UWOT (Urban Water Optioneering Tool)

Hands-on training

D. Bouziotas, D. Nikolopoulos, S. Manouri and C. Makropoulos

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Introduction
UWOT application and training material

- Navigate through the detailed page of UWOT model available at the Knowledge Portal and download supportive material

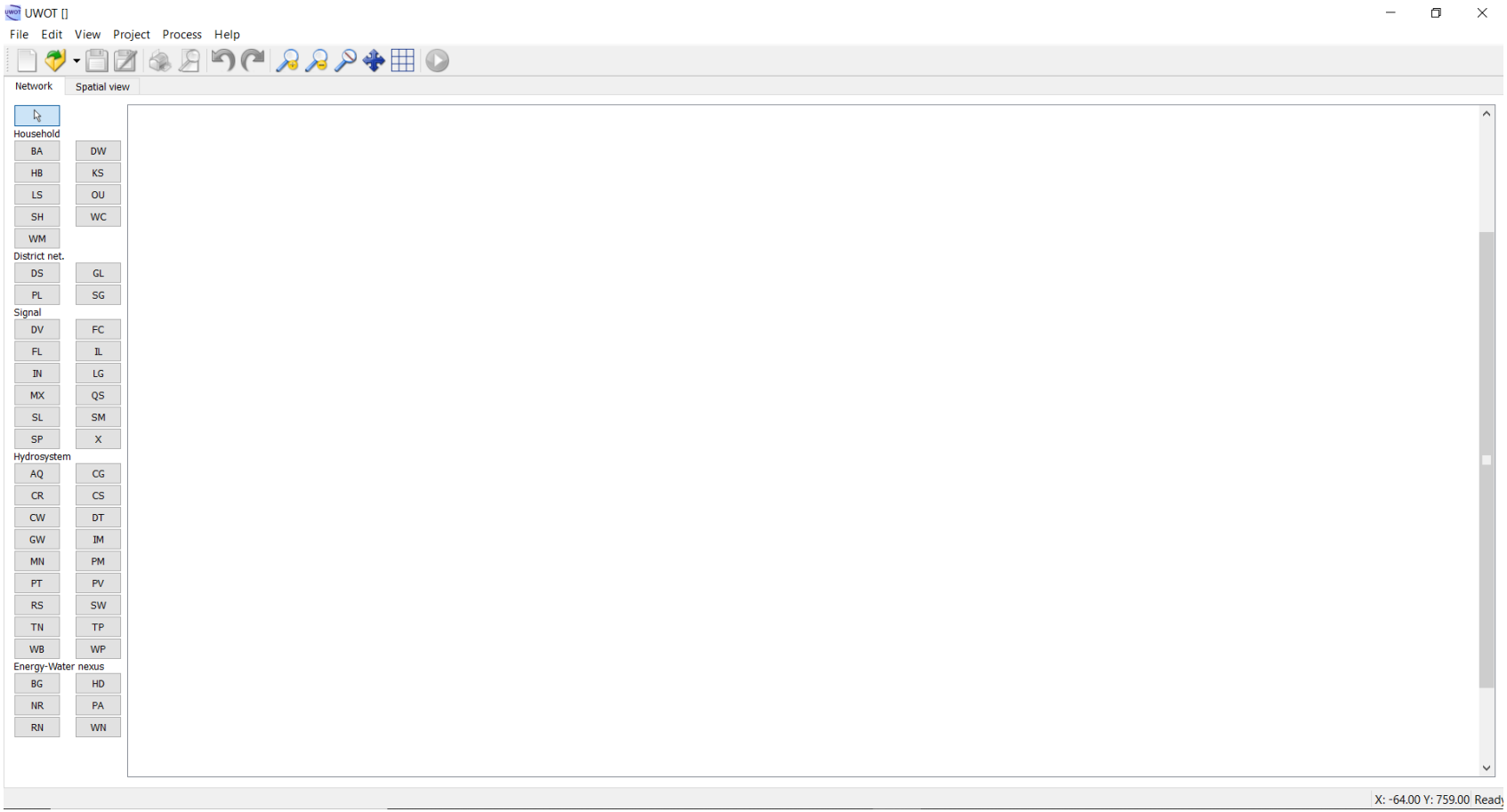
  https://mp.nextgenwater.eu/d/Product/25

  - **UWOT overview presentation:**
    An overview presentation of UWOT tool, introducing the users to its content and role, explaining the way it works and providing results of its application to case studies and insights from past projects.
  - **UWOT hands-on training:**
    A step-by-step guide to create a topology and run a simulation
  - **UWOT short guide and FAQ:**
    A short guide on installation and usage along with the most typical issues and their solutions
  - **Demo timeseries of UWOT model:**
    Demo timeseries of fluctuation, occupancy, rainfall and runoff

- Contact Christos Makropoulos (cmakro@mail.ntua.gr) to provide you with UWOT application

- Unzip (in common folder) & run *main.exe* (after receiving the UWOT application)

UWOT user interface



Categories and components

UWOT five categories:

- **Household Appliances**
- **District Network**
- **Signal**
- **Hydrosystem**
- **Energy**

Each component is classified into one of these categories.

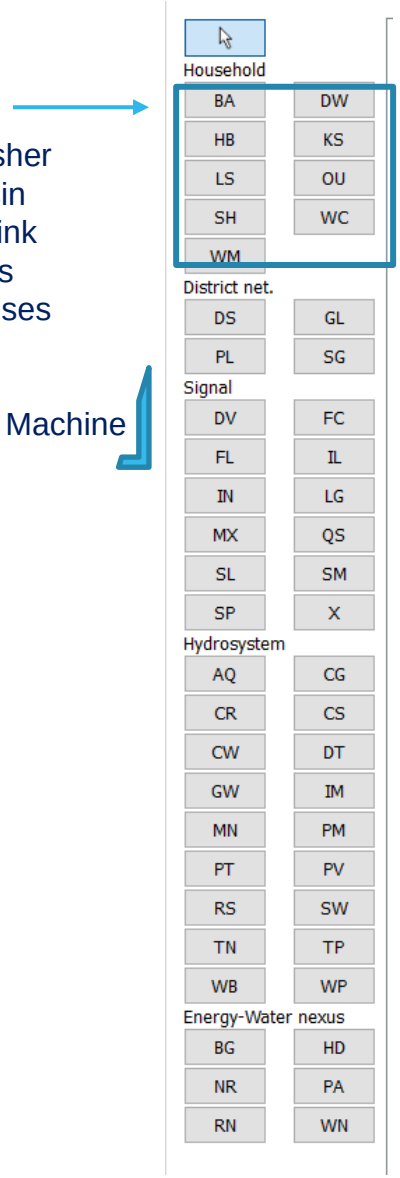
UWOT distinguishes between two types of demand signals, the ***push*** and the ***pull*** signals.
Push signals are related with a need to dispose an amount of water (e.g. stormwater).
Pull signals have to do with the need to bring water to cover a demand.

UWOT Household modelling
Introduction

The **Household Appliance** category includes the components inside household, such as:

- the appliances that consume water (e.g., washing machine, toilet, shower, etc.)
- the appliances that offer decentralized water management (local greywater treatment)
- the components that represent the part of the mains directly serving every household (e.g., distribution network of potable water, drainage network, etc.)

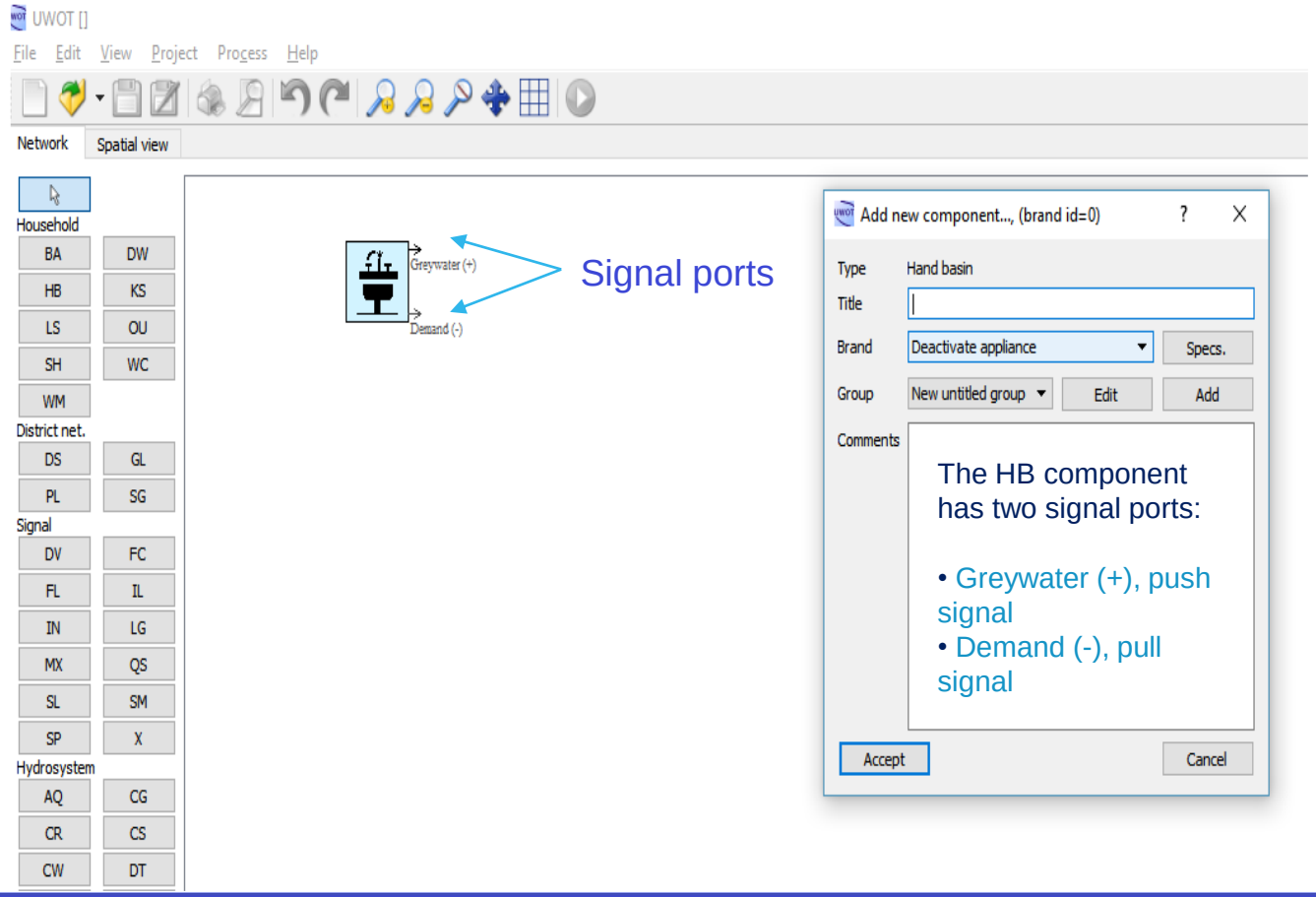
BA: Bath
DW: Dish Washer
HB: Hand Basin
KS: Kitchen Sink
LS: Local Suds
OU: Outside uses
SH: Shower
WC: Toilet
WM: Washing Machine



How to create a topology step by step

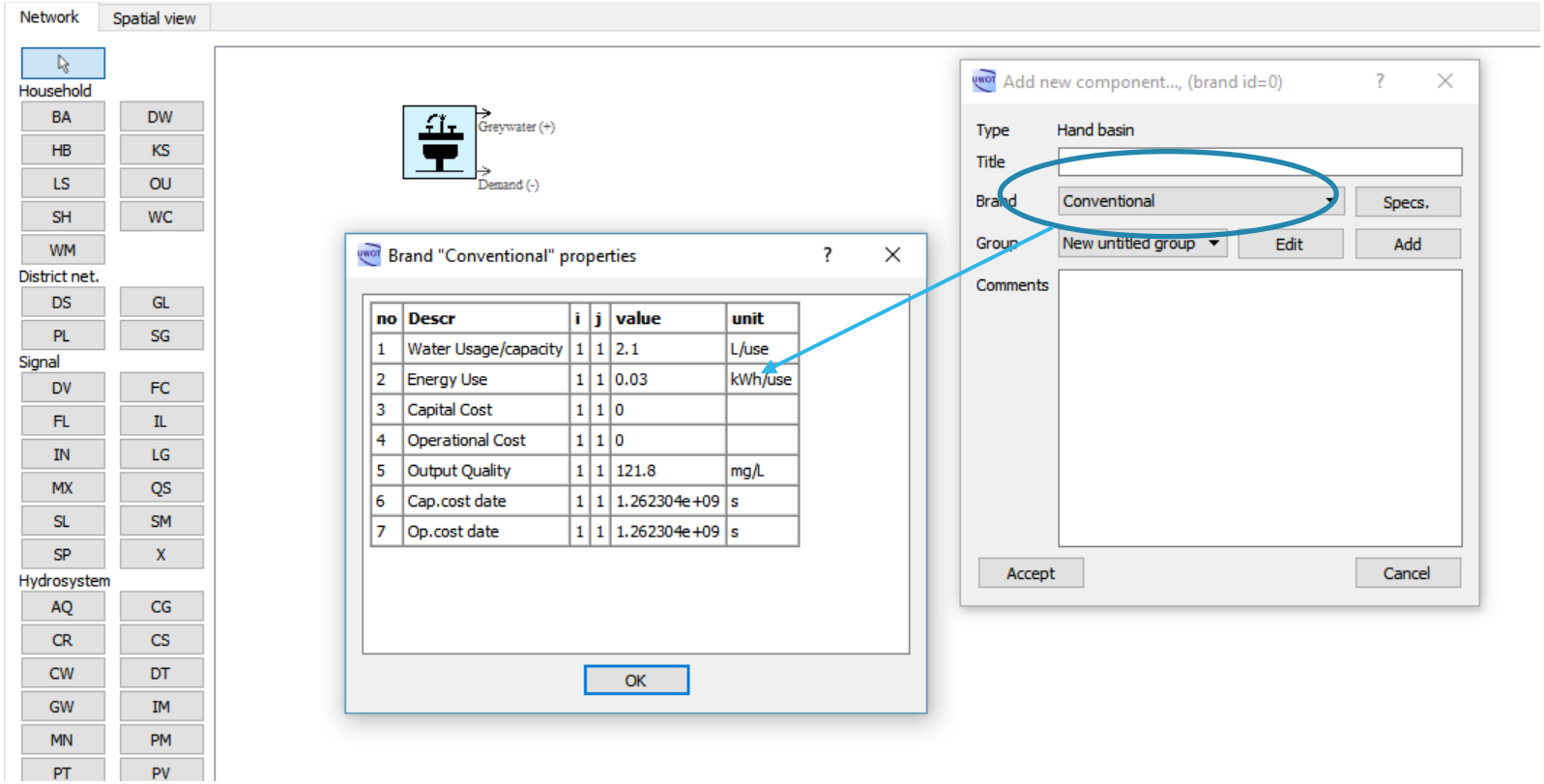
Adding components…

- Select HB and click on the drawing space



Adding Brands & Groups

- Select the conventional Brand from the list and inspect its Specs.



- Click Add to attach the component to a new Group

Group editing

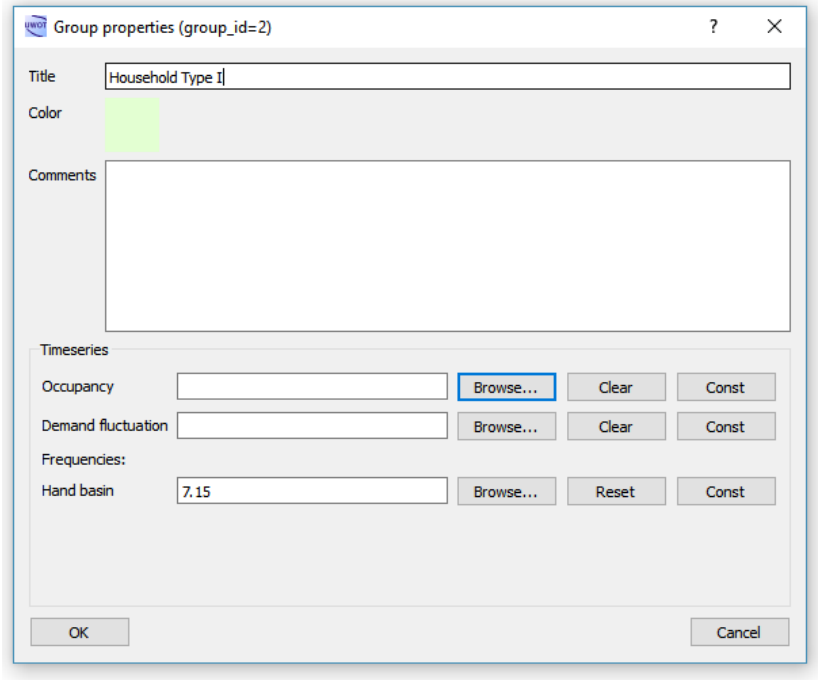
- Name the Title “Household Type I”

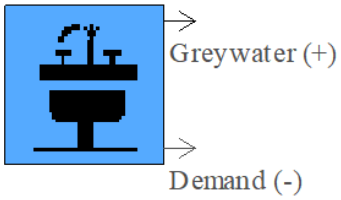
Right now, three Timeseries are available for editing, which affect all components in the Group:

•Occupancy: number of people using the Group’s components (i.e., #people/household)

•Demand fluctuation: Multiplier of Demand per usage of the components

•Frequencies: Number of uses per person, of a specific component



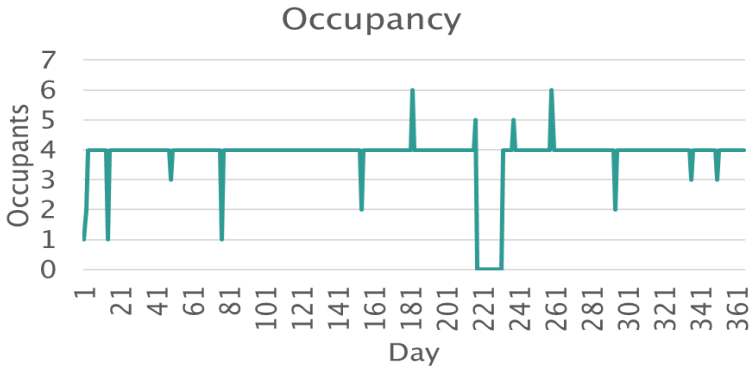


Demand signal value of the HB component in a daily time step = Occupancy × Demand fluctuation × Hand Basin Frequency.

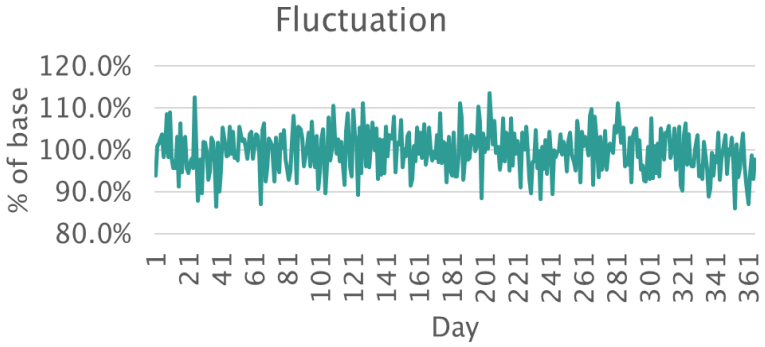
Greywater signal value is assumed to be the same.

Group editing

- Browse the training material folder and select the file *"Occupancy_TS.csv"* in Occupancy field

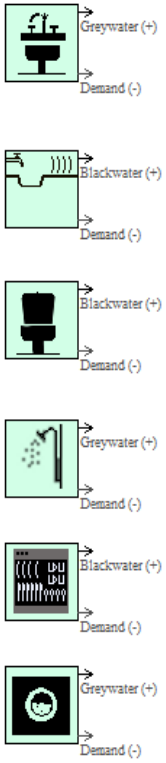


- Browse the training material folder and select the file *"Fluctuation.csv"* in Demand Fluctuation field

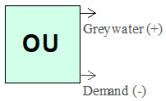


Add more components to define a household type

- Add more household UWOT components of type Kitchen Sink (KS), Toilet (WC), Shower (SH), Dish Washer (DW), Washing Machine (WM) and make sure to use the predefined "Conventional" Brand and attach them to the same Group

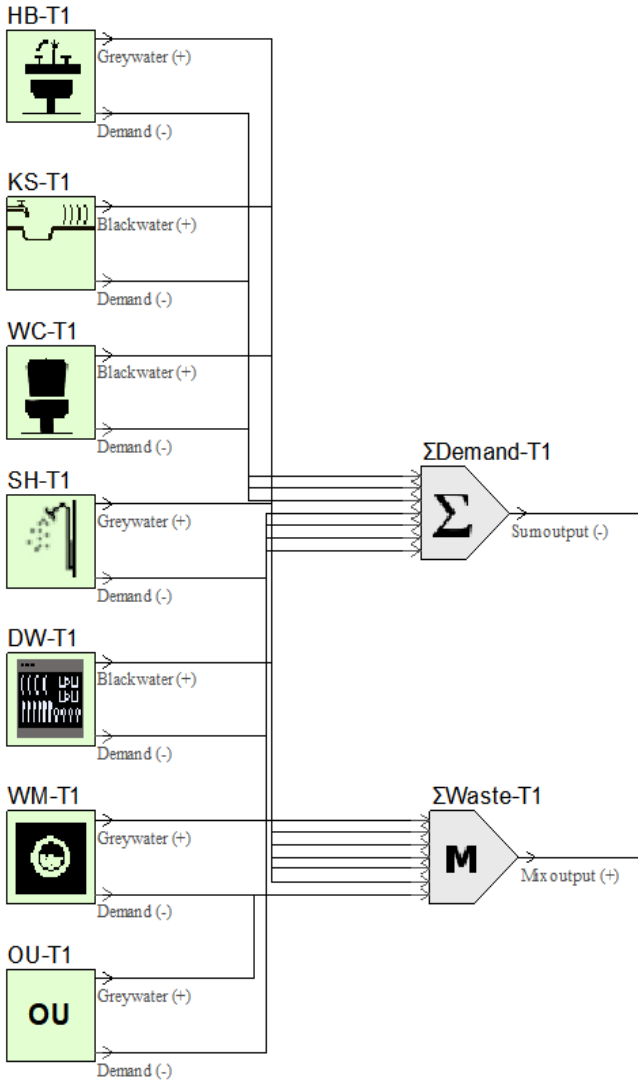


- Add a component of type Outside Use (OU). From the predefined Brands select the "Decorative Water Feature", and browse its specs.



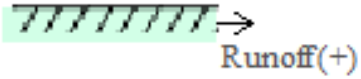
Add Summation and Mix component - Basic signal routing

- Add a Summation (SM) component from the signal panel. This signal is used with pull signals (-) and sums only quantities.
- Connect the Demand output of every component by right-clicking, selecting “Connect Demand (-)” and then left-clicking on the Summation component and selecting “Connect to Input(-)”.
- Add a Mix (MX) component from the signal panel. This signal is used with push signals (+) and sums quantities and mixes qualities (by a flow weighted average).
- Connect the Greywater/Blackwater output of every component by right-clicking, selecting “Connect Greywater/Blackwater (+)” and then left-clicking on the Mix component and selecting “Connect to Input(+)”

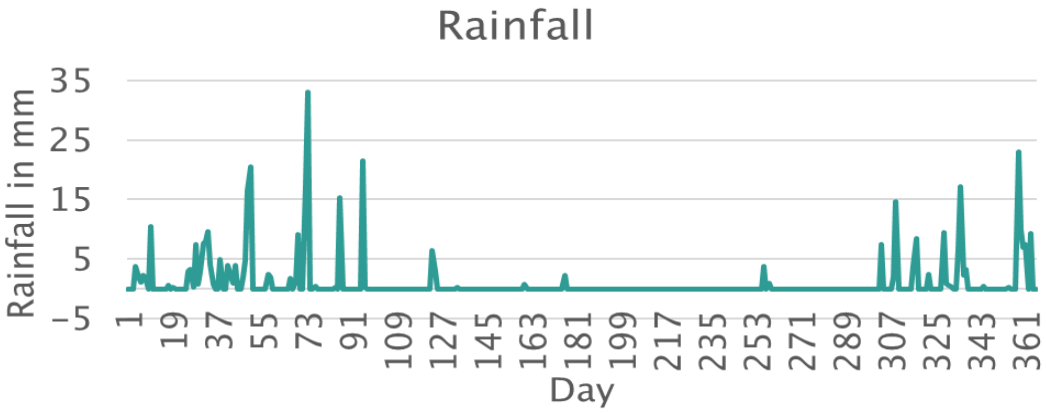


Add and edit household impervious areas

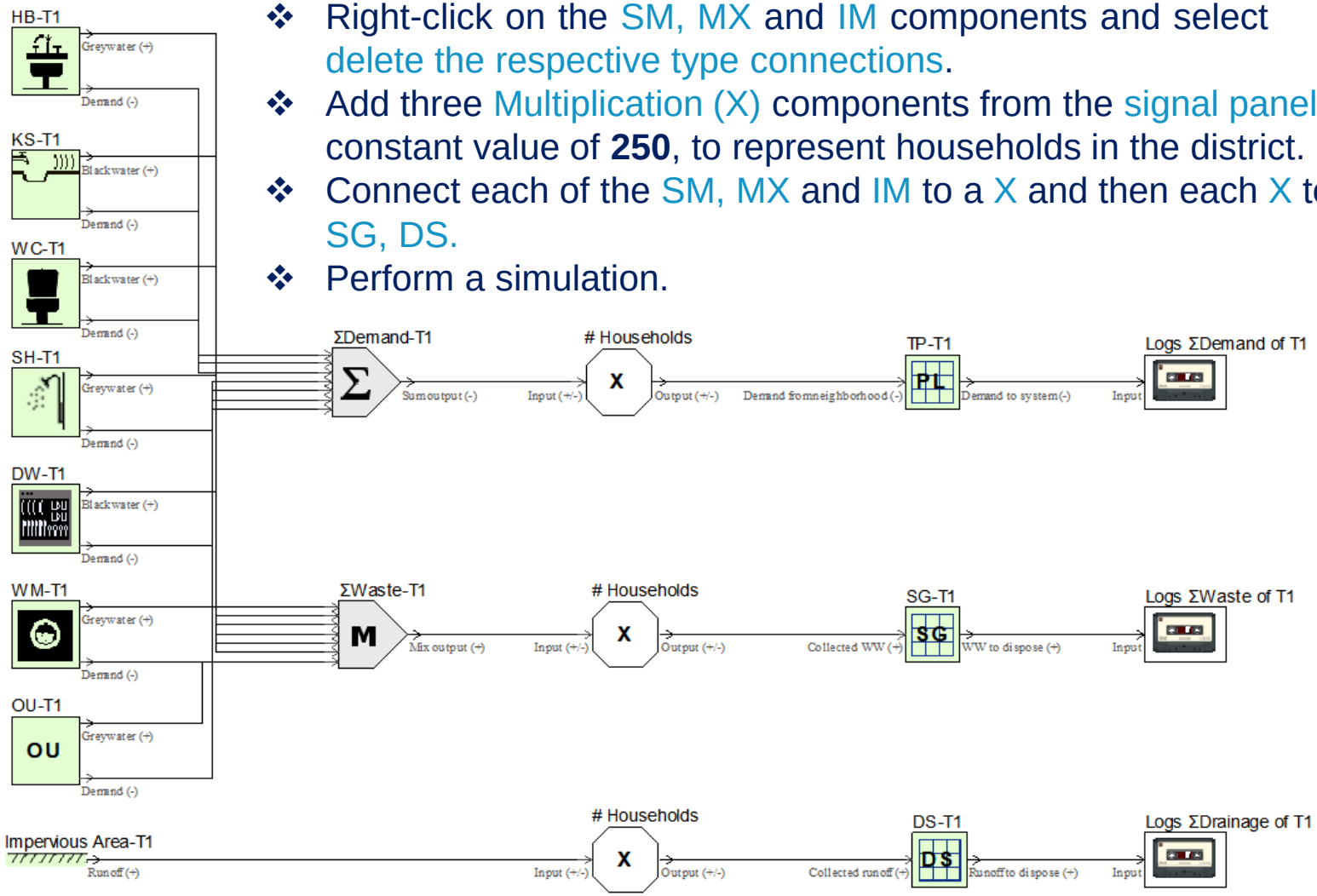
- Add an Impervious Area (IM) from the hydrosystem panel that corresponds to the impervious areas of this Household Type, define the area in m^2 as **100** and select the predefined “10% evaporates Brand”



- Edit the Group. A new automatically created Rainfall time series is created. Browse the training material folder for the *“Rainfall_TS.hts”* file.



Define a district



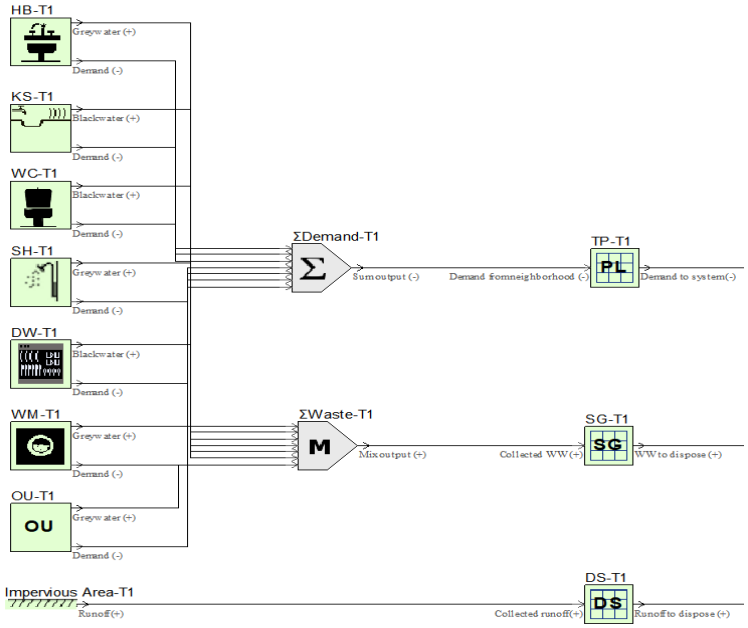
- Right-click on the SM, MX and IM components and select delete the respective type connections.
- Add three Multiplication (X) components from the signal panel. Use a constant value of **250**, to represent households in the district.
- Connect each of the SM, MX and IM to a X and then each X to PL, SG, DS.
- Perform a simulation.

Add tertiary network connections

- Add from the District network panel the Tertiary potable network (PL), Sewage collection (SG) and the Storm drains collection (DS) components. Make sure all belong to the same Group and select the predefined Brand “PE”.

These represent the water losses and energy use from the tertiary networks of a district.

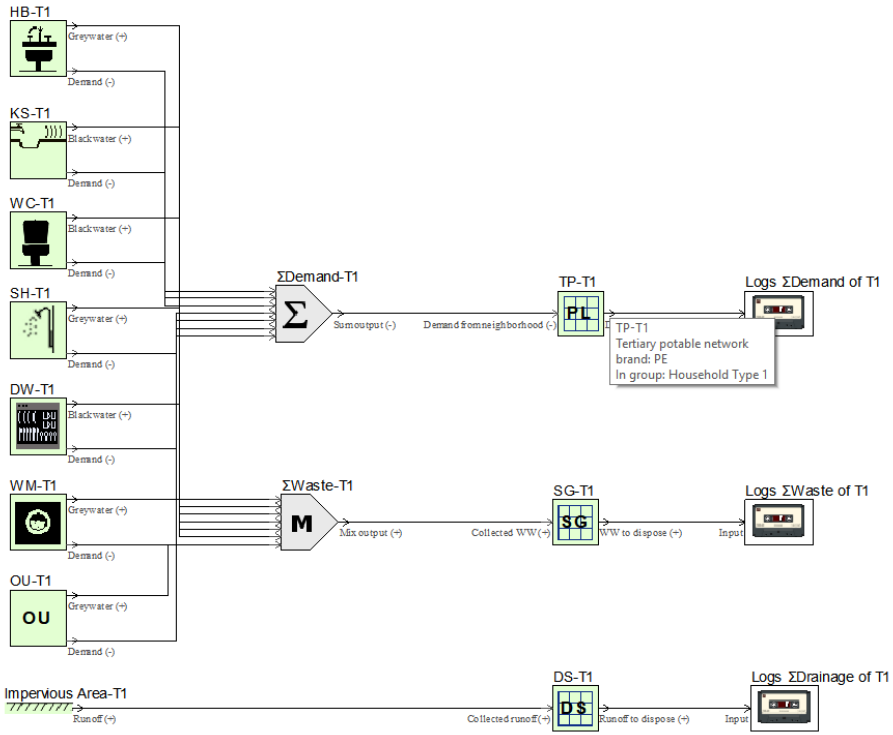
- Connect the SM component to PL, the MX to the SG and the IM to the DS.



Add logging signals

- Add three Logger (LG) components.
- Connect each of the PL, SG, DS to a LG.

These are used as final recipients that log incoming signals.



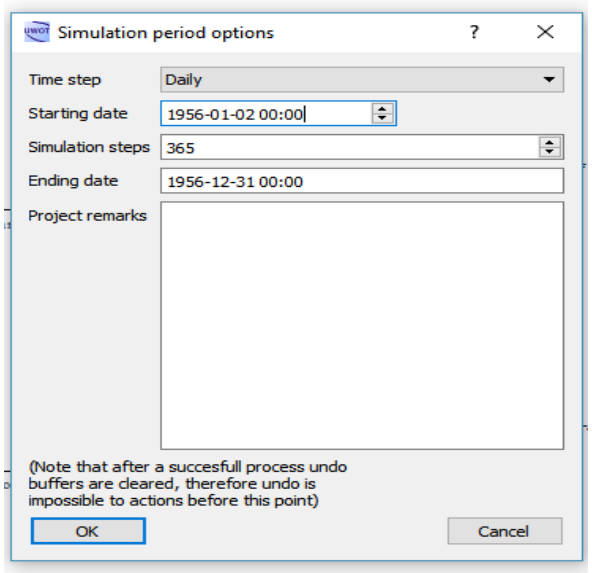
Before simulating

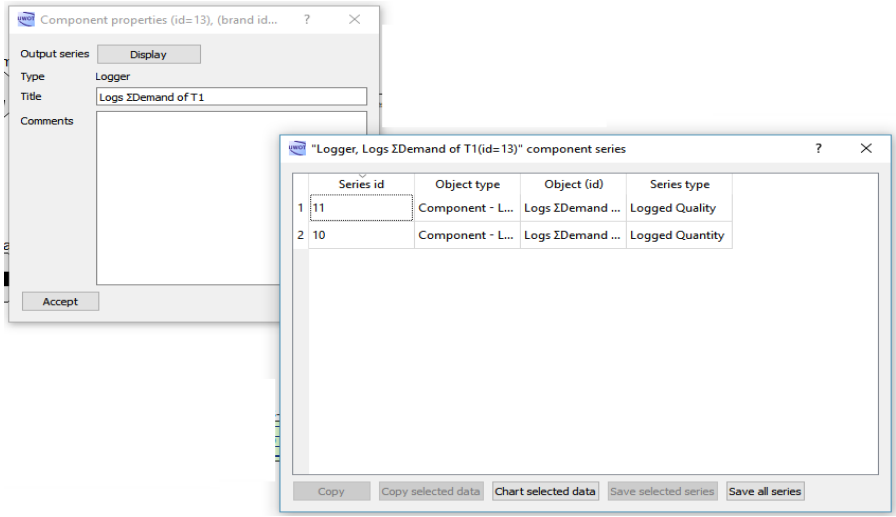
- Check the group properties again to view all requested timeseries and parameters.
- Save UWOT topology in the file *"part1.uwot"*.

Perform a simple UWOT simulation

- Click the Process button on the toolbar and press OK to perform a simulation.
- You can view all logged signals by double - clicking loggers, clicking the Output Timeseries Display button and selecting the Logged Quantity or Quality type.

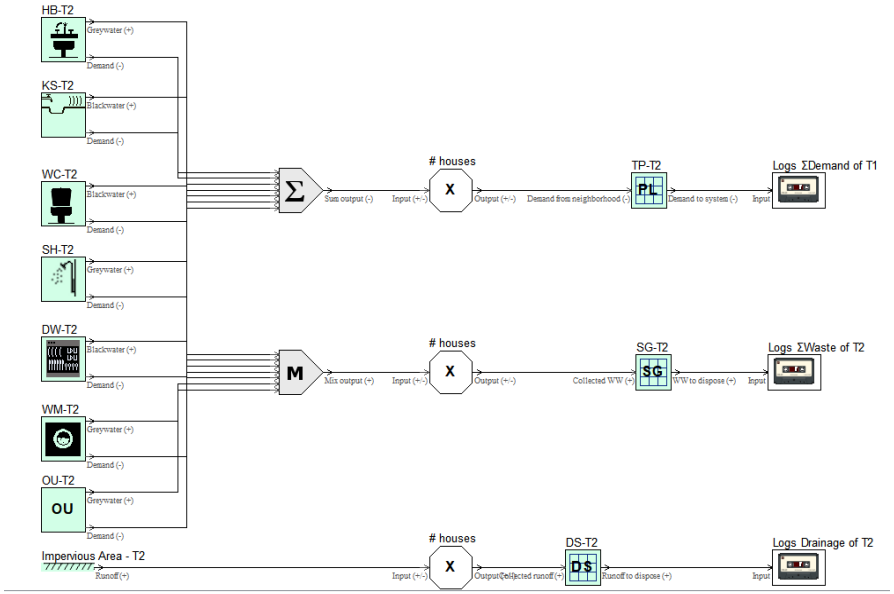
The loggers have captured the water cycle of a specific household (Demand, Waste, Runoff)





Define a second district

- In the same UWOT model, define a second district, comprised of a different Household Type (Add components to another Group, named “Household Type II”.
- For now, use the same components and brands. However, this district should have a size of **1000** households.
- The Group timeseries should be the same, except for Occupancy. Set it constant to **2.6.**

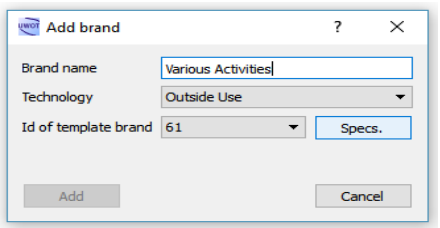


Defining Custom Brands

- Select Project on the toolbar, then Add Brand.
- Define a Brand named “Various Activities” of Technology type Outside Use. Click Specs.
- Modify the Brand’s specifications to:
- Click Add
- Modify the Brand of OU to ”Various Activities”

- Define a custom Brand “PE_T2” for tertiary connections using this template:

- Modify the Brands of SG, PL, DS of the second household type



Brand "Various activities" properties

no	Descr	i	j	value	unit
1	Water Usage/capacity	1	1	15	L/use
2	Water Loss	1	1	0.05	0 to 1
3	Energy Use	1	1	2.4	kWh/use
4	Capital Cost	1	1	380	pounds
5	Operational Cost	1	1	0.05	pounds/use
6	Output Quality	1	1	50	mg/L
7	Cap.cost date	1	1	1.262304e+09	s
8	Op.cost date	1	1	1.262304e+09	s

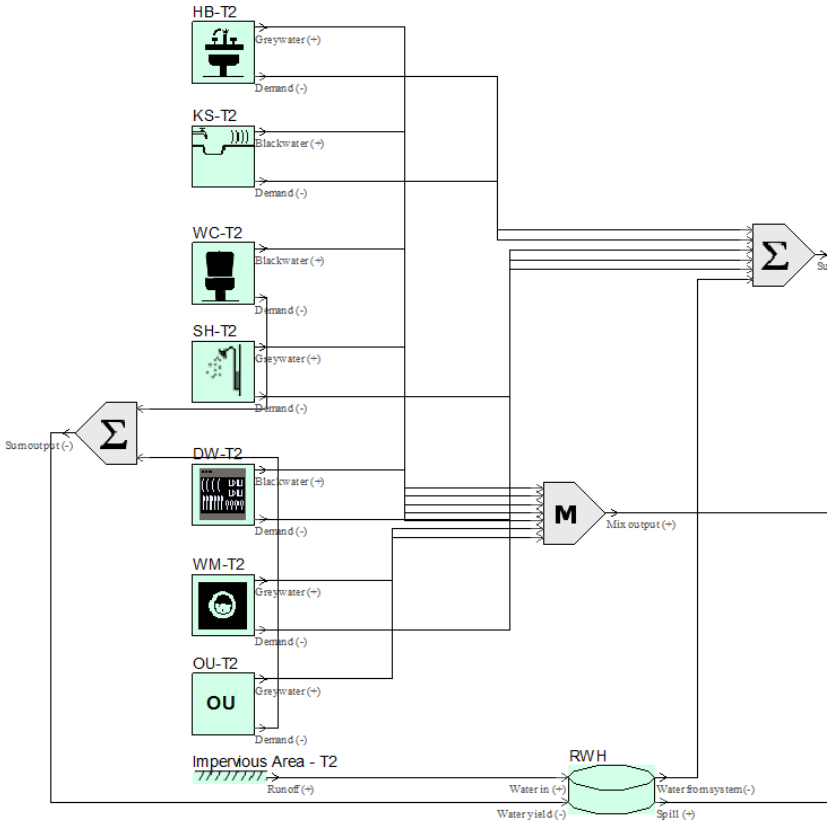
Brand "PE_T2" properties

no	Descr	i	j	value	unit
1	Water Loss	1	1	0.15	0 to 1
2	Energy Use	1	1	0	kWh/L
3	Capital Cost	1	1	374	pounds/household
4	Operational Cost	1	1	7.5	pounds/household/year
5	Cap.cost date	1	1	1.262304e+09	s
6	Op.cost date	1	1	1.262304e+09	s

OK

Exploring management options (RWH)

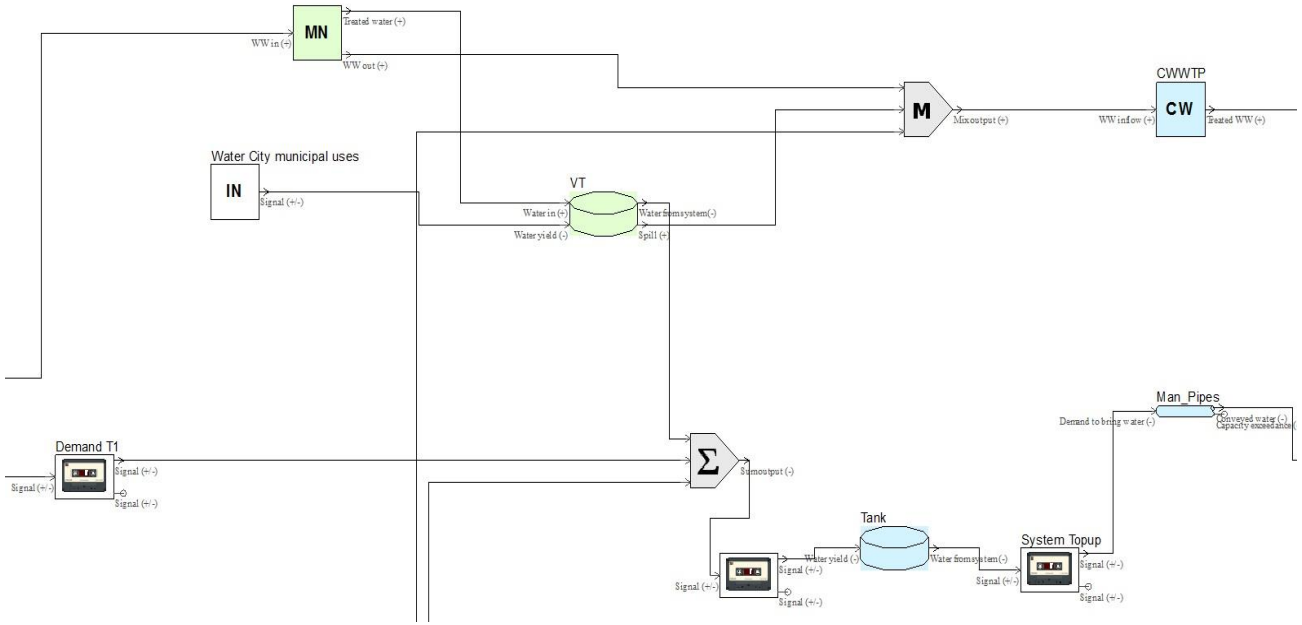
- Add an Tank (TN) component.
- Connect the runoff of Household Type II to the Water in (+) input.
- Add a new Summation(SM) for the demand signals of Toilet and Outside use
- Route the signal through Water yield (-)
- Connect Water from system to the respective SM component
- Spill signal goes to drainage
- Run simulations with varying tank capacities (3 m^2, 5 m^2, 10 m^2).
- Keep in mind this tank is in the level of the house.



Exercise: Sewer Mining

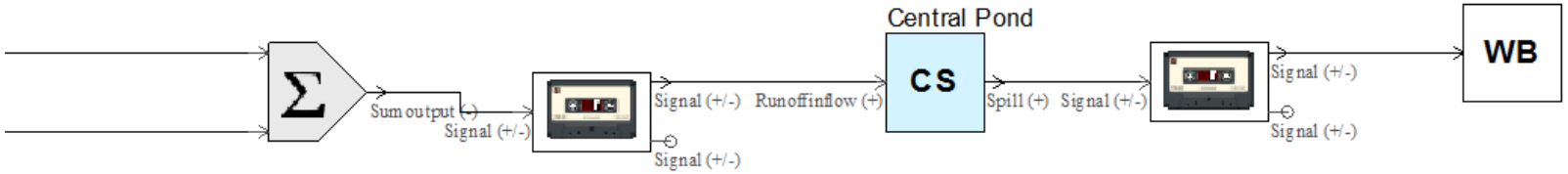
*Alter the topology with the use of a DESSIN sewer mining component (**10000 l/d, 0.0005 kWh/l**), located in the first district, in order to reuse water for the municipal uses. Find a way to connect all necessary components. Run a simulation and compare results.*

(Hint)



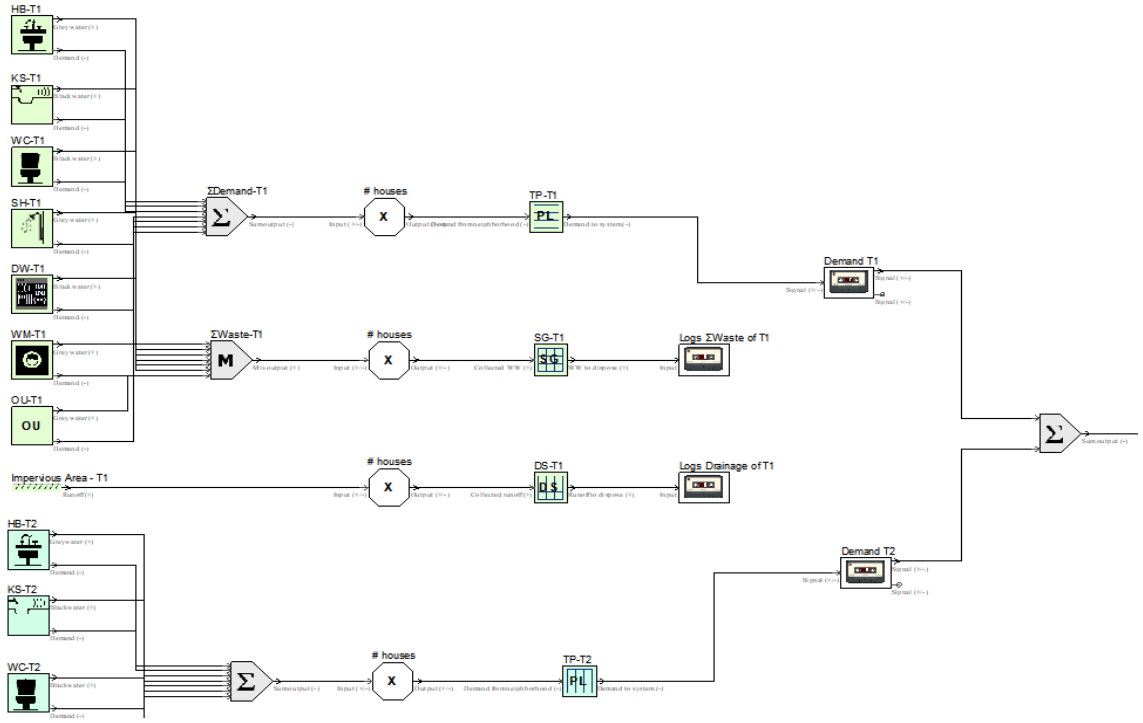
Exercise: Create a SUDS pond

Alter the topology with the use of pond to minimize storm runoff.



Creating the centralized water supply line

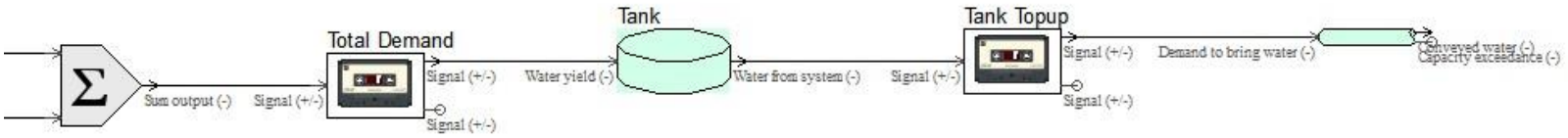
- Delete the loggers for demand of both districts.
- Create Inline Loggers* (IL). Connect the PL components to ILs, then sum signals from both Inline Loggers with a new SM.



*Inline loggers operate the same as normal loggers, but let the signal pass through.

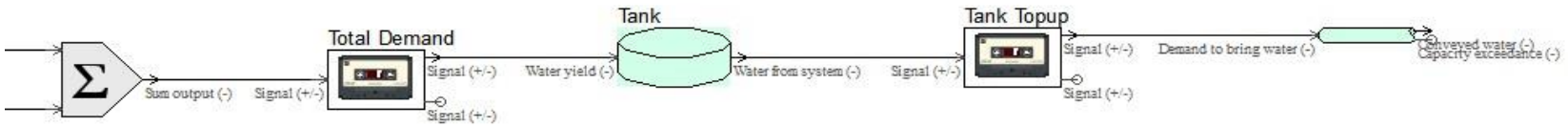
Creating the centralized water supply line

- Create a Central Reservoir component (RS) that represents the buffer tank between the hydrosystem and the supplied districts. Add it to a new Group, named “System”
- Route the signal through two inline loggers
- Add an Aqueduct component to simulate the main distribution network.



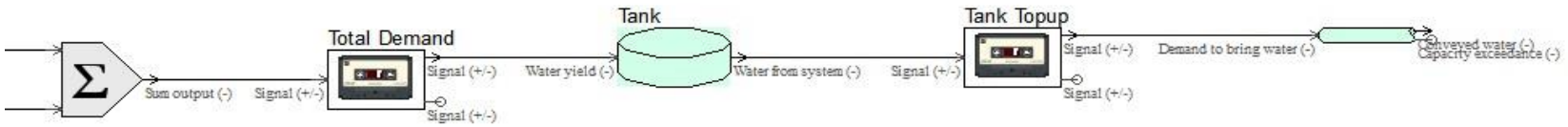
Creating the centralized water supply line

The RS component has an attribute called fill rate (daily ratio) which correlates with the capacity of the main distribution network. E.g. a 5000 m^3 tank with a fill rate of 0.5 will be able to top up with up to 2500 m^3 each day. Thus, the capacity of the Aqueduct component should be enough to handle this need.



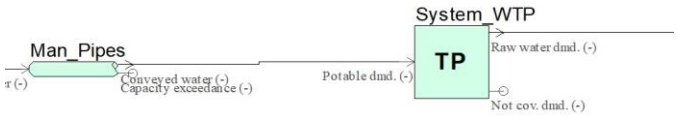
Creating the centralized water supply line

- Define the RS capacity at **1000** m^3. The initial water storage is small (10 m^3) – tank is empty. Create a new Brand with **0.25** refill ratio.
- Create a new Brand for the aqueduct with **250** m^3/d capacity and **10%** losses

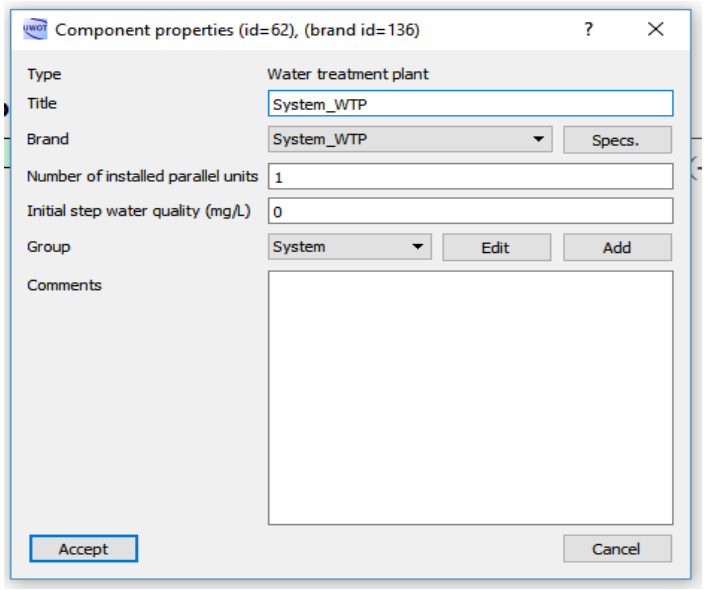


Water treatment plant

- Add a Water Treatment Plant (TP) component.



- Create a new Brand with the following attributes:



Brand "System_WTP" properties

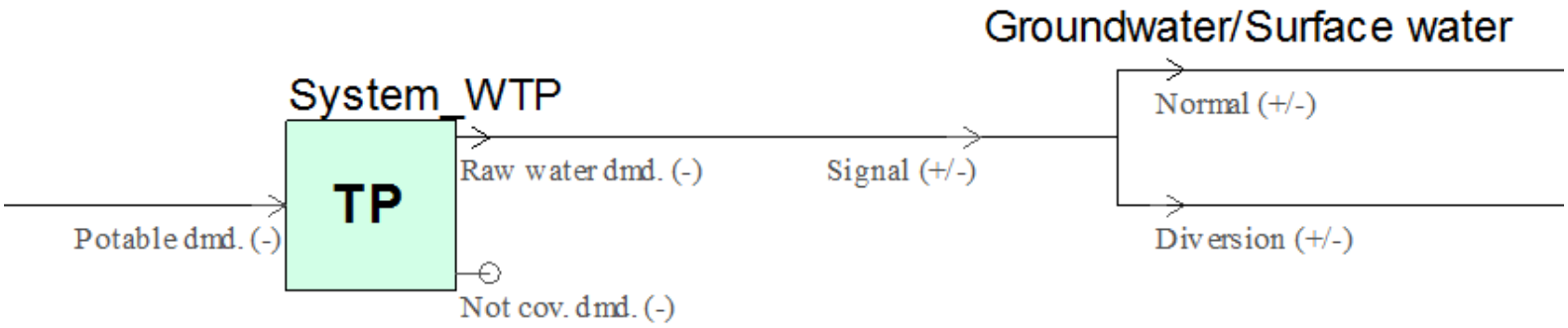
no	Descr	i	j	value	unit
1	Water Usage/capacity	1	1	300000	L/d
2	Water Loss	1	1	0.1	0 to 1
3	Energy Use	1	1	5e-05	kWh/L
4	Capital Cost	1	1	0	pounds
5	Operational Cost	1	1	0	pounds/year
6	Cap.cost date	1	1	1.262304e+09	s
7	Op.cost date	1	1	1.262304e+09	s

Add a Divergence component

- Add a Divergence (DV) component.

Divergence components are used to divert signals according to thresholds. Here, we simulate the preference for groundwater over surface water, but with an abstraction limit.

- Set the threshold to **150000** l/d

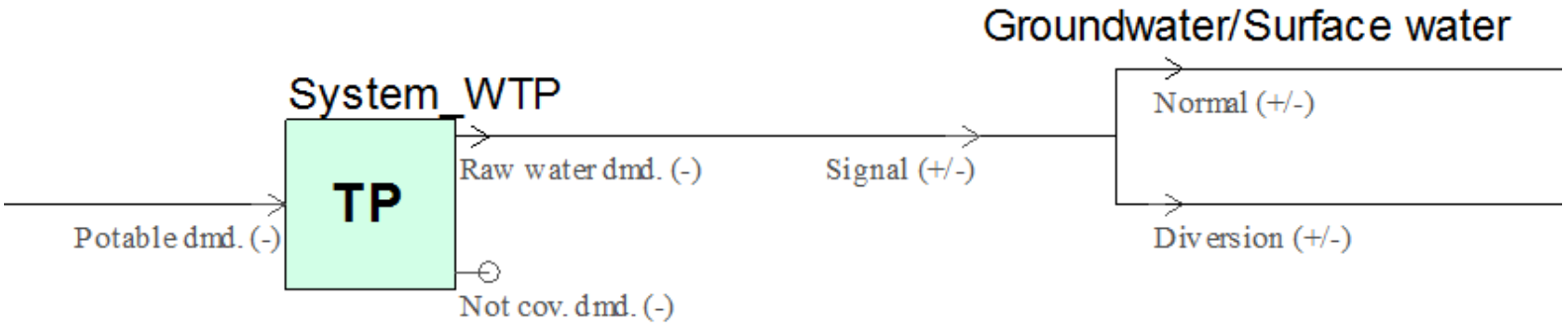


Add a splitter component

- Add a Splitter (SP) component in the normal signal path

Splitter components are used to split by percentage signals. Here, we simulate the abstraction from two different wellfields.

- Set the percentage to **50.**

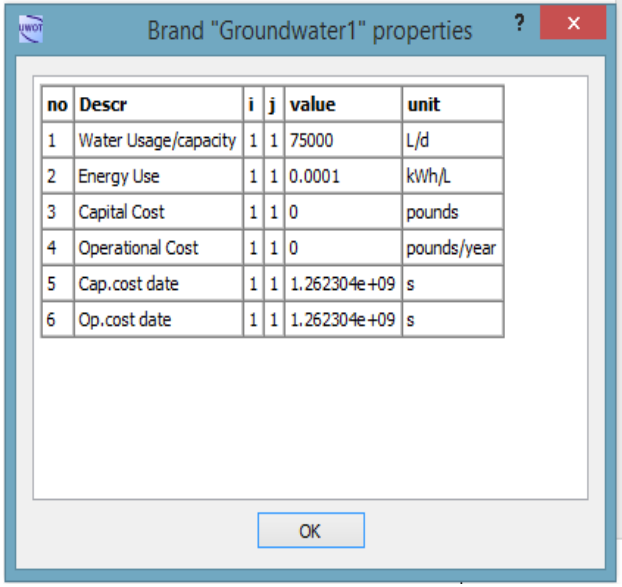


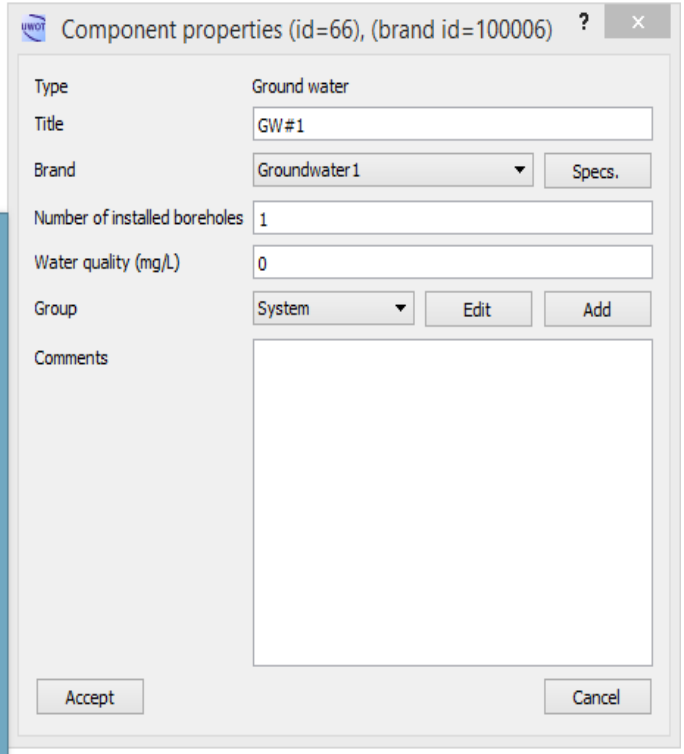
Connection with groundwater wells for water supply

- Add two Ground Water (GW) components and connect them to both splitter paths.

Groundwater components are used as sources for water supply.

- Add two Brands and differentiate them by energy use (**0.0001** vs **0.0005**). Both should have capacity of **75000** l/d.



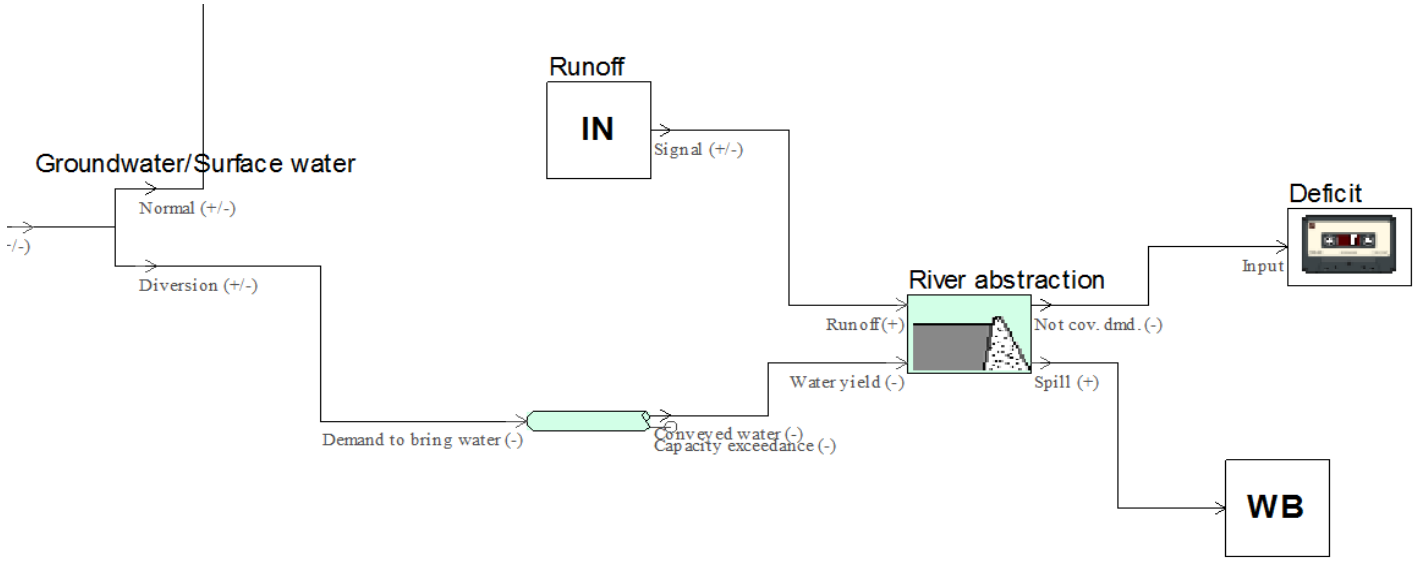


Connection with surface water for water supply

- Add a Surface Water (SW) component
- Connect the diversion to Water yield (-) input

We need a runoff timeseries to connect to Runoff (+).

- Add an Input (IN) component and attach the *runoff.csv* timeseries
- Connect a Logger (LG) to Not cov. Dmd. (-) outlet
- Connect a simple Water Body (WB) component to Spill (+) outlet

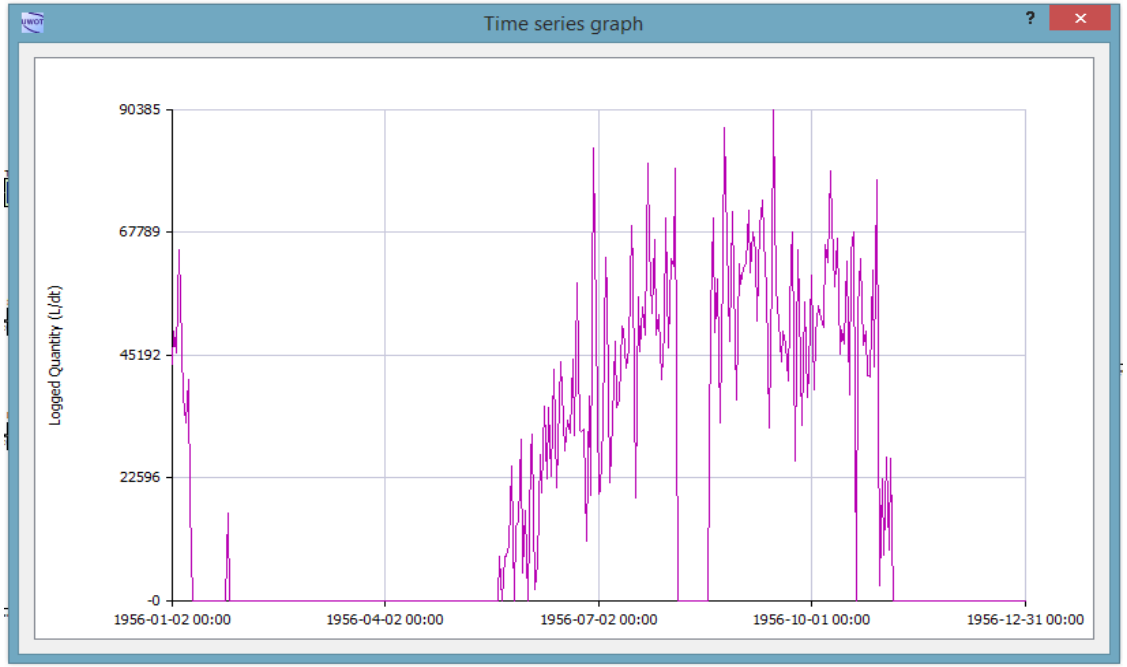


Connection with surface water for water supply

- Select the “no surface water” Brand
- Perform a simulation
- Open the Not covered demand logger

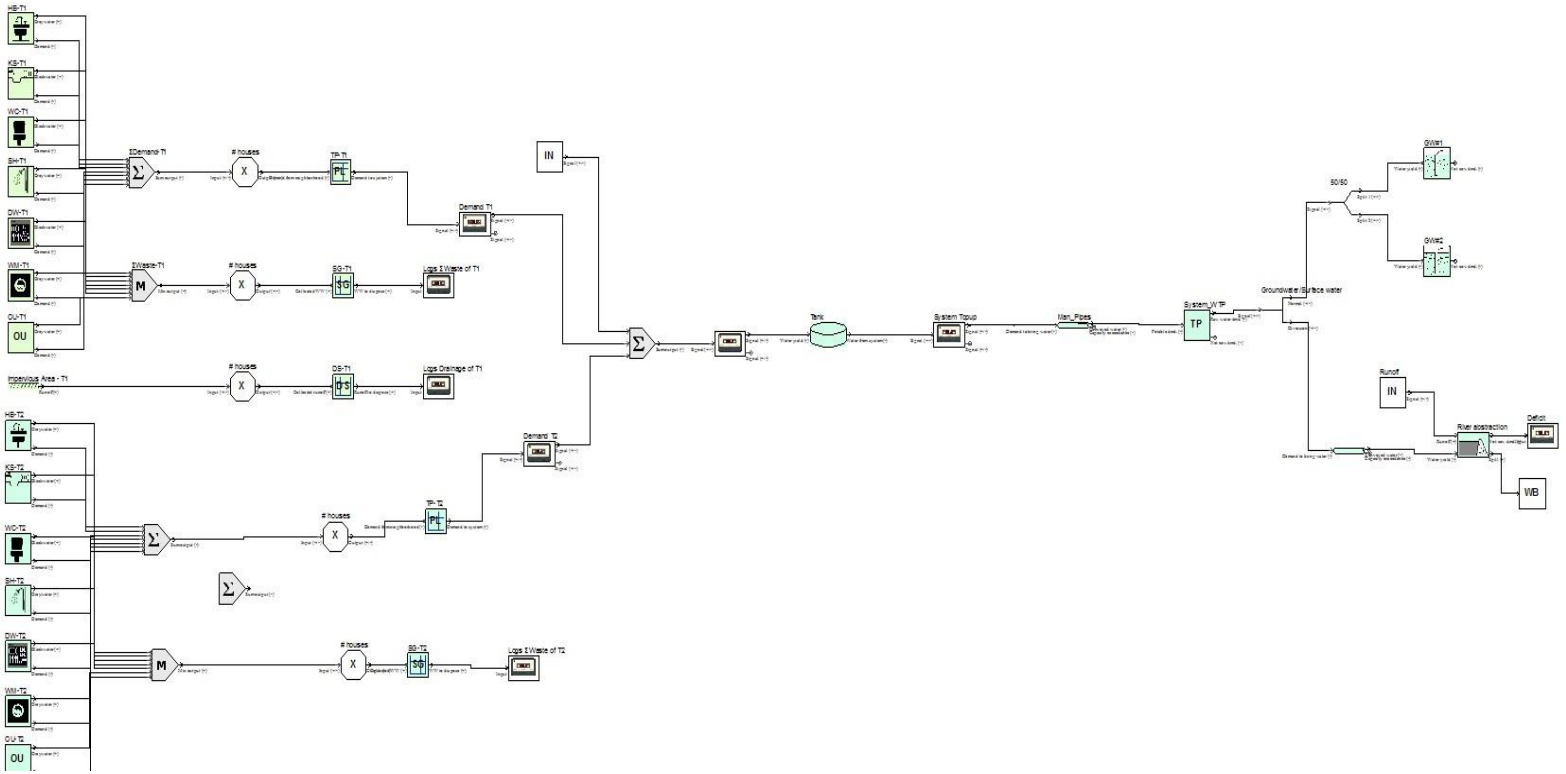
Note the failure frequency and volume

- Select the “Bank-side Reservoir”, “Small Reservoir” and compare results after simulations



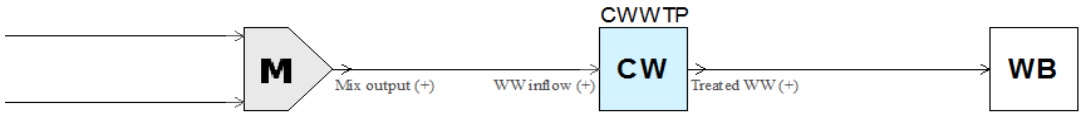
Add municipal uses

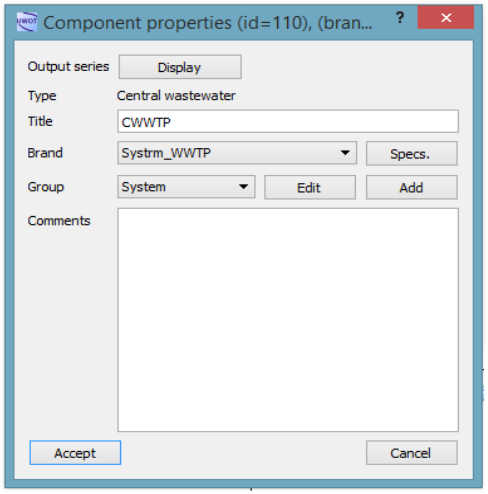
- Add an Input (IN) with a constant pull signal of **20000** l/d and run simulations again



Add Central Wastewater Treatment Plant

- Connect the runoff of *Household Type II* to the Water in (+) input.
- Add a MX and connect both wastewater signals from the two districts
- Add a Central Wastewater (CW) component.
- Make a new Brand with capacity of **300000** l/d.





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