatically from the element's schema, without the need for manual configuration.

8.4 Statistics

Queries Bar → Statistics…

Opens the **Statistics** panel, which calculates and displays the statistical distribution of any numerical or categorical attribute in the network, with support for automatic classification, second cross-classification, and graphical representation.

> **Note**
>
> **Note:** The Statistics panel opens **docked** in the main QGIS window and respects the panels already grouped into tabs. Its controls also adapt to narrow panel widths, without being cut off on the right edge.



Statistics panel with histogram of pipe diameters

Statistics Panel: histogram of pipe diameters with classification by intervals.

Panel structure

The Statistics panel is organized into two tabs:

- **Setup**: defines what is analyzed and how it is classified.

- **Report**: shows the histogram and results table. It is activated automatically after running the analysis.

Configuration Tab

Element type and property

Select the type of element (Junctions, Pipes, Tanks...) and the property to analyze. The property selector displays in a **unified list** both the design fields (Diameter, Length, Roughness...) and the simulation result fields (Pressure, Flow Rate, Velocity...). Result fields appear with **yellow/cream background** to visually differentiate them from design fields.

Main classification

Parameter	Description
Field	Property to sort by
Method	How to calculate the intervals (see table below)
Number of classes	How many groups are generated

Available sorting methods

The following methods are available for both the main sort and the second sort. The default method is **Pretty Breaks**.

Method	Description
Jenks (Natural Breaks)	Minimizes intra-class variance. Ideal for non-uniform distributions.
Pretty Breaks	"Round" interval boundaries. Preferable for presentations. *(Default)*
Equal Count	Each class contains the same number of elements.
Fixed Interval	All intervals have the same amplitude.

Method	Description
Manual	The user directly defines the limits of each interval.

> **Note**
>
> **Note:** When all values are identical or very similar, duplicate class endpoints are collapsed showing a single value instead of "100.0 - 100.0".

> **Note**
>
> **Note — Fields without useful data:** If the field chosen to classify does not have any calculated value, the panel does not show an error message: it directly generates a single class **NULL** that groups all elements without value. If the field has values but they are all equal (including the case where they are all zero), a single class is generated with that value, just as in the previous case of collapsed endpoints. In both cases the histogram and table are generated normally, without interrupting the analysis.

> **Note**
>
> **Note:** When analyzing a dynamic simulation result field, the **class limits are calculated once** considering all time instants simultaneously. As the simulation step progresses, the count of elements per bar varies, but the limits remain constant, allowing **to compare distributions between time instants** with complete consistency.

Pre-filtering

Before calculating, you can limit the set of elements with a condition on any field:

- **numeric** fields: `>=`, `<=`, `=`, `>`, `<`, `≠`, `Range`
- **list** fields: `=`
- **text** fields: `=`, `≠`, `ILIKE`, `NOT ILIKE`, `LIKE`, `NOT LIKE`
- Select **No Filter** to include all elements without restriction.

The **Value** field includes a **(×)** clear button: when pressed, it clears the entered text and leaves no active selection, making it easy to change the filter quickly.

When the filter attribute is a simulation result field, the combo displays the same **yellow/cream background** that is used for these fields in the property selector.

> **Note**
>
> **Note — Flow:** When filtering on the `Flow` field with a written numerical value, the value is always interpreted as **absolute value**, so it is not necessary to know the sign that EPANET internally assigns to the flow.

Restrict to active selection

The **Only selected elements** checkbox limits the analysis to the elements currently selected on the map. The selection is evaluated jointly between the **Inputs** layer and its corresponding **Results** layer: if the element is selected in either layer of the same type (for example, `Pipes` in Inputs and its pipeline results theme), it is included in the calculation.

> **Warning**
>
> If you activate the box and no element is selected in either layer, the panel displays a warning and does not run the analysis.

While the checkbox is active, both the histogram and the table display a note indicating that there is a selection filter (and, if there is also an active attribute filter, both are combined in the same text).

Preview on map

The Filters section includes two additional items to scan the filter before running the full scan:

- **"Preview on map" checkbox**: When checked, items that meet the filter condition are highlighted in **orange** on the map canvas. The preview updates automatically when you change any filter parameter.
- **Match counter** (e.g. *"43 items match"*): visible whenever the Filters section is displayed, even before running the analysis.

Highlights are automatically removed when you close the panel or collapse the Filters section.

Second classification *(optional)*

A collapsible group—collapsed by default—allows you to define a **second classification criterion** on the same set of elements. When deployed, the following are configured:

Parameter	Description
Field	Second classification property
Method	Jenks (Natural Breaks), Pretty Breaks, Equal Count, Fixed Interval or Manual
Number of classes	Second classification groups

When the second sort is active, the results table becomes a **cross matrix**: the rows represent the groups of the first sort and the columns represent the groups of the second.

> **Note**
>
> **Note:** When changing the element type and returning to the previous one, the second classification settings (method, number of classes, intervals, manual values) are **automatically recovered**.

Report Tab

The Report tab is divided into two frames: **Histogram** and **Table**.

Histogram

The histogram shows the distribution of the analyzed property:

- **Statistic selector**: Choose what is represented on the Y axis: Count, Sum, Avg, Min, Max or StdD.

- **Expand button**: opens the histogram in a **separate floating window**, useful for having the settings panel and the graph visible at the same time.
- The **chart title** includes the statistic selected as a prefix and the field units. For example: *"Avg Pressure (mca) by Diameters (mm) for PVC Material"*.
- For categorical fields, the histogram displays bars per category instead of numerical ranges.

Results table

The table displays the same data in tabular format:

- The values are formatted with the decimals corresponding to each field according to the CSV of project units.
- Whole numbers are displayed without decimals.
- The **table title** always reflects the two active classification dimensions, including the units of each field.
- The **export row** includes a statistics selector to choose which value is dumped when exporting to CSV (Count, Sum, Avg...).
- The CSV export includes the **manual breakpoint values** of both classifications (main and second), with the column headers accompanied by the units in parentheses.
- When the second sort is active, the table becomes a **cross matrix** with additional columns for each group of the second sort.

Available fields

Categorical fields

The following fields are treated as categories (discrete values):

Field	Description
`Material`	Pipe material
`Type`	Element type
`ValveType`	Valve type
`MeterType`	Counter type

Field	Description
`SourceType`	Font type
`IniStatus`	Initial operational status (Open / Closed / CV)
`InstalDate`	Installation date
`InstDate`	Installation date
`Tag`	Free label

Numeric input fields

Any numeric field in the model: `Diameter`, `Length`, `Roughness`, `Elevation`, `BaseDem`, etc.

Simulation result fields

Available only if results are uploaded:

Nodes:

Field	Description
`Pressure`	Pressure (m.c.a.)
`Head`	Piezometric height (m)
`Demand`	Calculated demand (l/s)
`Quality`	Water quality

Pipes:

Field	Description
`Status`	State in simulation
`Flow`	Flow rate (l/s)
`Velocity`	Velocity (m/s)

Field	Description
`HeadLoss`	Head loss (m)
`UnitHdLoss`	Unit loss (m/km)
`FricFactor`	Friction factor
`ReactRate`	Reaction rate
`Quality`	Water quality

> **Warning**
>
> **Note:** Fields `Velocity`, `UnitHdLoss`, `FricFactor` and `ReactRate` are not available when the selected element type is **Pumps** or **Valves**; They are exclusive to pipes.

Usage Notes

- The Statistics panel does not modify any data in the model.
- You can keep the panel open while you navigate the map or change parameters; updates the calculation when you press the run button again.
- The second classification is collapsed by default; deploy it only when you need cross-analysis.

9 🧪 Analysis

The **Analysis** bar groups the hydraulic simulation tools, visualization of results and export of the model. It is the bar that closes the work cycle: once the model is defined, verified and calibrated, this bar is used to run EPANET, explore the results on the map and export to other formats.

> Before simulating it is advisable to have passed the topology and attribute checks to avoid convergence errors.



QGISRed Analysis Toolbar

Analysis bar: simulation, results viewer, time series and export.

Analysis Bar Tools

#	Tool	Function
1	**Run model**	Run the EPANET simulation and load the results into the map
—	**Results browser**	Open the results panel with the data from the last simulation
—	**Status report**	Open the results panel in the status report tab
2	**Analysis options…**	Configure EPANET engine parameters (units, formula, times, quality)
3	**Time series…**	Activate the time evolution graphs tool by element
4	**Export results to CSV…**	Export simulation results to separate CSV files for nodes and pipes
5	**Export model to INP…**	Export the complete model to EPANET `.inp`

Run model, Results browser and Status report share a drop-down button in the bar.

In this section

- Execution and Options — simulation, engine options and status report access
- Results Viewer — results panel, temporal navigation and time series
- Model Export — export to INP and CSV of results

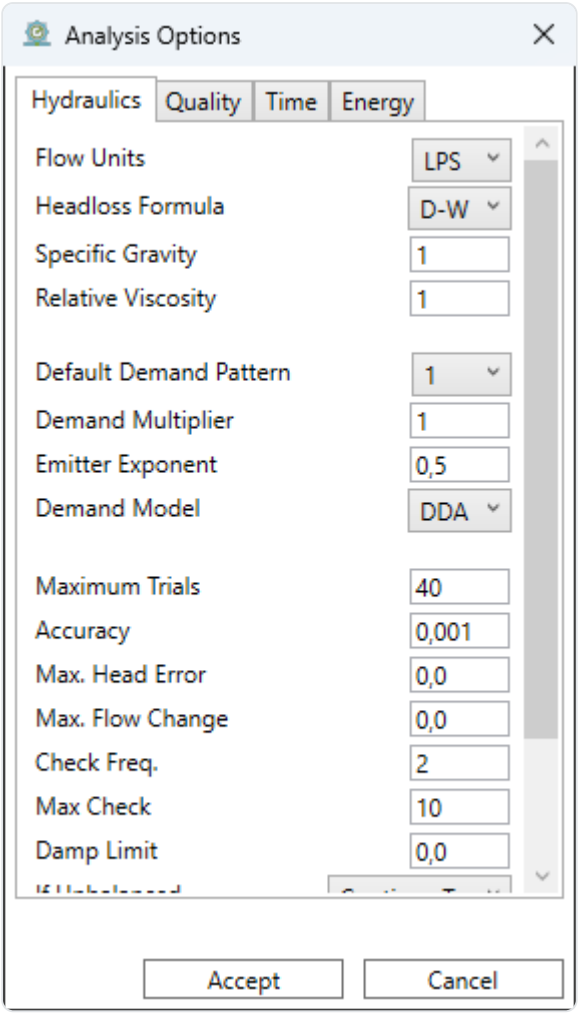
9.1 Execution and Options

The first three actions on the Analysis bar control the simulation cycle: configure engine options, launch the simulation, and review the status report.

Analysis options…

Analysis bar → Analysis options…

Opens the EPANET Engine Options dialog. It allows you to configure all the parameters that control how the hydraulic and quality simulation is carried out.



Analysis Options dialog with EPANET engine configuration tabs

Analysis Options dialog: complete configuration of the EPANET engine.

Configurable parameters

Group	Main parameters
Hydraulics	Flow units (LPS, GPM, CMH…), head loss formula (H-W / D-W / C-M), viscosity, specific gravity
Quality	Type of quality analysis (none, chlorine, water age, source trace), reaction coefficients
Times	Total Simulation Duration, Hydraulic Time Step, Quality Time Step, Report Step, Start Time
Energy	Price of electricity, overall efficiency of pumps
General	PDA (Pressure Dependent Analysis) mode: activates local pressure dependent demand

> The Project Materials Table stores the roughness in D-W units (mm). If you change the hydraulic formula here, QGISRed will offer to automatically convert the existing roughness coefficients.

Run model

Analysis bar → Run model

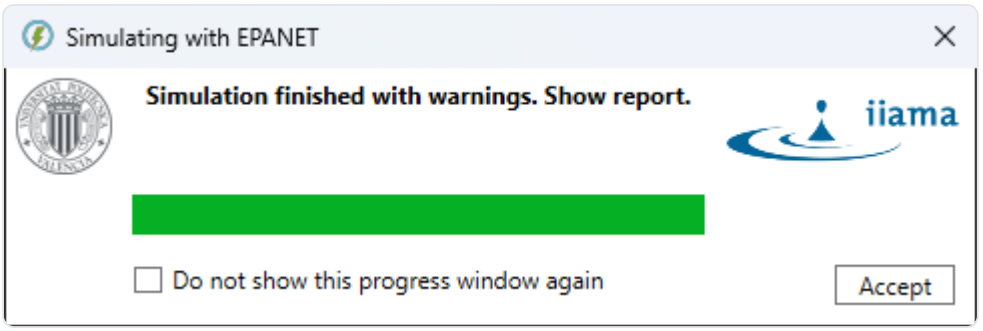
Launch the EPANET simulation with the options configured and load the results into the results panel.

Process

1. QGISRed validates the project (active layers, no layers being edited).
2. Call the EPANET engine through the QGISRed toolkit.
3. When finished, it automatically opens the Results dock on the right of the screen and loads the calculated data.
4. The map updates the layer symbology with the values of the first available time instant.

If the simulation detects problems (negative pressures, disconnected nodes, pumps in cavitation), the status report records them at a warning level.

Progress Dialog Options



EPANET Simulation Progress Dialog

The progress dialog includes a **Pause** button (⏸ icon). When pressed, the simulation stops at the end of the current time step and the icon changes to ▶. Pressing again resumes execution. The button disappears once the simulation has concluded.

The dialog also includes the **"Do not show this progress window again"** checkbox. If you check it and the simulation finishes successfully, subsequent runs will launch the calculation directly without displaying the dialog.

Warning

Exception for large networks: if the product (number of nodes: junctions + tanks + reservoirs) × (number of calculation instants = Duration / hydraulic time step) exceeds **500,000**, the progress dialog is always shown in that run, even if the "Do not show this progress window again" box is checked from a previous run. Furthermore, in that case the box itself is hidden from the dialog, since the saved preference remains ineffective for the duration of that large network.

> To re-enable the progress dialog on networks that do not exceed that threshold, go to **Project Properties** and uncheck the *"Do not show progress window when running simulation"* option.

Warning

When the progress window is hidden, the system cursor changes to a standby cursor in all applications while the simulation is in progress. The cursor is automatically restored upon completion of the calculation.

Status messages during execution

The progress dialog informs about the different phases of the calculation:

- **Saving results…**: indicates that the results are being written to disk after the hydraulic calculation is completed.
- If the result files (`.out` , `.hyd`) are **locked by another application** (for example, EPANET Desktop opened with the same project), the plugin detects it and notifies the user with a specific warning.

Error handling

- If EPANET returns an error during the calculation, the content of the report (`.rpt`) is automatically displayed in the incident log without the need to search for it manually.
- Unexpected exceptions during the process are also captured and displayed in the log, avoiding silent failures.

Results browser

Analysis bar → Results browser

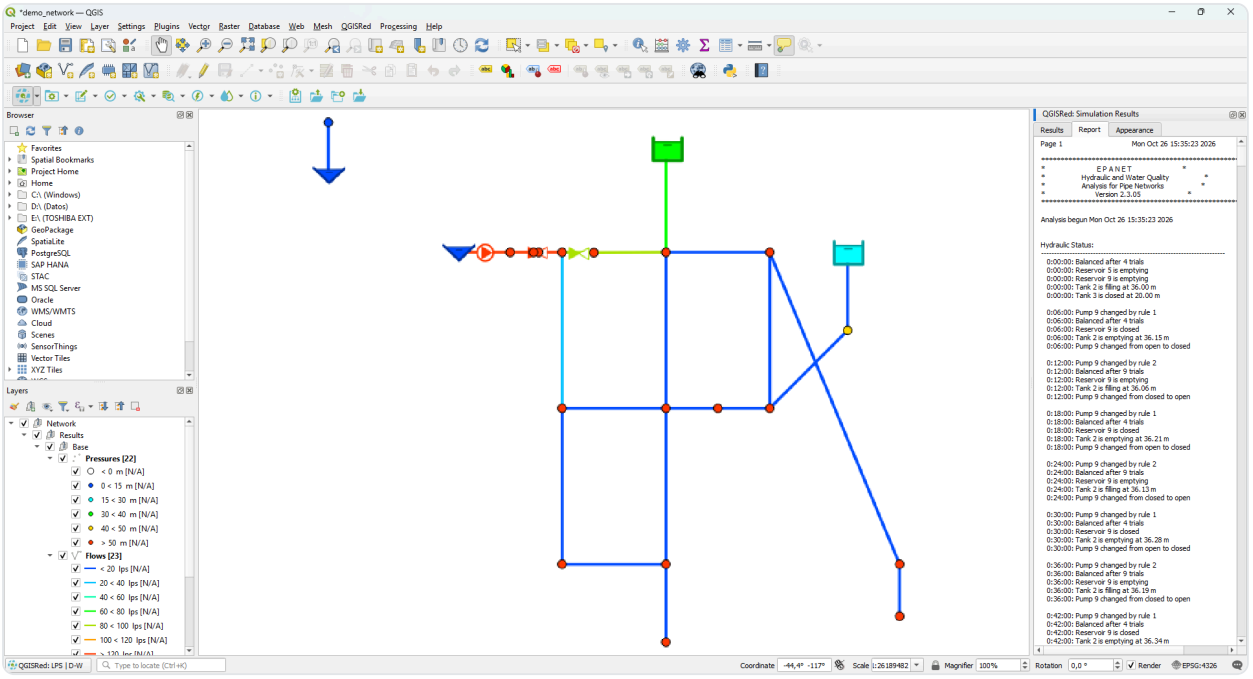
Opens the results panel if a previous simulation already exists for the active project, without simulating again. If there are no results, it launches the simulation automatically.

It is equivalent to **Run model** but prioritizing the results already calculated: if the file `.out` exists and corresponds to the current project, it loads them directly. Useful to reopen the viewer after closing it without losing the results.

Status report

Analysis bar → Status report

Opens the results panel directly to the **Status Report** tab, which displays the text report generated by the EPANET engine upon completion of the simulation.



Results Dashboard Status Report Tab

The report includes:

- General mass balance of the network.
- List of nodes with negative pressure or out of range.
- Warnings of pumps operating outside their curve.
- Convergence status of the hydraulic calculation in each step.
- Summary of quality reactions (if quality was simulated).

> The status report is the first place to look when a simulation produces unexpected results or does not converge.

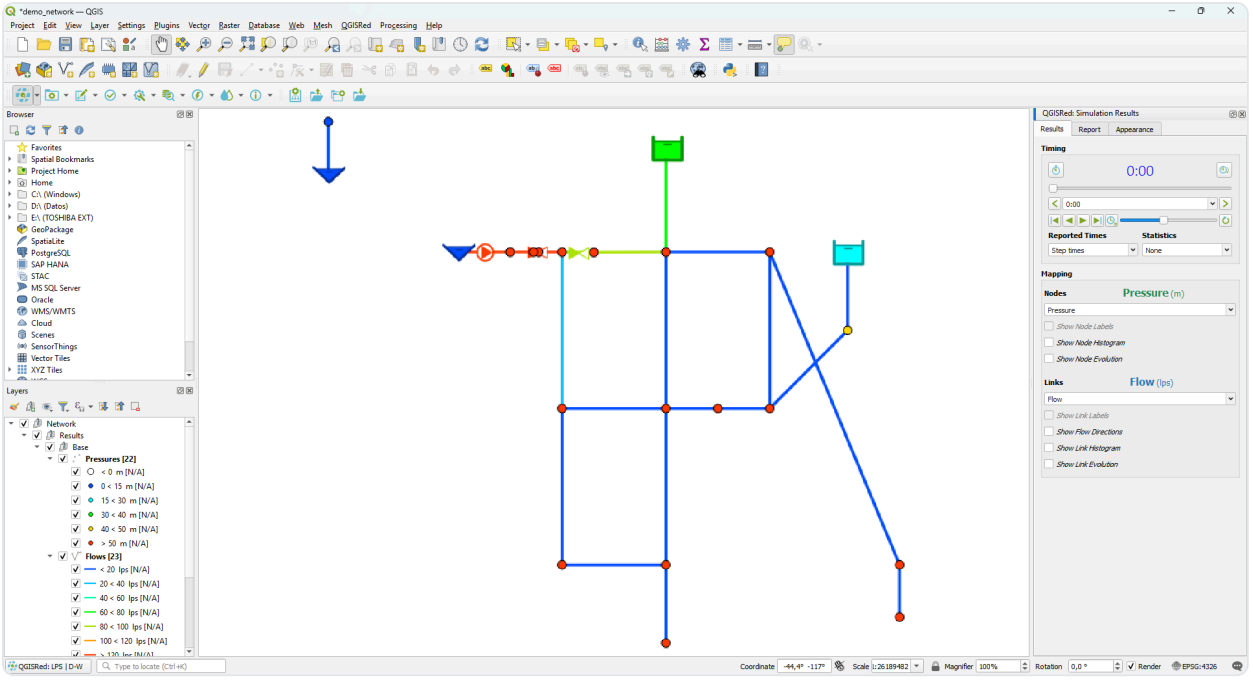
9.2 Results Viewer

Once the simulation is complete, QGISRed offers two complementary tools to explore the results: the Results dock, which controls the display on the map, and the Time series dock, which shows the evolution of any variable over time for individual elements.

Results dock

The Results dock is anchored to the right area of the screen. Contains **three tabs**:

- **Results**: interactive visualization on the map with variable selection, temporal navigation and map options.
- **Report**: EPANET engine text report.
- **Appearance**: complete configuration of the visual appearance of the results on the map.



Results panel with variable selector and time bar

Results dock: variable selection, statistics mode and navigation by time instants.

Results tab

Timing Group

Displays the current time instant in `HH:MM:SS` format (or in am/pm format if active). Includes buttons to toggle between civil format and elapsed time format.

When a stat mode is active (Maximum, Minimum...), the time area shows the name and description of the stat instead of the clock.

Temporal navigation (Time controls)

Control	Description
Time Slider	Scroll through the moments of the report.
Combo of moments (`cbTimes`)	Drop-down list with all available moments.
Forward/backward buttons	Next, previous, start, end.
Play / Play backward	Automatic forward or backward animation.
Speed slider	Controls the relative speed of the animation (1–10). It is hidden when **Constant playback rate** is active.
Constant playback rate	Switchable button next to the speed slider. When activated, the slider is replaced by the field **"1h in: N sec"**: N are the actual seconds it takes to play an hour of simulated time (1–3600), so the playback speed is constant with respect to the simulated time even if the step between instants is not uniform. When you deactivate it, the relative speed slider is used again. The state and value are saved in the project.
Loop	Repeat the animation in a loop.

> 💡 When you change the time instant, activate or deactivate a statistics mode, modify the decimals in the Appearance tab, or load all the results at once, QGISRed rereads and reformats the values. If the operation takes a while (large networks with many elements), a notice appears superimposed and centered on the map: **"Reading results… NN%"**. In quick operations it is not displayed, to avoid flickering.

Reported Times and Statistics

Two combos located under the time controls:

Combo	Description
Reported Times (`cbResultTimes`)	Filter which moments are shown: Single Period, Step times or All calculation times.
Statistics (`cbStatistics`)	Applies a statistic on all periods: Maximum, Minimum, Range, Average, StdDev, Warning. When active, the clock is replaced by the stat name.

> 💡 In **Maximum** and **Minimum** modes, the map labels show the value along with the time of occurrence in the format `valor (@ HH:MM:SS)`. When you place the cursor over a map element, the tooltip includes an additional line `@ HH:MM:SS` with the exact moment in which that maximum or minimum occurred.

> 💡 With any stat mode active, the tooltip prepends the value with the abbreviation of the displayed statistic: **Max**, **Min**, **Avg** (Average), **Rng** (Range) or **Std** (StdDev). For example, `Max 45.2` instead of simply `45.2`.

Mapping Group — Nodes

Control	Description
Combo Nodes (`cbNodes`)	Property to display in nodes: Pressure, Head, Demand, Quality.
Show Node Labels	Displays labels with the ID and value on each node on the map.
Show Node Histogram	Opens a built-in histogram in the dock with the distribution of the current value in nodes.
Show Node Evolution	Opens an integrated mini-graph with the temporal evolution of the selected node on the map.

> 💡 When a variable is selected in the **Nodes** combo, a label appears next to the group header with the variable name in bold and its unit in parentheses (for example, **Pressure** (m)).

Mapping Group — Links

Control	Description
Combo Links (`cbLinks`)	Property to display in pipes/valves/pumps: Flow, Velocity, HeadLoss, UnitHdLoss, FricFactor, Status, ReactRate, Quality.
Show Link Labels	Displays labels with the ID and value on each pipe.
Show Flow Directions	Add flow direction arrows on the pipes.
Show Link Histogram	Histogram integrated into the dock with the distribution of the current value in pipes.
Show Link Evolution	Integrated mini-graph with the temporal evolution of the selected pipeline on the map.

> 💡 Similarly, when a variable is selected in the **Links** combo, a label appears next to the group header with the variable name in bold and its unit in parentheses (for example, **Velocity** (m/s)).

> **Warning**
>
> When the **Links** variable is **Status**, the text labels are simplified: the ~13 internal states that EPANET can return are grouped into just two texts, **"Closed"** (includes "Temp Closed") and **"Active"** (includes "Active (Rev Pump)"). Links with any state *"Open"** do not show any labels, so as not to clutter the map with most of the pipes (which are usually open). It is not an error if, with Status active, most of the pipes appear without label.

> The **Appearance** button (icon in the header of the Nodes group) takes you directly to the Appearance tab without having to navigate through the tabs.

> 💡 When the **Nodes** or **Links** combo is set to "None", the corresponding layer does not disappear from the map: it is shown with a uniform gray symbol and no legend, so the network remains visible as a reference while no result variable is active for that element type. This gray style can also be customized (color, size) by opening the **Legend Editor** on the layer, just like with any other single-symbol layer.

> 💡 In the QGIS layers panel, each open results layer now shows only the name of the represented property (for example, **Pressures**, with no unit in the name); the unit appears in each legend class instead, at the end of its label (for example, "< 20 m"). Each class also indicates in parentheses the number of elements it contains — just as the input layers already do.

> 💡 The **Results** and **Queries/Issues** groups in the layers panel are mutually exclusive when checked by hand: checking one unchecks the others automatically. QGISRed can still have several of them open at once when it opens them itself (for example when generating a thematic map with results visible).

Report Tab

Displays the text report generated by the EPANET engine upon completion of the simulation. Includes:

- General mass balance of the network.
- List of nodes with negative pressure or out of range.
- Warnings of pumps operating outside their curve.
- Convergence status of the hydraulic calculation in each step.
- Summary of quality reactions (if quality was simulated).
- In case of error, the full content of the report is automatically displayed here.

> The status report is the first place to look when a simulation produces unexpected results or does not converge.

Appearance Tab

Concentrates all the options for visual presentation of the results on the map. Settings are automatically saved to `{Red}_Results_Config.cfg` within the project's `Results/` folder and restored in the next session.

> 💡 Each numerical control in the Appearance tab has a small individual ↺ button that restores only that field to its default value, without affecting the rest of the settings.

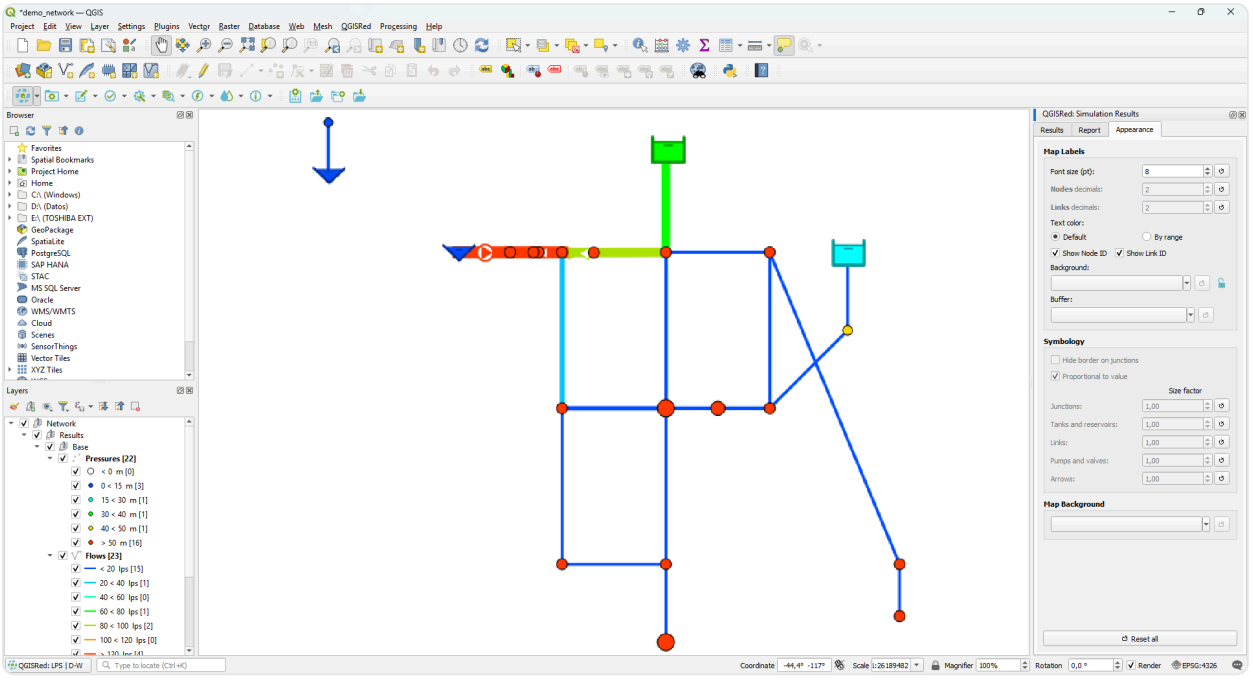
> **Warning**
>
> The **Nodes** group controls are automatically disabled when the Nodes combo is set to "None", and the same is true for **Links**. Additionally, the **Decimals** control is disabled when the active variable is **Status** (categorical variable with no applicable decimals).

Map Labels

Option	Description
Font size (pt)	Font size of labels on the map (6–24 pt, default 8).
Nodes / Links decimals	Number of decimals displayed on node and pipe labels respectively (0–6). The control is labeled with the name of the currently active variable.
Text color	Default Color: Nodes **#333333** (Dark Grey), Pipes **#0A143C** (Navy Blue). **Black**: always black text. **By range**: The text color follows the palette of the active value range. When **Show Node ID** or **Show Link ID** is active, the Id line uses the color of the element itself and the value line uses the color of the symbol or range.

Option	Description
Background	Background color behind map labels. Includes a color picker and a delete button to remove the background. Next to the selector is a **lock** icon: open (by default), the labels background is independent of the map background; When you close it, the selector and clear button are disabled and the labels background is linked to the **Map Background** color (see below), so changing that color also automatically changes the labels background.
Buffer	Outline color (halo) around label text, with its own color picker and delete button. It is independent of the Background and is never linked to the Map Background. Without an assigned color (default) no halo is drawn.
Show Node ID / Show Link ID	Two independent boxes: add the ID of the node or the pipe, respectively, in the first line of its label.

Symbology



Appearance tab with Proportional to value and Id tags activated, network colored by results on the map

Option	Description
Hide border on junctions	Hides the edge/outline of junction markers. Enabling this option removes the outline surrounding the node symbol.
Proportional to value	Scales the size of the nodes and the thickness of the pipes linearly with the represented value. Does not apply to the Status field.
Nodes factor	Base scale factor of node marker size (0.25–4.0, default 1.0).
Links factor	Pipe thickness base scaling factor (0.25–4.0, default 1.0).
Arrows factor	Flow direction arrows scale factor (0.25–4.0, default 1.0).

Map Background

Allows you to set a solid background color for the map canvas while viewing results. The color is restored to the original when the dock is closed. The **×** button removes the background color.

> 💡 The outline of tank and reservoir symbols is automatically recalculated to remain visible against the chosen background color.

Reset all

Returns all parameters on the Appearance tab to their default values.

Scenarios

The dock supports multiple outcome scenarios. Each scenario is identified by a name (by default `Base`) and is stored as files `.out` / `.hyd` in the `Results/` subfolder of the project. The name of the active scenario appears in the panel title.

Available properties

Nodes (Junctions, Tanks, Reservoirs):

Property	Description
`Pressure`	Pressure in m.c.a.
`Head`	Piezometric height in m
`Demand`	Calculated demand
`Quality`	Water quality (depending on the type configured in Analysis options)

Pipes, valves and pumps (Links):

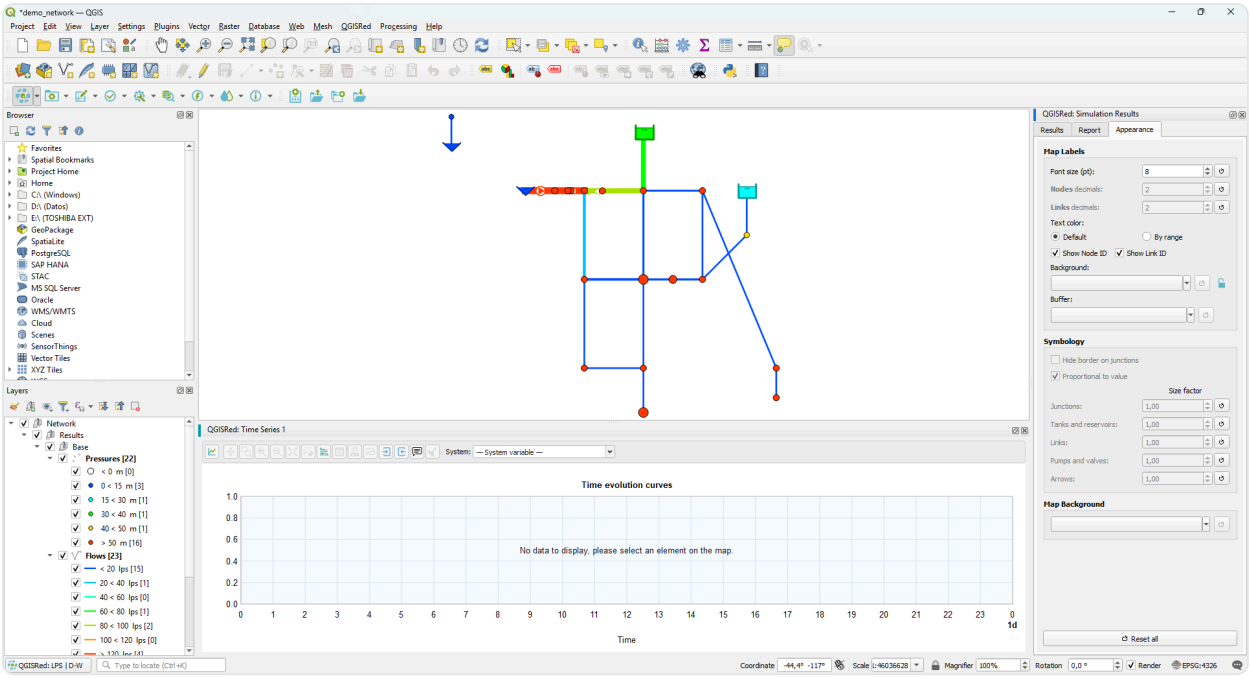
Property	Description
`Flow`	Flow rate (with sign or without sign)
`Velocity`	Velocity in m/s
`HeadLoss`	Head loss in m
`UnitHdLoss`	Unit loss in m/km
`FricFactor`	Friction factor
`Status`	Operational status (Open / Active / Closed)
`ReactRate`	Reaction rate (quality models)
`Quality`	Water quality

> 💡 The map labels for the **Flow** variable always show the absolute value (without a negative sign), even in the Maximum and Minimum statistics modes. The direction of flow is indicated by the direction arrows, not by the value sign.

Time series

Analysis bar → Time series…

Activates an interactive selection tool that plots the time evolution of any result property for one or more network elements.



Panel Time series with multi-node pressure curves

Panel Time series: time evolution of pressure in several nodes selected simultaneously.

Process

1. Activate **Time series** (checkable button). The Time series panel opens at the bottom of the screen.
2. Click on any element on the map (node, pipe, valve, pump, tank, reservoir).
3. The panel draws the time curve of the active property in the Results dock for that element.
4. The item is highlighted in blue on the map.

Multiple selection

- **Shift + click** on another element: adds its curve to the graph without deleting the previous ones. Each curve receives a different color from the palette.
- **Shift + click** on an element already selected: removes it from the graph.
- **Click without Shift** with more than one active curve: asks for confirmation before clearing the selection.

Property Selection

- By default, the active property is represented in the Results dock for the type of element clicked.
- **Right click** on an element: Opens a context menu to choose any other properties available for that element without changing the Results dock view.

Additional properties for buckets

For the **Tank** element type, two additional quantities are available:

Magnitude	Description
Volume	Stored volume in m^3 (or ft^3 depending on project units), calculated from EPANET output binaries.
TankSpill	Overflow flow. It is only non-zero if the tank has the EPANET overflow option enabled.

Network global variables

In addition to individual elements, the Time series panel allows you to add **global series** that aggregate values over the entire network. These series do not require clicking on the map: they are added from the graph's variable selection menu.

Global variable	Description
TotalWaterSupply	Total flow supplied by all reservoirs and sources in the network.
TotalWaterDemand	Total demand consumed by all nodes in the network.
AverageNodePressure	Average pressure of all nodes (excludes tanks and reservoirs).
TotalStoredVolume	Total stored volume adding all tanks in the network.
TotalTankSpill	Total overflow flow adding all the tanks in the network.

Curve configuration

From the Time series panel you can adjust for each curve:

- Name in the legend.
- Color, line style (solid, dashed, dotted) and thickness.
- Markers: symbol, size, color, space.
- Show values at each point of the curve.
- Visibility (show/hide without deleting).

Table of values

The values table displays the numerical data for all active curves. The **first column** (time instant) is **fixed**: it does not disappear when scrolling the table horizontally when there are many curves. This makes it easy to identify where each row is at without having to go back to the beginning.

Synchronization with the value table

When you move the cursor over the chart, the corresponding row of the stock table is automatically highlighted in real time.

Copy table to clipboard

The copy function generates **two header rows**: the first with the name of the element or magnitude and the second with the unit. Facilitates direct pasting into spreadsheets.

Export and import chart settings

The **Export chart configuration** and **Import chart configuration** buttons save and retrieve the complete configuration of curves, axes and styles in a `.cfg` file. It is also possible to export the general template configuration (axes, styles) even if there are no curves loaded, and apply it when importing it on a new graph.

Multiple chart windows

The **New chart window** button opens a new independent Time Series window. Each window has its own curve context, property and selected elements. You can keep several windows open simultaneously to compare different variables or areas of the network.

Time format synchronization

The "Time of Day" column in the values table automatically uses the same format (24h or am/pm) as the Results panel.

Closing

When you turn off the **Time series** button or close the panel, the highlight disappears and the cursor returns to standard navigation mode.

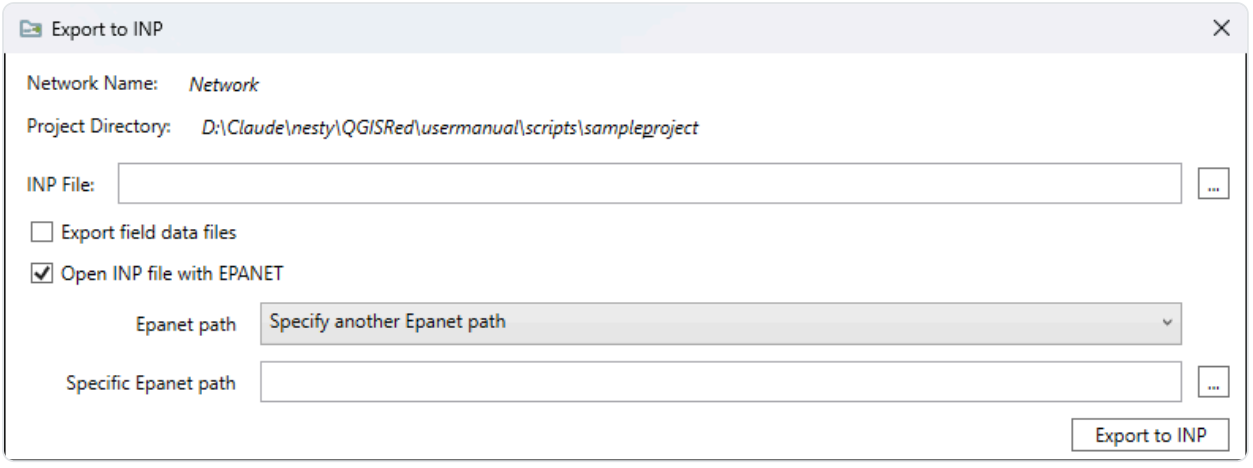
9.3 Model Export

The Analysis bar offers two export paths: the full model as an EPANET `.inp` file, and the simulation results as CSV tables.

Export model to INP…

Analysis bar → Export model to INP…

Exports the entire model to the standard EPANET **INP** format. Useful for sharing the model with other users, running it in the EPANET graphical interface or integrating it with third-party tools.



Export dialog to INP format

Export to INP dialog: destination route, field data export and automatic opening in EPANET.

Dialog Options

Option	Description
INP file	Full path of the `.inp` file to be generated. Use the `…` button to navigate.
Export field data files	Also exports the auxiliary field data files associated with the model.

Option	Description
Open INP file with EPANET	If active, opens the `.inp` in EPANET upon completion of the export.
Epanet path	EPANET executable detected on the system. The dropdown shows all installed versions.
Specific Epanet path	Manual path to an EPANET executable not automatically detected.

Press **Export to INP** to generate the file with the chosen configuration.

> **Note**
>
> **Decimal precision according to project default values.** The number of decimal places used for each field in the generated `.inp` file respects the precision configured in the project default values, the same as that shown in the Properties and Queries panels. In previous versions, a fixed format of 4 to 6 decimal places was applied regardless of the project configuration.

Export results to CSV…

Analysis bar → Export results to CSV…

Exports the results of the last simulation to two CSV files: one for nodes and one for pipes. It is the standard method for getting results into Excel, Python, R, or other external analysis tools.

> Only available if a simulation file `.out` exists for the active scenario.

Dialog Options

Option	Description
CSV nodes	Output file path for node results. By default `{Red}_{Escenario}_Nodes.csv` in folder `Results/`.
CSV Links	Output file path for pipeline results. By default `{Red}_{Escenario}_Links.csv`.
List separator	Field separator (automatically detected from the regional system; common `;` in European premises).
Decimal separator	Decimal separator (detected from the system; common `,` in European locations).

File contents

CSV Nodes — one row per time instant per node, with columns:

`Time | ID | Pressure | Head | Demand | Quality`

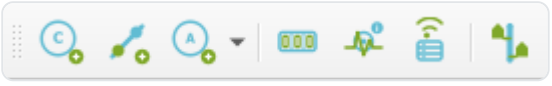
CSV Links — one row per time instant per pipe/valve/pump, with columns:

`Time | ID | Status | Flow | Velocity | HeadLoss | UnitHdLoss | FricFactor | ReactRate | Quality`

> The separators adapt to the locale of the operating system so that the file opens correctly in Excel without the need for conversion.

10 🧬 Digital Twin

The **Digital Twin** bus adds to the hydraulic model the infrastructure elements that connect the network with the end user and with the field monitoring systems: connections, shut-off valves, meters and sensors. These elements are not strictly part of the EPANET model but enrich the digital twin with operational and remote reading information.



QGISRed Digital Twin Toolbar

Digital Twin Bar: connections, shut-off valves, meters and field data loading.

Digital Twin Bar Tools

Group 1 — Network elements

#	Tool	Function
1	**Add service connection**	Draw a connection from the main pipe to the customer's supply point
2	**Add isolation valve**	Add a shut-off valve by clicking on a pipe
3	**Add meter** (dropdown)	Place a meter or sensor on a pipe. 11 types available

Group 2 — Operational data

#	Tool	Function
4	**Load meter readings…**	Load smart meter readings and associate them with the project connections
5	**Set pipe's initial status from isolation valves**	Propagates the open/close status of the shut-off valves to the `InitStatus` field of the affected pipes
6	**Load field data…**	Import SCADA field data and associate it with the project meters

Group 3 — Integration into the model

#	Tool	Function
7	**Convert service connections into pipes/nodes**	Converts connections into point nodes or pipes of the EPANET model

---

In this section

- Connections and Shut-Off Valves — drawing of connections, shut-off valves and conversion to the hydraulic model
- Sensors and Meters — meter types, loading readings and field data

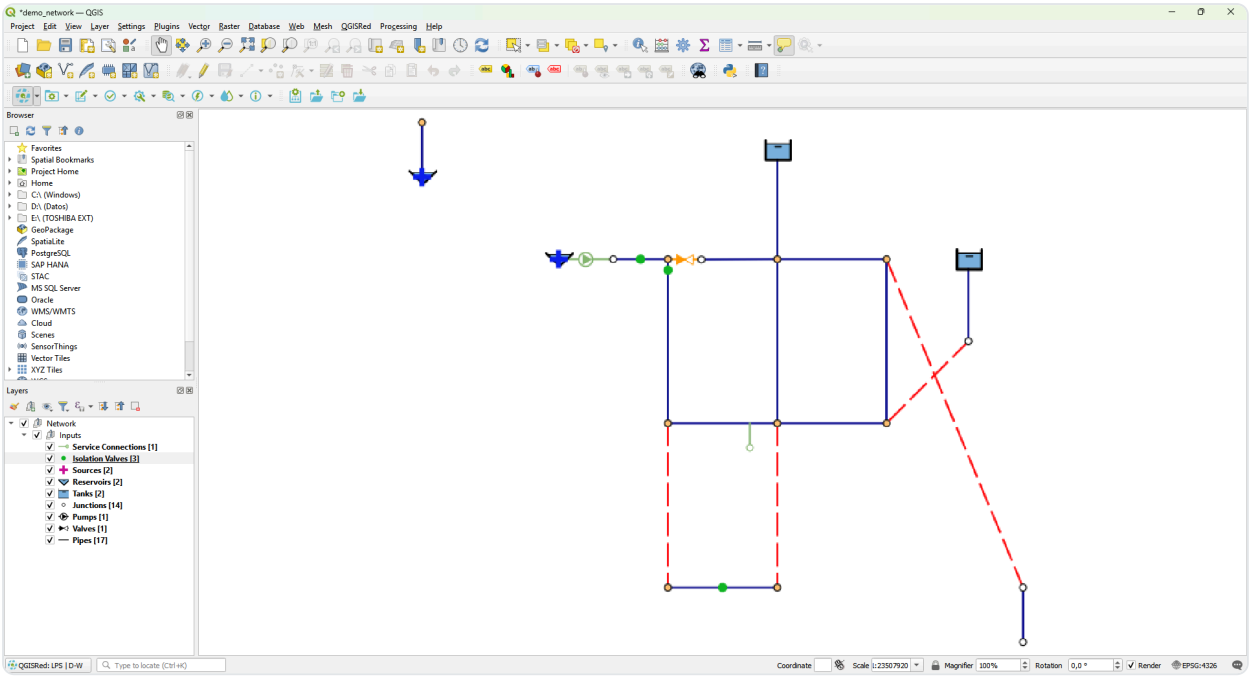
10.1 Connections and Shut-Off Valves

The connections and cut-off valves are the two elements that connect the hydraulic model with the operational reality of the network: the connections represent the individual connection with each client and the cut-off valves allow the isolation of sectors to be modeled without the need to modify the topology of the EPANET model.

Add service connection

Digital Twin Bar → Add service connection

Draws a drop as a polyline from the main pipe to the customer's delivery point. The connection is stored in the complementary layer `ServiceConnections` of the project.



Connection drawing tool on the map

Service drawing: the line starts from the main pipe and reaches the client's plot boundary.

Process

1. Activate **Add service connection**. The cursor changes to line drawing mode.
2. Click on the main pipe at the intake point.
3. Click on the intermediate points of the trace if the connection is not straight.

4. Double click on the end point (plot boundary or counter) to complete the layout.
5. QGISRed calls the C# engine (`GISRed.AddConnection`) and updates the `ServiceConnections` layer.

The connection automatically inherits the closest connection node from the main network. The `IsActive` field of each connection allows the supply to be activated or deactivated individually without deleting the element.

Add isolation valve

Digital Twin Bar → Add isolation valve

Add a manual shutoff valve to an existing pipe by clicking on it. The cut-off valves are stored in the complementary layer `IsolationValves` and are not EPANET elements: they do not appear in the simulation but they do appear in the analysis of isolated segments (**Isolated segments**, Tools bar).

Process

1. Activate **Add isolation valve**.
2. Click on the pipe at the point where you want to place the valve.
3. QGISRed inserts it into the `IsolationValves` layer and represents it on the map.

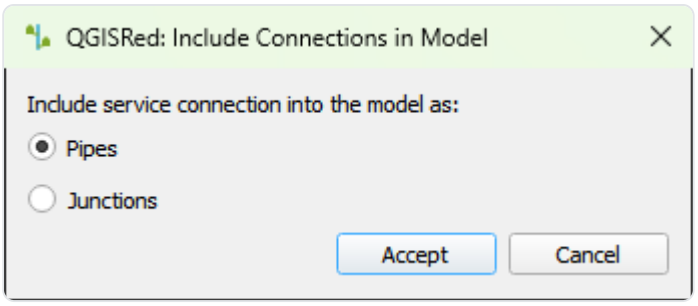
Relationship to simulation

Shutoff valves alone do not modify the EPANET model. To have its status (open/closed) affect the simulation, use the **Set pipe's initial status from isolation valves** tool in Group 2.

Convert service connections into pipes/nodes

Digital Twin Bar → Convert service connections into pipes/nodes

Incorporates the connections drawn in `ServiceConnections` to the active EPANET model. Requires that layer `ServiceConnections` exists and contains at least one connection.



Connection conversion dialog, with the As nodes and As pipes options

Conversion options

When you run the tool, a dialog appears with two options:

Option	Result in the model
As nodes	Each connection becomes a point demand node at the connection point with the main pipeline. The geometry of the connection does not enter the model.
As pipes	Each connection becomes a small diameter pipe that goes from the intake node to a new final node. Allows you to simulate losses in the client connection.

When to use each option

- **As nodes**: when the only interest is to incorporate the customer's demand into the model without simulating the internal losses of the connection. It is the usual option for distribution networks at the neighborhood or city scale.
- **As pipes**: when you want to simulate subscriber networks with real connection diameters, or when the length of the connection is significant with respect to the main network.

> This operation modifies the EPANET model (layer `Junctions` and/or `Pipes`). Save the project before running it if you want to keep the previous state.

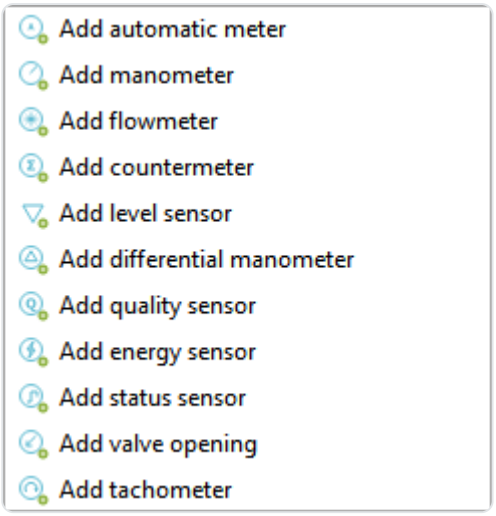
10.2 Sensors and Meters

The Digital Twin meters and sensors are elements that record physical magnitudes at specific points in the network. QGISRed stores them in the complementary layer `Meters` and uses them to load field data and compare it with the simulation results.

Add meter (dropdown)

Digital Twin Bar → Add meter

Place a meter or sensor on a pipe by clicking on the installation point. The button drop-down menu allows you to choose the type before placing it; The last type used remains as the default action of the button.



Meter type dropdown in the Digital Twin bar

Add meter drop-down: the 11 meter types available.

Available meter types

Type	Name on the bar	Recorded magnitude
Automatic meter	Add automatic meter	Type automatically determined by context
Manometer	Add manometer	Pressure (m.c.a.)
Flowmeter	Add flowmeter	Flow rate (l/s or configured unit)

Type	Name on the bar	Recorded magnitude
Countermeter	Add countermeter	Accumulated volume (water meter)
Sensor level	Add level sensor	Free sheet level in tank
Differential manometer	Add differential manometer	Pressure difference between two points
Quality sensor	Add quality sensor	Chlorine concentration or other quality parameter
Energy sensor	Add energy sensor	Power or energy consumed (pumping groups)
Sensor status	Add sensor status	Operational status of a pipe or valve
Valve opening	Add valve opening	Degree of opening of a regulating valve
Tachometer	Add tachometer	Speed of rotation of a pump (rpm)

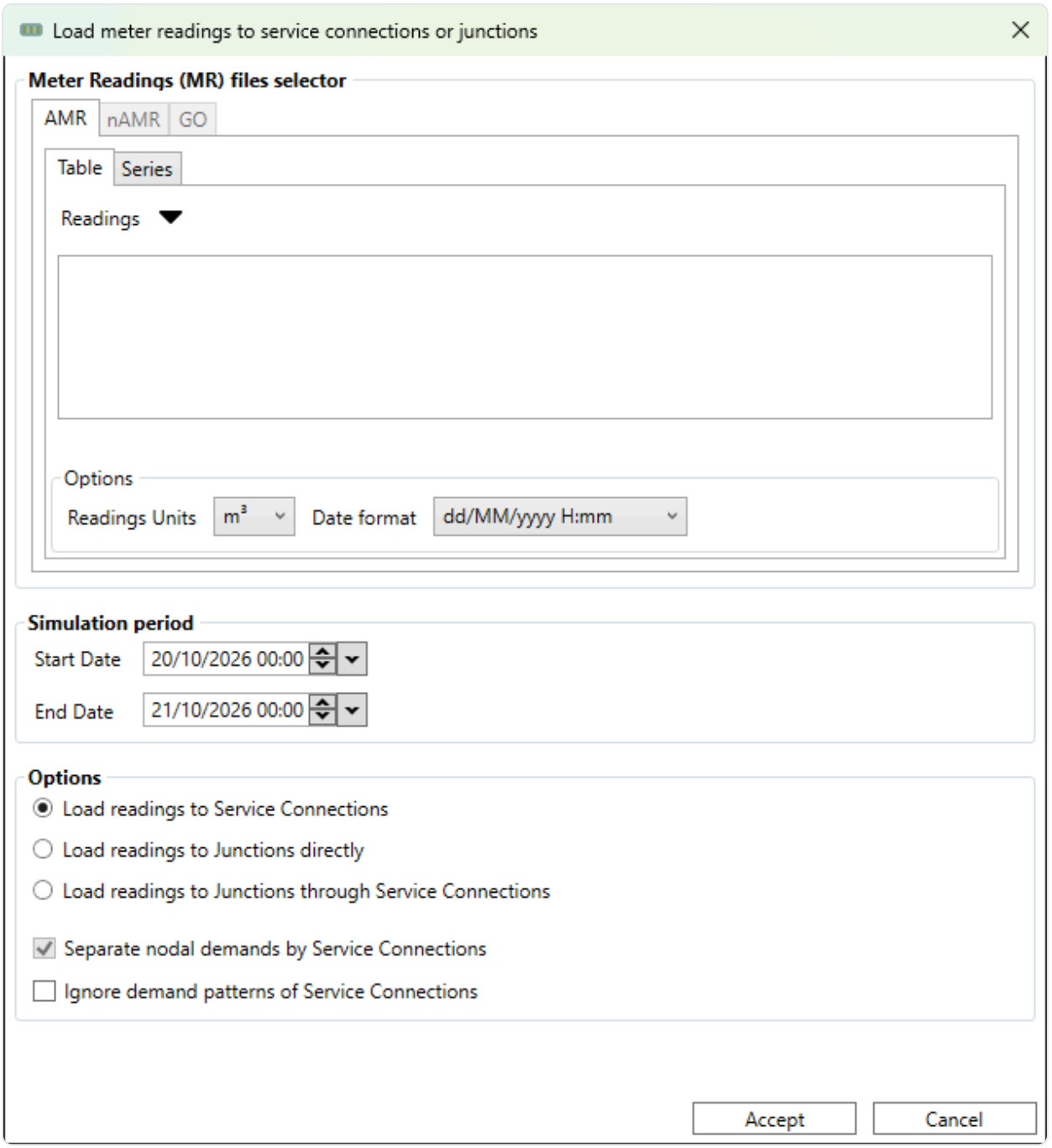
Process

1. Choose the type of meter from the drop-down menu.
2. Click on the pipe at the installation point.
3. QGISRed calls `GISRed.AddMeter` with the selected type and updates layer `Meters`.

Load meter readings…

Digital Twin Bar → Load meter readings…

Imports smart meter readings (smart metering) and associates them with the project connections. The readings enrich the model demands with actual consumption data rather than estimated demands.



Meter Readings Load Dialog, in its default state

Supported import formats

Format	File structure
Table	First row: header with `Time; Id1; Id2; …`. Columns: one counter per column.
Series	One row per record: `Id; Time; Demand`. All counters in the same file.

Field separators are automatically detected from the regional system. The `Time` field accepts both absolute timestamps and offset in hours from the start of the simulation.

> The dialog also has tabs for other reading formats (hourly/daily/periodic, and a GO billing format) — they are disabled in the current version, reserved for future expansion.

Where readings are uploaded

A group of options (radio buttons) decides which element of the model receives the imported readings:

Option	Result
Load the readings to the service connections	The readings are associated with the `ServiceConnections` layer itself, without touching the EPANET model nodes.
Load the readings to the junctions directly	The readings are assigned directly to the nearest node (`Junction`), ignoring the intermediate service connection.
Load the readings to the junctions through the service connections	The readings are assigned to the node following the service connection → node chain, aggregating several service connections on the same node if they share a connection.

Set pipe's initial status from isolation valves

Digital Twin Bar → Set pipe's initial status from isolation valves

Propagates the opening or closing state of the cut-off valves from the `IsolationValves` layer to the `InitStatus` field of the pipes that pass through each valve. Thus, the EPANET model collects the real state of the network without the need to manually modify each pipe.

Requirement

The `IsolationValves.shp` layer must exist in the project directory. If it does not exist, the tool displays a warning and does not make any changes.

When to use it

- Before simulating a specific operational scenario (for example, with a sector closed for maintenance).
- After updating the status of several cutoff valves on the map and before running **Run model**.

> This operation does modify the EPANET model (field `InitStatus` of `Pipes`). To return to the original state, use **Scenario builder** (Tools bar) if you had saved the base scenario before the operation.

Load field data…

Digital Twin Bar → Load field data…

Imports field data from SCADA systems or data loggers and associates them with the meters of the `Meters` layer. The uploaded data is linked to each sensor for later comparison with the simulation results.

The dialog allows you to select the data file and configure the date/time format and field separator. QGISRed calls `GISRed.LoadScada` and updates the records of layer `Meters` with the imported time series.

Typical usage

1. Export field sensor data from SCADA to a CSV or DAT file.
2. Run **Load field data** and select the file.
3. Run the simulation (**Run model**).
4. Visually compare the measured (field) and calculated (simulation) values for each sensor in the **Time series** dock.

11 DBF Formats and Management

Reference for users who edit project data directly in the QGIS attribute tables or from external tools, without going through the QGISRed dialogs.

Date format

Field `InstalDate` of layer `Pipes` stores the installation date as a text string in the format:

```
yyyyMMdd
```

Component	Description	Example
`yyyy`	Year (4 digits)	`2023`
`MM`	Month (2 digits, with leading zero)	`07`
`dd`	Day (2 digits, with leading zero)	`15`

Correct example: `20230715` (July 15, 2023)

If the value does not follow this exact format, the **Check pipe installation dates** tool (Debug bar) will flag it as an issue and the **Set roughness coefficients** tool (Tools bar) will not be able to calculate the aging roughness for that pipe.

Patterns and Curves (DBF)

Demand patterns and curves (H-Q, efficiency, volume) are stored in separate DBF tables. If you edit them directly outside of QGIS:

- **Decimal separator**: Always use the **dot** (`.`), regardless of the system locale. Commas as a decimal separator cause reading errors.
- **Order field**: each table has a numerical order field (`Order` or similar) that determines the sequence of the points or factors within the series. Do not alter this field or leave gaps in the numbering.

Rules

Control rules are stored as individual records in the rules DBF table. Each rule occupies several rows (one per logical line: IF, AND, OR, THEN, ELSE). If you view the table outside of the QGISRed rules manager, sort the rows by these two columns in this order so that the rules are readable:

1. `RuleOrder` — groups all the lines of the same rule.
2. `LineOrder` — defines the logical order of the conditions within each rule.

The `Name` field stores a descriptive label visible in the rules manager. It does not affect the simulation and can be left empty.

12 📜 Changelog

Stay up to date with the latest QGISRed improvements.

Version 0.19

User Interface:

- Grouping of informative options such as News, Incidents, Manual, Rating, Subscriptions and About... in a new Info entry in the main menu.
- Relocation of the Queries menu behind the Tools menu, in the main menu bar.
- Incorporation of a brand and a prefix in the title of all QGISRed panels to differentiate them from others.
- Incorporation of a warning icon in those layers that may become outdated when changes are made to the data.

Project Manager:

- Now you can independently change the name of the QGISRed project and the name of the file that houses the map information (qgz).
- When moving a project, you can move the data and the map file (qgz) together, or independently to different folders.
- The option to make a backup of the project has been removed, and has been replaced by the option to Export the project, with more alternatives.
- When exporting a project, you can choose the QGISRed layer groups and the layers outside the project (cartographies, MDT, etc.) to copy, among those present in the layers panel. All of this is saved in a single .zip file.

- To export the map qgz file, it must be in the same project folder or at a higher level. The cartographic information should be in folders parallel to the project folder.
- When importing a QGISRed project, all previously exported information is restored to a new folder, maintaining the structure of all files.

Import of shapes:

- Possibility of selecting the candidate pipes to connect the connections that start from the imported consumption points.

Material tables:

- Declaration of a different default material table for each of the four supported languages.
- New options in the materials table editing dialog, to copy, load and edit new tables at a global level, before creating a project or from within it.
- New options to choose the desired material table when creating a new project or importing shape files for the first time.

Layer management:

- Creation of a new group of layers called AuxiliaryLayers to host complementary themes to the basic themes.
- Creation of a subgroup within the group of Auxiliary Layers, called Demand Builder, to host its own topics: sectors, specific demands and links.
- Adding a new tab to the Layer Manager to create, delete, load or download auxiliary layers linked to the Demand Builder.

Graphic edition:

- Wand tapping on a pump, valve, or pipe now toggles only between open and closed states.
- To toggle between the active or closed state of a valve, or declare a CV on a pipe, hold the Ctrl key when wand-clicking.
- When inserting a pump or valve in a section smaller than the separation established between the extreme nodes, they are maintained and no longer move.
- When moving a node no layer is left open, avoiding conflicts with other editing tools.
- Revised the vertex editing tool to make it more user-friendly.

- When splitting a pipe at an intermediate point, the Id is split by adding a numerical suffix. The original Id can be recovered if the sections are merged in the opposite direction to which the intermediate nodes were created.
- When two pipes in series cannot be joined by eliminating the intermediate node, the cause is reported.
- Revised the tool for merging or separating nodes, allowing greater separation between them.
- Creating a T connection now extends the last section of the branch until it intersects with the main pipe.
- Revised the undo T and crosses tools, removing some restrictions and standardizing mouse actions.

Group property editing:

- New Edit menu option to edit the properties of group elements.
- Graphical preselection of the elements to modify with multiple selection tools.
- Application of filters to restrict the elements to modify, depending on the type of property.
- Option to display the elements that are going to be modified on the map.
- Multiple options to modify the chosen property, differentiating whether the property is numerical, text or enumerated.
- Preview in the attribute table of the changes made before consolidating them.

Thematic maps:

- Incorporation of new thematic maps linked to pipes: Year of installation, age, and roughness coefficient according to loss formula.
- New thematic maps linked to junctions: Elevations and Total Base Demand graduated by size.
- When creating the material map, each material is now assigned its own color based on its abbreviation and language, which is editable.
- When a thematic map becomes outdated due to a change in units or loss formula, a warning icon is displayed and can be updated by clicking on it.

Legend Editor:

- Improvements to wizards to automatically create ranges, sizes and colors to set the legend for all layers.
- Possibility of modifying some style parameters of the basic themes of the Data group.

- Incorporation to the QGISRed Legends Editor of the layers created by Queries (thematic maps, hydraulic sectors, trees, etc.).
- Added Results layers to the Legend Editor to customize its style.
- Option to save legends at the project level, or at the user level to apply them to new projects.
- Option to store wizards with which to adapt the legend to the data, instead of saving a preconfigured legend.
- Creation of a QGISRed library of symbols, ramps and color palettes, accessible from the Legend Editor and editable from QGIS.

Demand Builder:

- Option to consolidate the imported parameters related to the assignment of demands by sectors in a QGISRed theme.
- Option to distribute global demand or by sectors based on the diameters that converge at the candidate nodes.
- Option to declare consumption by linear sections or by polygons, as an alternative to specific consumption.
- Option to consolidate imported specific consumption in a QGISRed theme.
- Option to manage specific consumption topics and add several demands to the same topic.
- Recognition of various units when declaring the consumption to be imported.
- Option to assign specific demands to the ends of the nearest pipe instead of directly searching for the nearest nodes.
- Option to consider or not the ends of pumps and valves as possible demand nodes.
- Option to distribute specific demands based on the diameters of the pipes that converge at the nodes, or in combination with their distance from the consumption points.
- Notification of loaded nodes that are more than a given distance from consumption points.
- Possibility of editing and reusing links between consumption points and demand nodes.
- Assignment of demands to nodes based on connections declared as elements of the Digital Twin.
- Differentiation of base demands by categories, both in specific consumption and by connections, creating multiple demands at the nodes.
- Option to load demands only from the selected sectors, consumption points or connections.

- Option to use your own theme to assign efficiencies and patterns by sector, import their values and edit them.
- Option to apply hydraulic efficiencies and assign demand patterns by categories.
- Option to readjust efficiencies and patterns declared at one level using those imposed at a higher level (categories -> sectors -> global).

Statistics panel:

- New option in the Queries menu to perform all types of statistics with the model data and results.
- Evaluation of the statistics of a magnitude, classified by ranges or classes of said magnitude or another magnitude of the same type of element.
- Ability to use a second classification magnitude to create double entry tables.
- Possibility of applying filters on the starting data and viewing the elements affected by the query on the map.
- Display of statistics in histograms or through an exportable table of values.
- Export of the query configuration and its subsequent import.

Topology queries:

- Revised the Connectivity, Hydraulic Sectors and Tree Graphs tools: new names, relocation of layers, style changes, etc.
- New topic to highlight isolated demands in the hydraulic sectors.
- Possibility of creating and managing the existence of several themes for Tree Graphs (now called Minimum Cost Trees).

Simulation:

- New progress dialog to show the progress of hydraulic and quality calculations.
- The progress dialog can be paused to carefully observe the progress of the calculations.
- The progress dialog can be omitted for greater speed in calculations, except for networks with long processing times.

Results panel:

- Option to show all calculation moments in the results map and other panels in which time intervenes.
- Option to show the moment of the simulation in various formats: time elapsed since the beginning (in accumulated hours or grouped by days) or calendar time (in 24 hour or am/pm format).

- New button bar to perform animations at controlled speed or step by step.
- The variables chosen to display the results of nodes and lines are now highlighted and have their own color assigned.
- New tab with several options to improve the visualization of the results on the map, the symbology and the background color.
- New option to show in a histogram the distribution of the current variable of nodes or lines and their accumulated values, at the current moment.
- New option to show a simplified evolution curve of the current variable of nodes or lines, for the chosen element on the map.
- When rescuing the Results Panel, the options from the last action are preserved, instead of applying the default options.
- When the scenario data is changed, the result layers display a warning icon, which can be updated by clicking on it.

Evolution graphs:

- New buttons to navigate the evolution curves graph.
- New button with multiple options to customize the appearance of all the components of the graph.
- Adaptation of the time scale according to the options chosen in the Results Panel.
- Possibility of showing all time moments or only scheduled moments, as chosen in the Results Panel.
- Optional synchronization of the cursor with the current moment of the Results Panel.
- Incorporation of the evolution of the volume of a tank or the overflow flow, as new variables.
- Option to represent the evolution curves of some global variables for the entire system.
- New button to display in a table the numerical values of the passing points of the evolution curves and export their values to a CSV file.
- New button to export graphs as images.
- Option to save and recall evolution chart settings including template creation.
- Ability to create and keep open several evolution curve windows at the same time.

Languages:

- All QGISRed menu options, dialogs and messages are now also displayed in French and Brazilian Portuguese, when this language is chosen for the QGIS interface. Currently they are already shown in English and Spanish.

Other changes:

- All security controls verified and incidents related to code quality, reported by the QGIS Security Scan system, corrected.
- Checked version 0.19 code for compatibility with Qt6 and QGIS 4.xx.
- End of support for QGISRed libraries on 32-bit (x86) systems. From now on QGISRed will only work on 64-bit systems.
- Removed the minimize and maximize buttons in all dialogs built into the libraries.
- Revised the names of some fields in shape files, dbf tables and CSV files, for uniformity. All identifier fields now end with ID.
- Revised the property names displayed in all QGISRed dialogs, depending on the language, for uniformity.
- Revised the decimals shown in the topic attribute tables, depending on the units used.

Bug fixes:

- Review of possible situations when loading GISRed libraries to avoid repeated attempts.
- Review of the export format of INP files to avoid overlaps that caused reading errors.
- Corrected a bug that prevented creating new behavior curves.
- Checking that the identifiers of the elements, curves and patterns do not contain any blank space.
- Corrected an error that prevented consolidating the civil start time of the simulation.