Force Main Design

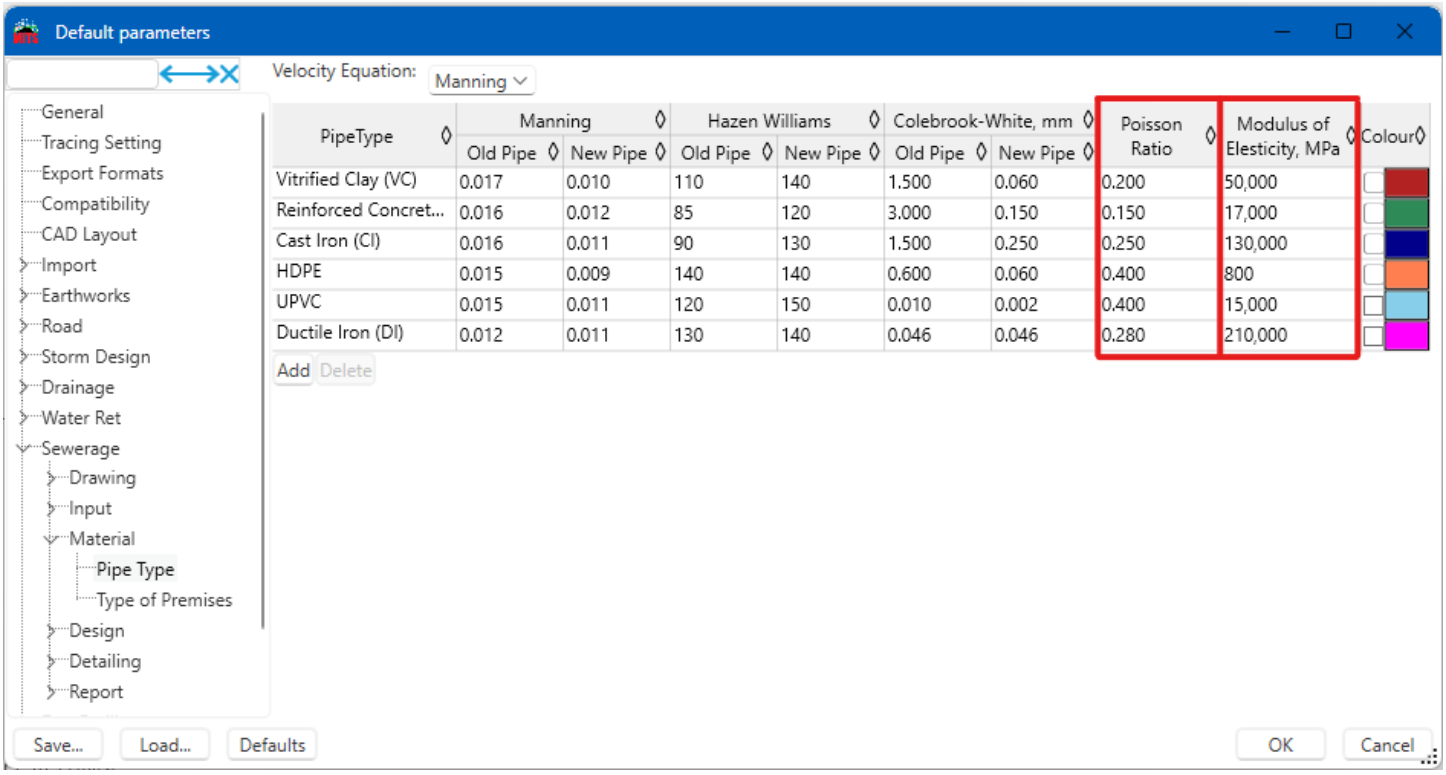
Output · https://mes100.com/docs/force-main-design/

Parameters

Additional parameters have been added with regard to the force main design, with explanations in each picture below. Kindly take note that changes in parameters will not affect the design for normal sewers

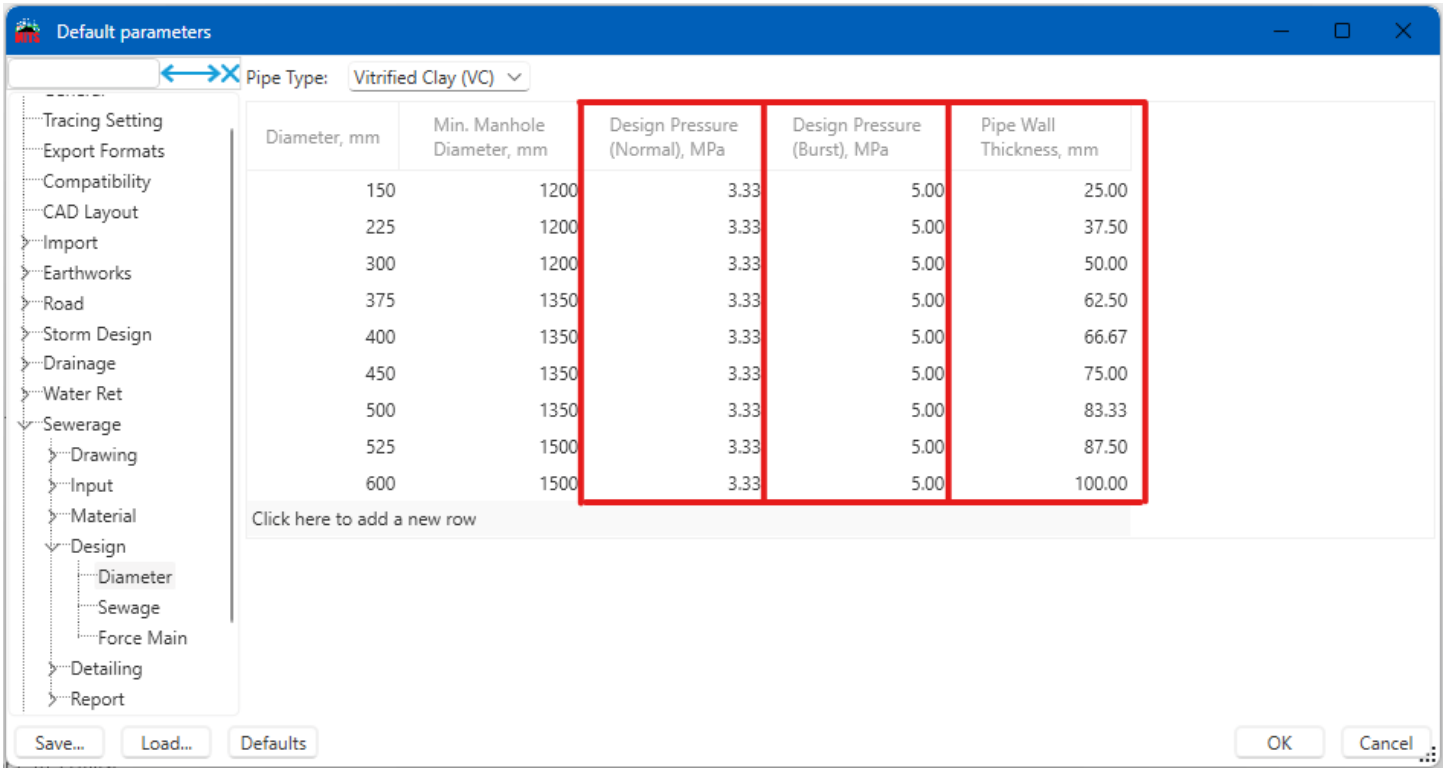
Material Pipe Type

Parameters poisson ratio and elasticity have been added, which will be used to calculate the force main resistance to surge pressure



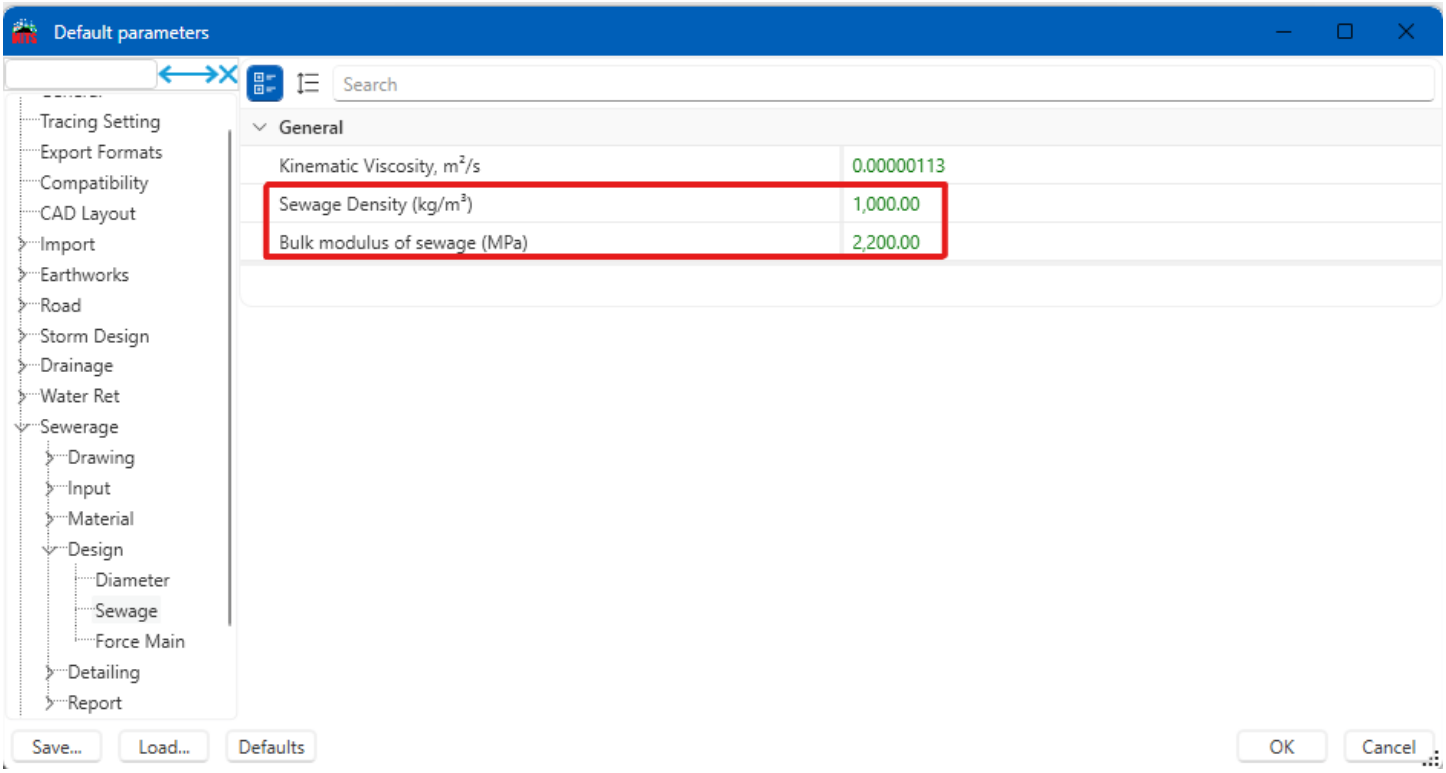
Design Diameter

Design pressure (Normal) shows force main resistance to normal pressure, whereas design pressure (burst) shows force main resistance to surge pressure; Pipe wall thickness shows sewer thickness (outer diameter minus inner diameter)



Design Sewage

Parameters circled are used in calculation of surge pressure for force main

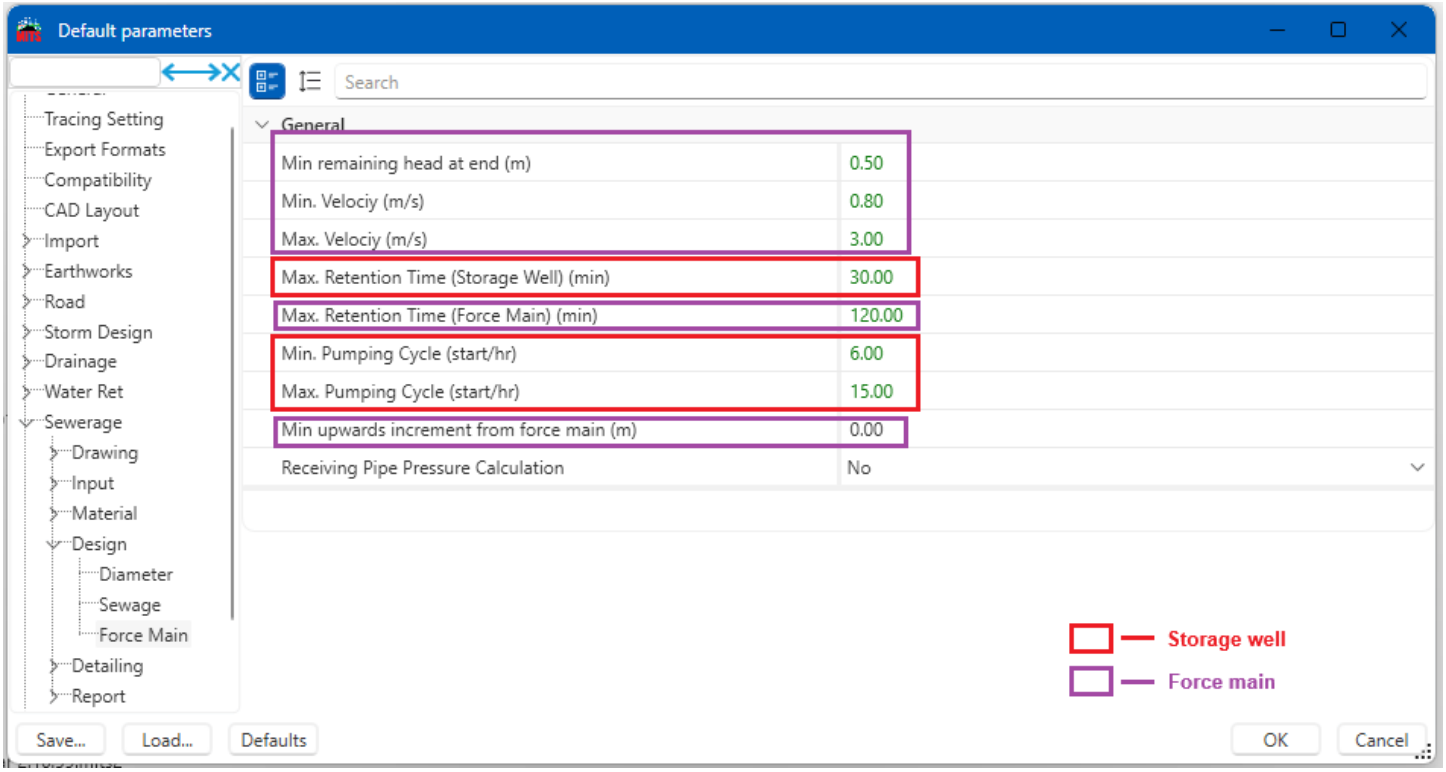


Design Force Main

Parameters circled below will affect the following:-

1. Storage well: Max. Retention Time (Storage Well), Min. Pumping Cycle, Max. Pumping Cycle
2. Force main: Min. remaining head at end, Min. Velocity, Max. Velocity, Max. Retention Time (Force Main), Min upwards increment from force main

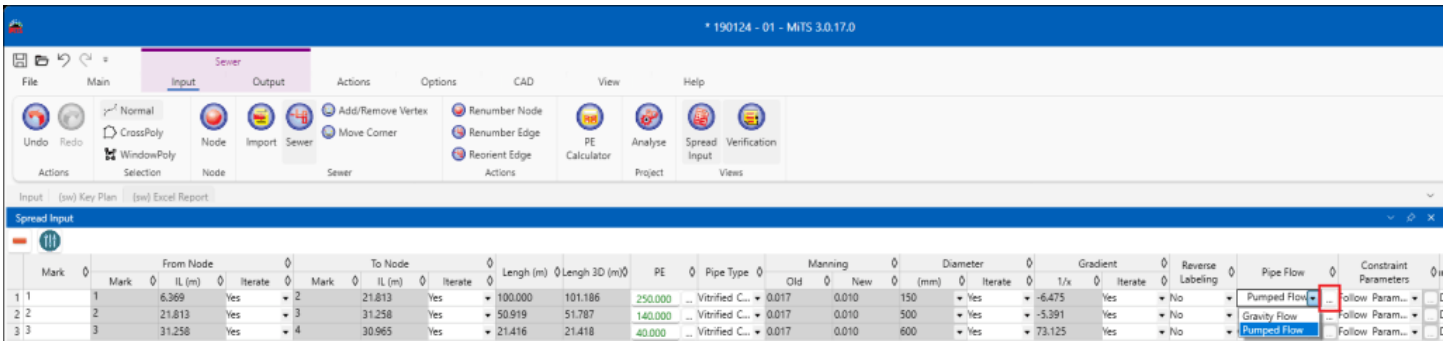
Note: 'Receiving Pipe Pressure Calculation' parameter will help to calculate if the downstream pipe is able to withstand remaining pipe pressure at force main end if changed to 'Yes'



Pipe & Storage Well Input

Pump flow requires input in force main UI to run correctly, which can be accessed via clicking on the button circled in red in the picture below

(this is only applicable when the flow type has been switched to pumped flow)

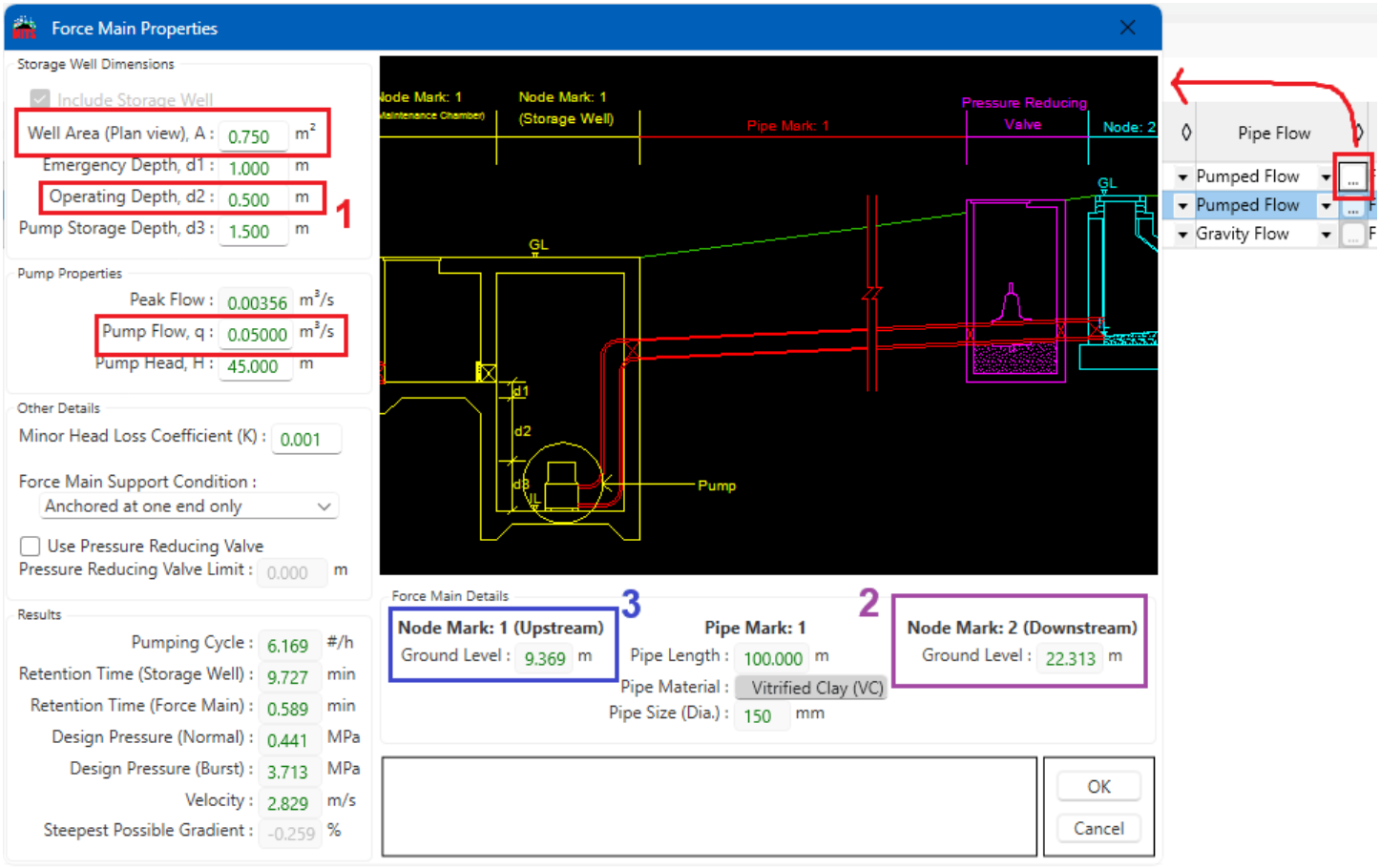


Parameters circled below will affect the following:-

1. Well Area (Plan View), Operating Depth, Pump flow: Pumping cycle, Retention Time (Storage Well & Force Main)

2. Pressure at downstream end of force main: Pump Head, Minor Head Loss Coefficient, Force Main Support Condition, Pressure Reducing Valve Limit

3. Invert level of force main upstream end: Emergency Depth, Operating Depth, Pump Storage Depth

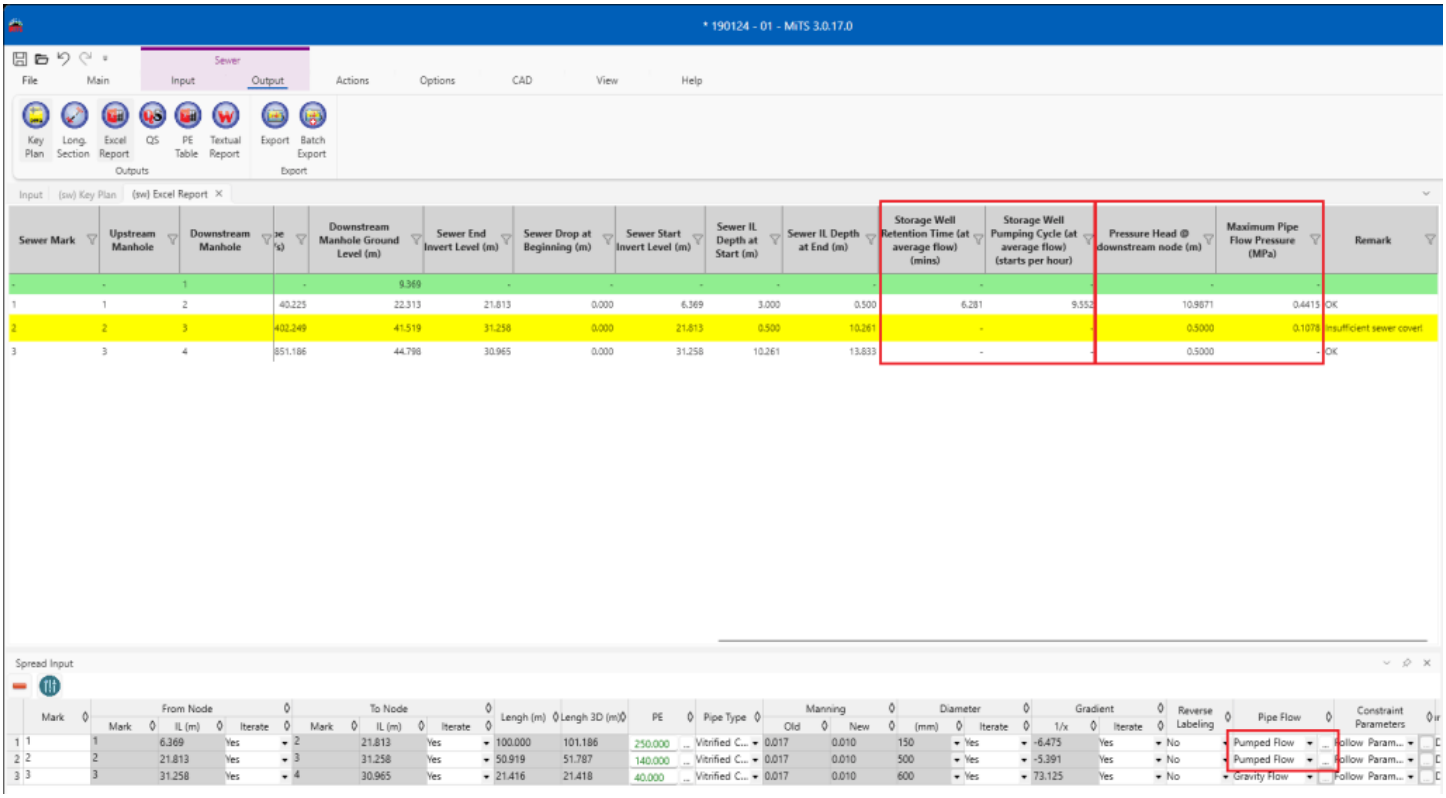


Calculating Results and Export

Result tabs ‘Excel Report’ and ‘Textual Report’ will be updated with force main-related results. For exporting results, kindly refer to section 6

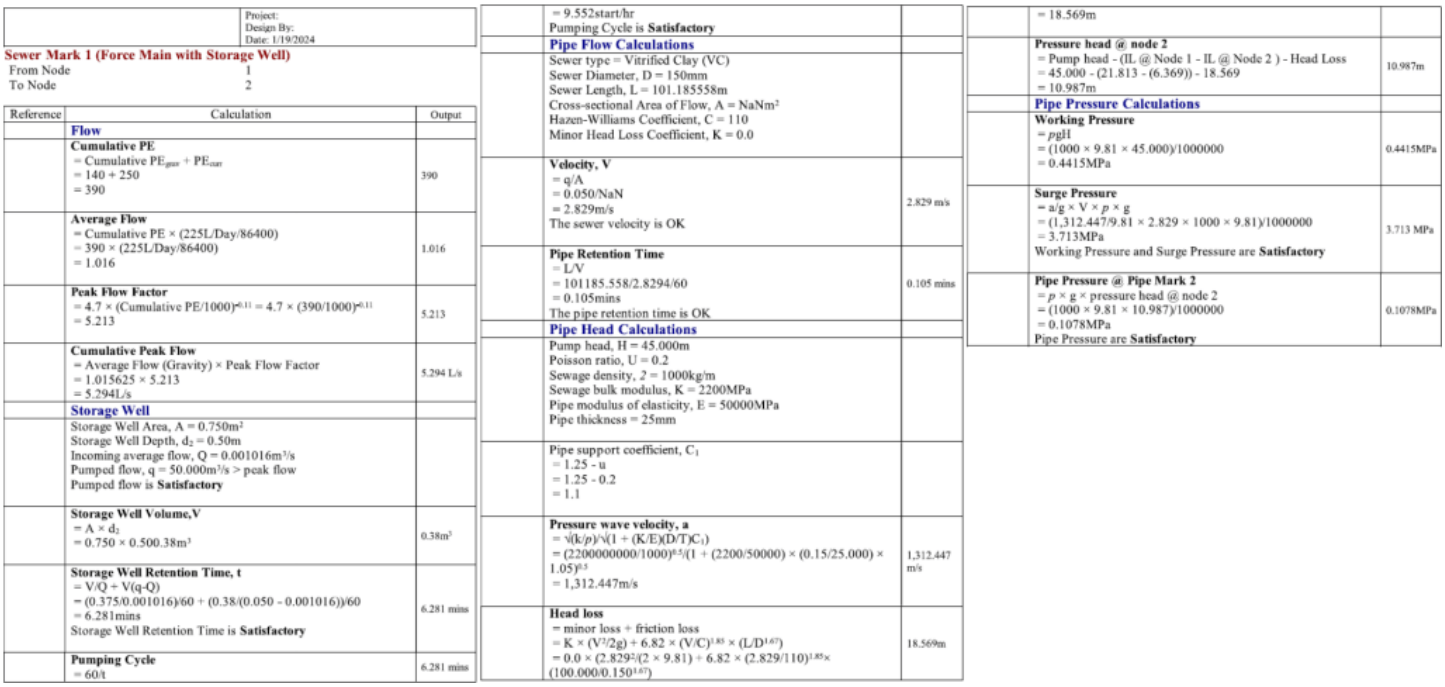
Excel report

Excel report has been updated with storage well and pressure calculation results



Textual report

For sewers identified with pumped flow, calculations will be modified to show calculations for force main and storage well designs.



Project:
Design By:
Date: 1/19/2024

Sewer Mark 1 (Force Main with Storage Well)

From Node 1
To Node 2

Reference	Calculation	Output
	Flow	
	Cumulative PE = Cumulative PE_{max} + PE_{start} = 140 + 250 = 390	390
	Average Flow = Cumulative PE × (225L/Day/86400) = 390 × (225L/Day/86400) = 1.016	1.016
	Peak Flow Factor = 4.7 × (Cumulative PE/1000)$^{-0.11}$ = 4.7 × (390/1000)$^{-0.11}$ = 5.213	5.213
	Cumulative Peak Flow = Average Flow (Gravity) × Peak Flow Factor = 1.015625 × 5.213 = 5.294L/s	5.294 L/s
	Storage Well	
	Storage Well Area, A = 0.750m² Storage Well Depth, d_2 = 0.50m Incoming average flow, Q = 0.001016m³/s Pumped flow, q = 50.000m³/s > peak flow Pumped flow is **Satisfactory**	
	Storage Well Volume,V = A × d_2 = 0.750 × 0.500.38m³	0.38m³
	Storage Well Retention Time, t = V/Q + V(q-Q) = (0.375/0.001016)/60 + (0.38/(0.050 - 0.001016))/60 = 6.281mins Storage Well Retention Time is **Satisfactory**	6.281 mins
	Pumping Cycle = 60/t	6.281 mins
	= 9.552start/hr Pumping Cycle is **Satisfactory**	
	Pipe Flow Calculations	
	Sewer type = Vitrified Clay (VC) Sewer Diameter, D = 150mm Sewer Length, L = 101.185558m Cross-sectional Area of Flow, A = NaNm² Hazen-Williams Coefficient, C = 110 Minor Head Loss Coefficient, K = 0.0	
	Velocity, V = q/A = 0.050/NaN = 2.829m/s The sewer velocity is OK	2.829 m/s
	Pipe Retention Time = L/V = 101185.558/2.8294/60 = 0.105mins The pipe retention time is OK	0.105 mins
	Pipe Head Calculations	
	Pump head, H = 45.000m Poisson ratio, U = 0.2 Sewage density, ρ = 1000kg/m Sewage bulk modulus, K = 2200MPa Pipe modulus of elasticity, E = 50000MPa Pipe thickness = 25mm	
	Pipe support coefficient, C_1 = 1.25 - u = 1.25 - 0.2 = 1.1	
	Pressure wave velocity, a = $\sqrt{(k/\rho)}/\sqrt{(1 + (K/E)(D/T)C_1)}$ = (2200000000/1000)$^{0.5}$/(1 + (2200/50000) × (0.15/25.000) × 1.05)$^{0.5}$ = 1,312.447m/s	1,312.447 m/s
	Head loss = minor loss + friction loss = K × (V^2/2g) + 6.82 × (V/C)$^{1.85}$ × (L/$D^{1.67}$) = 0.0 × (2.829²/(2 × 9.81) + 6.82 × (2.829/110)$^{1.85}$× (100.000/0.150$^{1.67}$)	18.569m
	= 18.569m	
	Pressure head @ node 2 = Pump head - (IL @ Node 1 - IL @ Node 2) - Head Loss = 45.000 - (21.813 - (6.369)) - 18.569 = 10.987m	10.987m
	Pipe Pressure Calculations	
	Working Pressure = ρgH = (1000 × 9.81 × 45.000)/1000000 = 0.4415MPa	0.4415MPa
	Surge Pressure = a/g × V × ρ × g = (1,312.447/9.81 × 2.829 × 1000 × 9.81)/1000000 = 3.713MPa Working Pressure and Surge Pressure are **Satisfactory**	3.713 MPa
	Pipe Pressure @ Pipe Mark 2 = ρ × g × pressure head @ node 2 = (1000 × 9.81 × 10.987)/1000000 = 0.1078MPa Pipe Pressure are **Satisfactory**	0.1078MPa

Nodes and Sewers Element Reordering

Starting from MiTS 2.4.30 version, users are now allowed to reorder the numbering for nodes / lines (**available for drainage & sewer module**).

Concepts applied:

1. The numbering will always start at the upstream and then proceed gradually to downstream,
2. The numbering will strive to be consecutive when moving from one pipes/drains to another,
3. The upper stream will always have smaller running compared to the downwards stream.

Therefore, it is expected that the last node / drains will always be the biggest number.

For example;

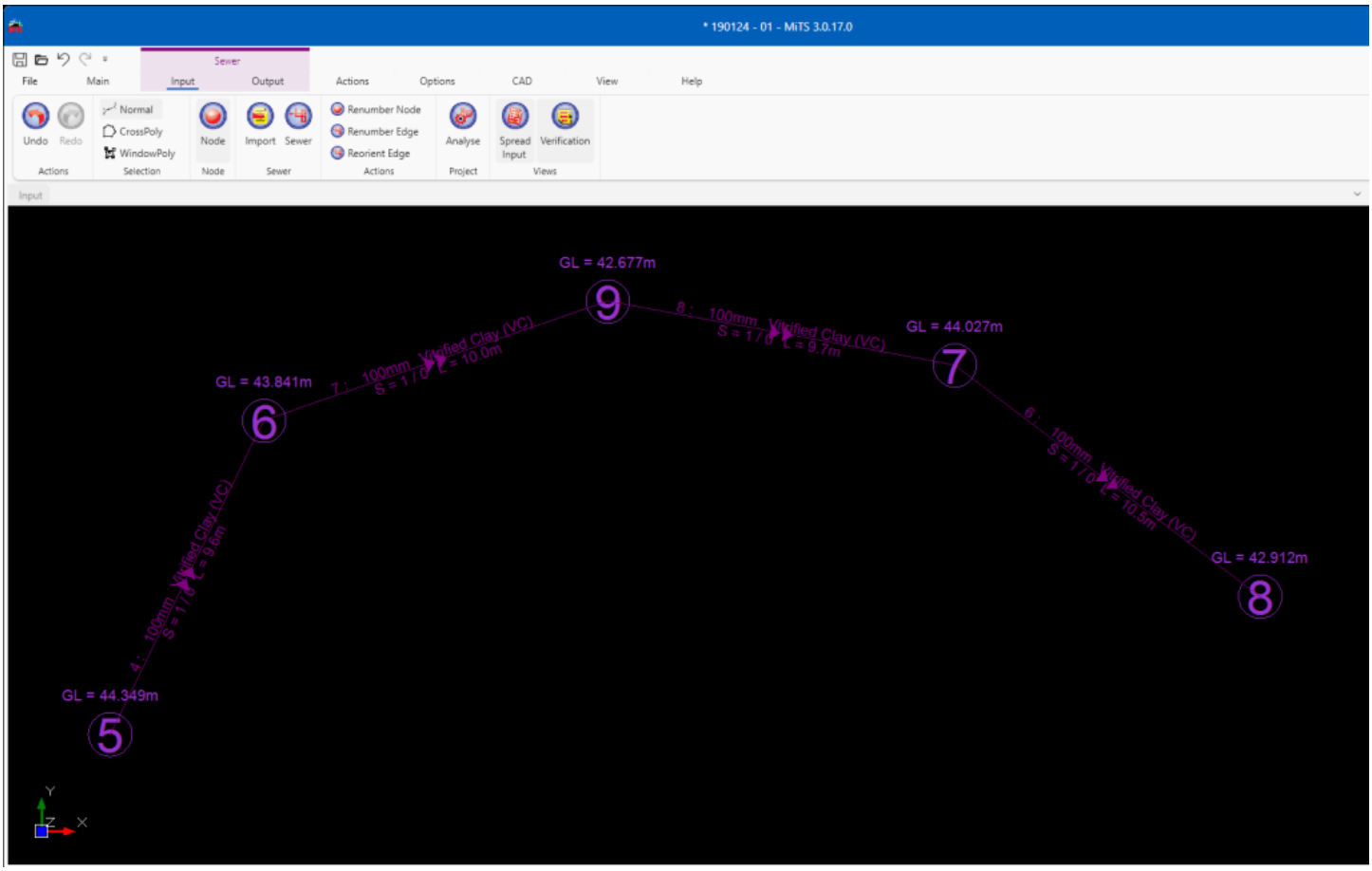


Image 1: Example of sewerage network

Users will require to analyse and go to input tab

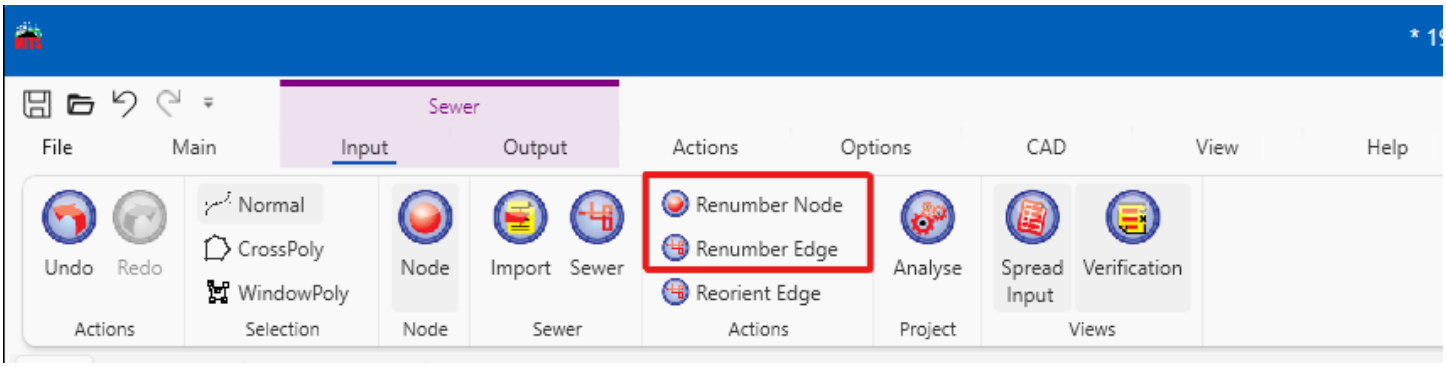


Image 2: Renumbering button

As the image above, to reorder the node number click ‘Renumber Node’ OR to reorder the sewerage number click ‘Renumber Edge’

**Please refer image 3 and image 4*

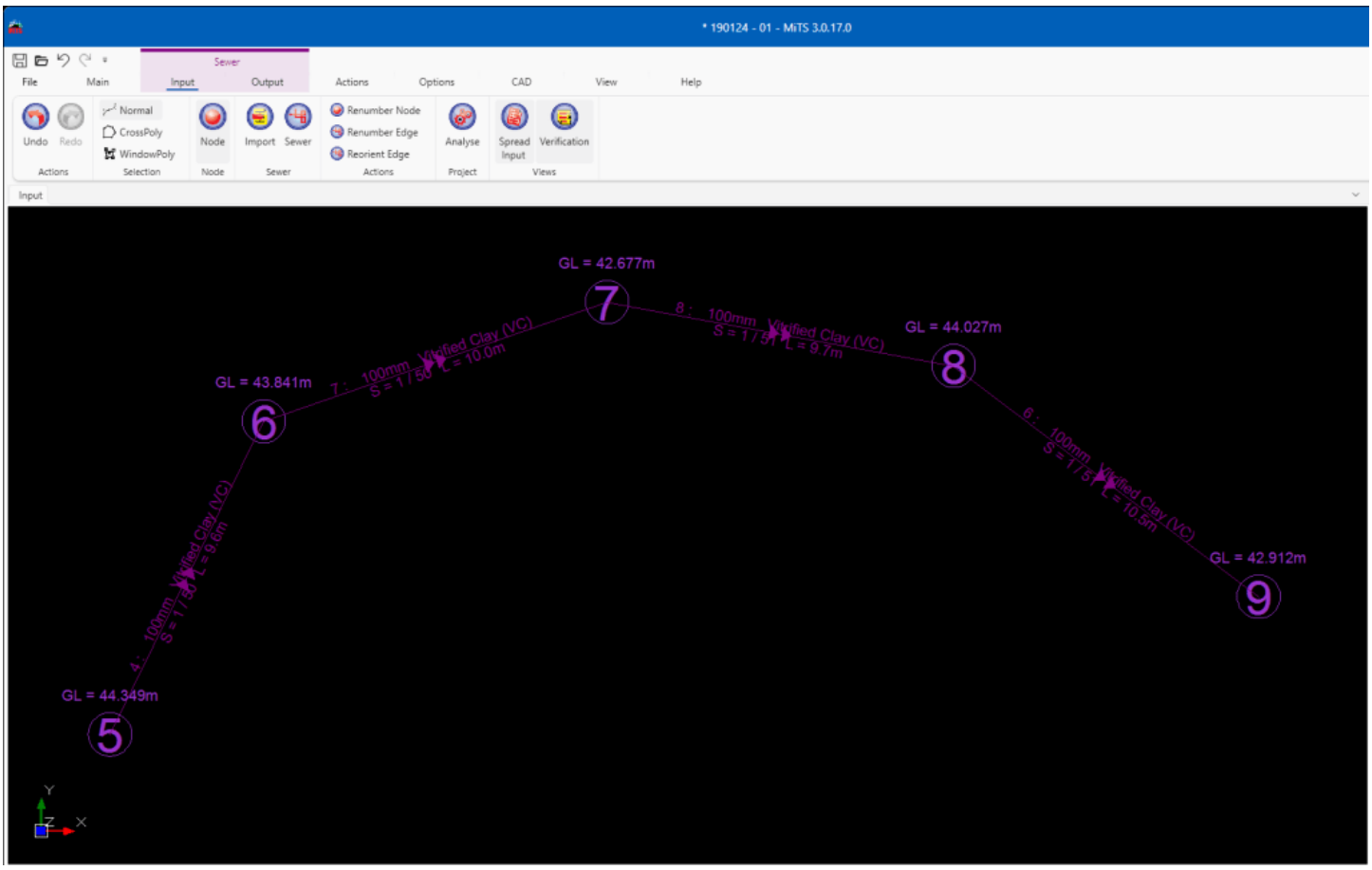


Image 3: Example of renumbering node applied

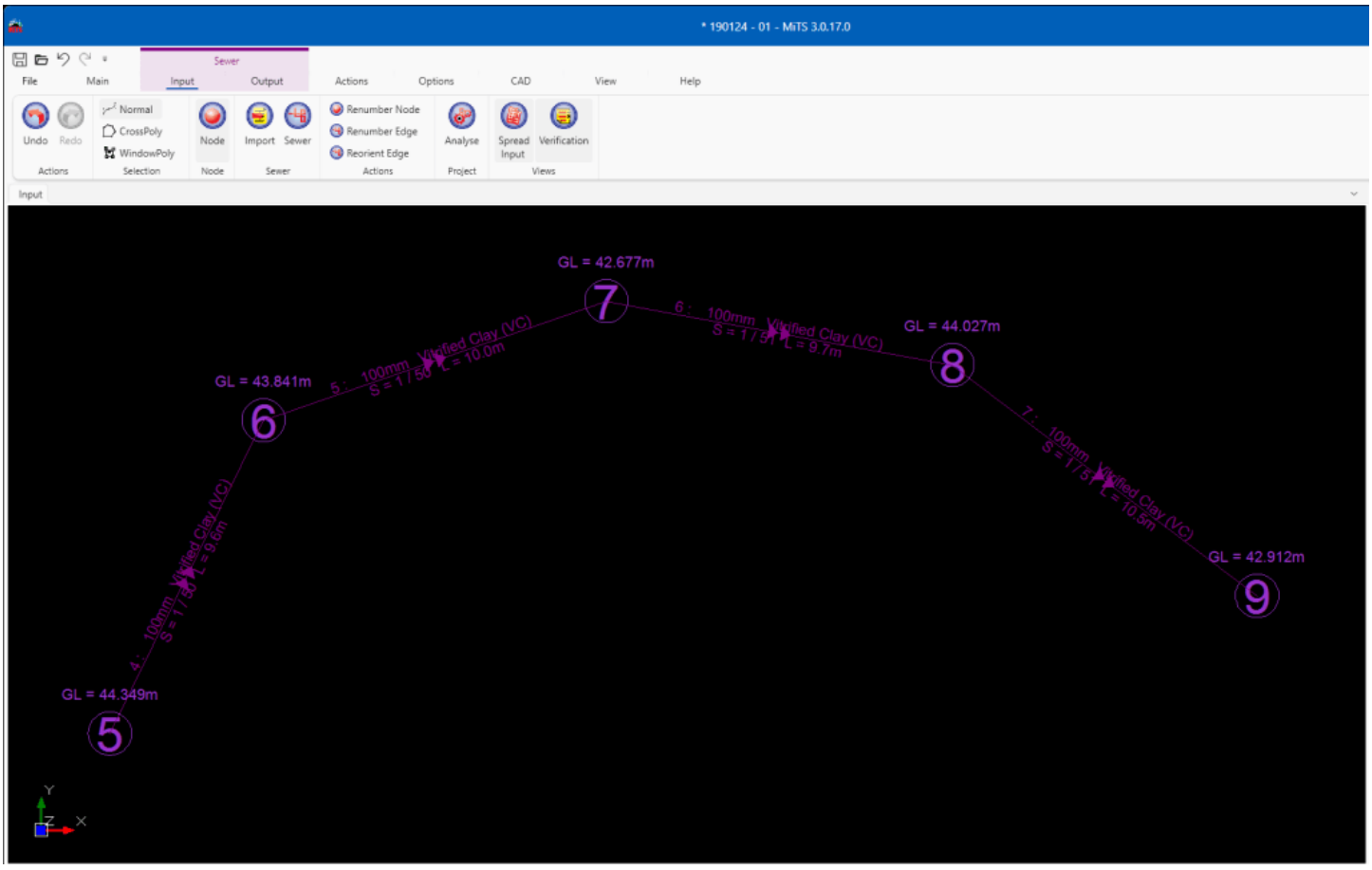


Image 4: Example of renumbering sewer applied

Related



Ngu Soon Hui

I'm the Benevolent Dictator for Life for MiTS Software cum Editor of this website. Read more here.

You can also contact me at soonhui@mes100.com