KINGDOM OF SAUDIA ARABIA

شركة المياه الوطنية
National Water Company

CONSULTING ENGINEERS

Project Name

Water Quality Improvement Project - North Distribution Network & Reservoirs - Dammam Project 5

Main Contractor

Alkhorayef Water & Power Technologies

DOCUMENT TITLE:

DETAILED HYDRAULIC DESIGN FOR DAMMAM WATER SYSTEM – DAMMAM 5

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1 GENERAL

1.1 Introduction

The Kingdom of Saudi Arabia has been increasing its investment in clean energy, power and water.

In this context, many water quality improvement projects are being proposed in multiple cities in the Eastern region of Kingdom of Saudi Arabia in order to strategically improve the potable water quality, supply and storage by replacing poor quality high saline ground water with Saline Water Conversion Corporation (SWCC) water, in order to improve the network resilience and water delivery for the proposed growth area.

1.2 Purpose of this documents

The objective of this report is to present the detailed hydraulic design for Dammam water elements under the scope of Dammam 5 project. The detailed design will be based on analysing the system steady state hydraulic performance and during the different operating scenarios for the design target year 2050. In addition, transient hydraulic analysis will be performed and submitted in separate document in order to investigate the impact of water hammer on the proposed items and size the proper protection devices to mitigate the surge effect, if needed.

The detailed Hydraulic design of the overall system will be carried out to verify head losses, Pump station capacities, resulting flow rates and water velocities in the piping systems related to Dammam 5 scope. Boundary conditions at the connection points will be used from the received hydraulic model to allow appropriate operation of the system and will be clearly stated within the report.

1.3 References and Standards

The detailed hydraulic design criteria, system design and analysis are based on using the following references and standards:

- Hydraulic design basis for Dammam water system (WQIP-Q0-ILF-T-0012).
- Preliminary Hydraulic design for Dammam 5 water system (WQIP-D5-ILF-T-0043).
- 00_TES_SD_001-The Specification, Bills of Quantities and Typical Details for Water and Wastewater Networks Specifications – Water and Sewer Networks.
- Employers Requirements, RFP.
- RFP Drawings, D900208-DAM5-DG-EN-XXXX-01.

- Pipeline design basis and thickness calculation report for Dammam 5 (WQIP-D5-ILF-T-0024).
- Final masterplan report: SA025WTD-P1-S9-MP-REP-0001_01_Volume 1.

1.4 Abbreviations

NWC	:	National Water Company
ISO	:	International Organization for Standardization
DI	:	Ductile Iron
EPS	:	Extended Period Simulation
FCV	:	Flow Control Valve
VFD	:	Variable Frequency Drive
SOW	:	SCOPE OF WORK
RFP	:	REQUEST FOR PROPOSAL

1.5 System of Units

The International Unit System (SI) shall be used in accordance with the latest Standard of the ISO 80000 standard (drawings, calculations, etc.).

Item	Unit
Length	Meter (m) or millimeter (mm)
Diameter	Meter (m) or millimeter (mm)
Pressure	Bars
Force	Kilo Newton (kN)
Velocity	Meter per second (m/s)
Flow	Meter cube per second (m^3/s), Litre per second (l/s)

2 DAMMAM WATER SYSTEM

1.1 System Description

Generally, Saline Water Conversion Corporation (SWCC) provides water for most parts of the Dammam water system. The existing system is divided into two by Jubail Highway. The east part of the network is supplied by gravity through Tank 55, which gravitates to the local network in the southeast, and north along the two large main to the Central Pump Station that delivers pumped water to the lower-laying northeast. Pumps from Tank 71 supply the network on the west side of the Jubail highway through two mains. Moreover, several isolated networks also exist that are only supplied by groundwater (Figure 1).

Please note that Figure 1 is taken from the Request for Proposal (RFP) and presented without modifications with Reference. However, the terms reservoir and tanks are used interchangeably, and the red arrow in figure one should have been blue.

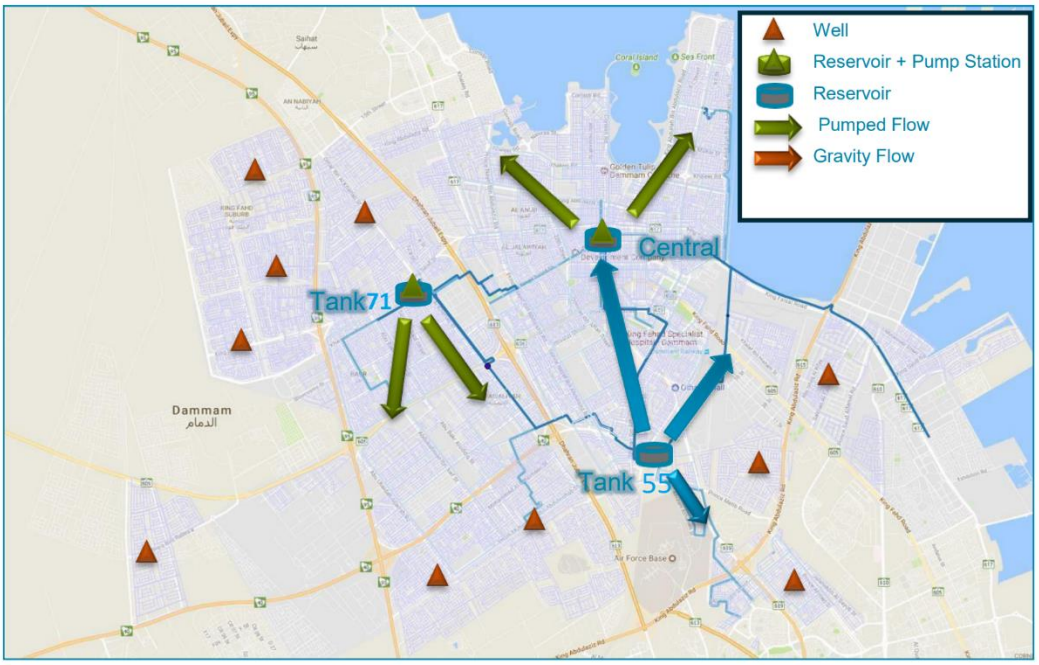

Figure 1: Current Dammam Water Network Operation (sources: NWC - Project requirements – Dammam project 2 – Rev Feb 2021)

According to the latest master plan, the Dammam city water distribution network is supplied continuously (24x7) from three reservoirs/pumping station sites, in addition to the wells located within the city:

- Tanks 71 complex (including a pumping station)
- Tanks 55 reservoirs (including a pumping station to Dhahran area)
- Central Tanks site (including a pumping station)
- 53 wells (distributed within the network)

Figure 2 shows Dammam Existing Water Supply Network Schematic.

The current local/operational reservoirs storages capacities and pumping stations are presented in the table1.

Table 1: Dammam Current Operational Storage and Pumping Capacities (Source: Master Plan)

Reservoir/Pumping Station Name	Current reservoir storage capacity (m^3)	Current pumping station capacity	No of duty/St-by Pumps
Tanks 71	4x12,000	1 x (Q = 500 l/s & H = 42 m) (Group 1) 1 x (Q = 500 l/s & H = 42 m) (Group 2)	1 duty + 1 St-by (Group 1) 1 duty + 3 St-by (Group 2)
Tanks 55	25,000	1 x (Q = 250 l/s & H = 65 m)	1 duty + 2 St-by
Central Tanks	2,340 + 2x10,000	1 x (Q = 388 l/s & H = 45 m)	1 duty + 4 St-by
Total	95,340		

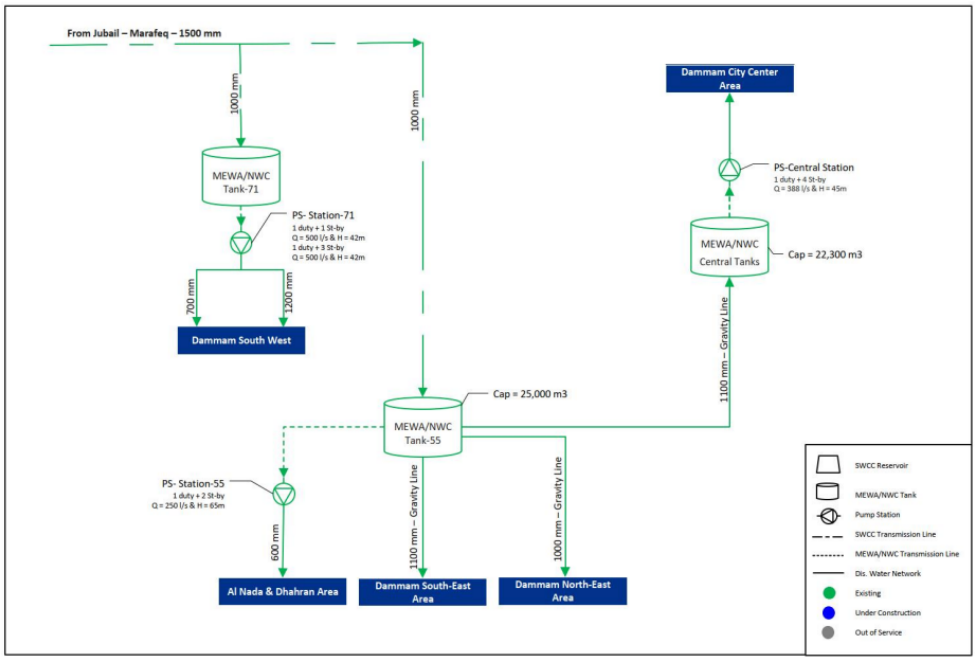

Figure 2: Dammam Existing Water Supply Network Schematic (Source: Master Plan)

However, according to the Dammam Water Improvement – Project 2 report (Project requirements – Dammam project 2 – Rev 2021) conducted by National Water Company NWC, the current system is faced with salinity problems, not functioning at its optimal condition and not supplying enough pressured water to some parts of the city due to many reasons including a limited supply of water by the SWCC, poor network connectivity, limited storage capacity and pumping stations, poor Operation and Maintenance (O&M), and limited electricity supply.

Jacobs has modeled the current network to improve the system performance, and its performance has been studied. The model showed that some areas connected with the SWCC could not receive water at an adequate pressure. As a result, groundwater is used in these areas to supplement the SWCC supply, but still, sufficient pressure is not maintained as pressure across the network generally is too low. Thus, a number of possible water improvement measures have been proposed by NWC in the same reports mentioned above that could improve the system's efficiency, Figure 3.

In summary, the water improvement measures have been divided into the following five projects:

- Project 1 (quick win) includes the strategic loop network between Dhahyia and Central tanks.
- Project 2 includes reticulation spines to address salinity in the north of Dammam, and storage and pump station upgrades at Dhahyia and Tank 71.
- Project 3 – this includes the strategic loop and distribution network between Jamiah and Dhahyia tanks, along with the construction of storage and a pump station at Ash Shulah.
- Project 4 includes the Jamiah tank and the SWCC supply main supplying Jamiah from the desalinated water supply.
- Project 5 includes the strategic loop and distribution network between Jamiah and Central tanks, along with the construction and upgrades of storage and pump stations at Central Tank, Tank 55, and Jamiah.

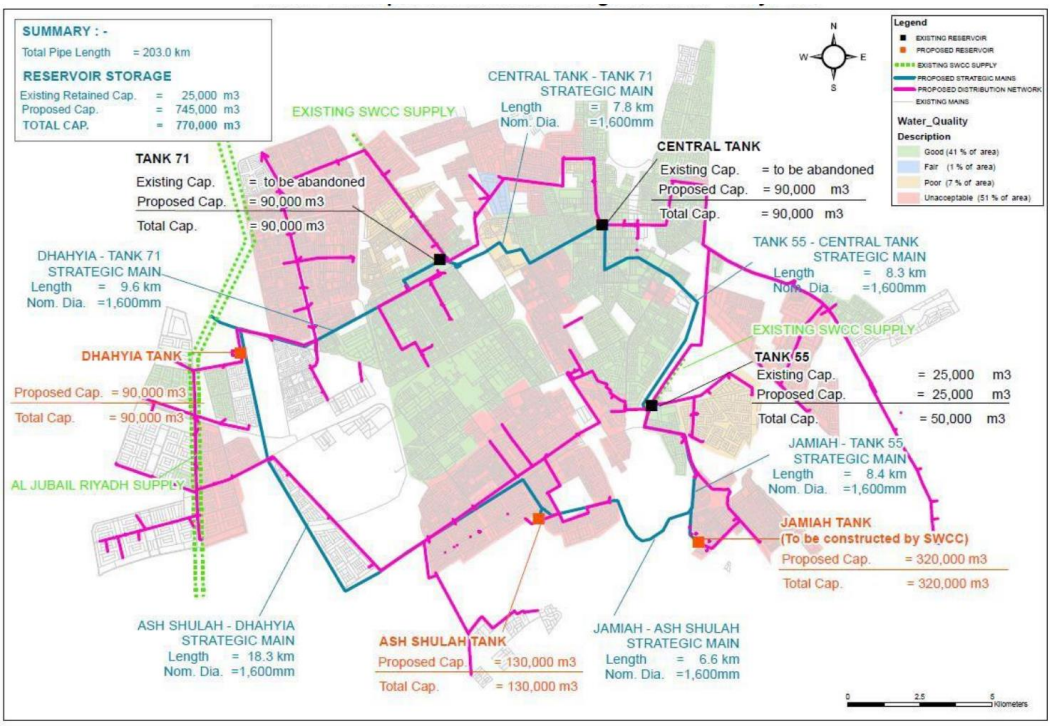

Figure 3: Layout of the proposed measure (sources: NWC - Project requirements – Dammam project 2 – Rev Feb 2021)

1.2 Focus of the study

As mentioned above, Dammam water Improvement program is divided into five projects. This document is only focused Dammam 5.

1.2.1 Project Number 5 (Dammam 5)

This project includes both the strategic loop and the distribution network between Jamiah and Central tanks, along with storage and pump station upgrades at Central Tank, Tank 55 and Jameah, Figure 4.

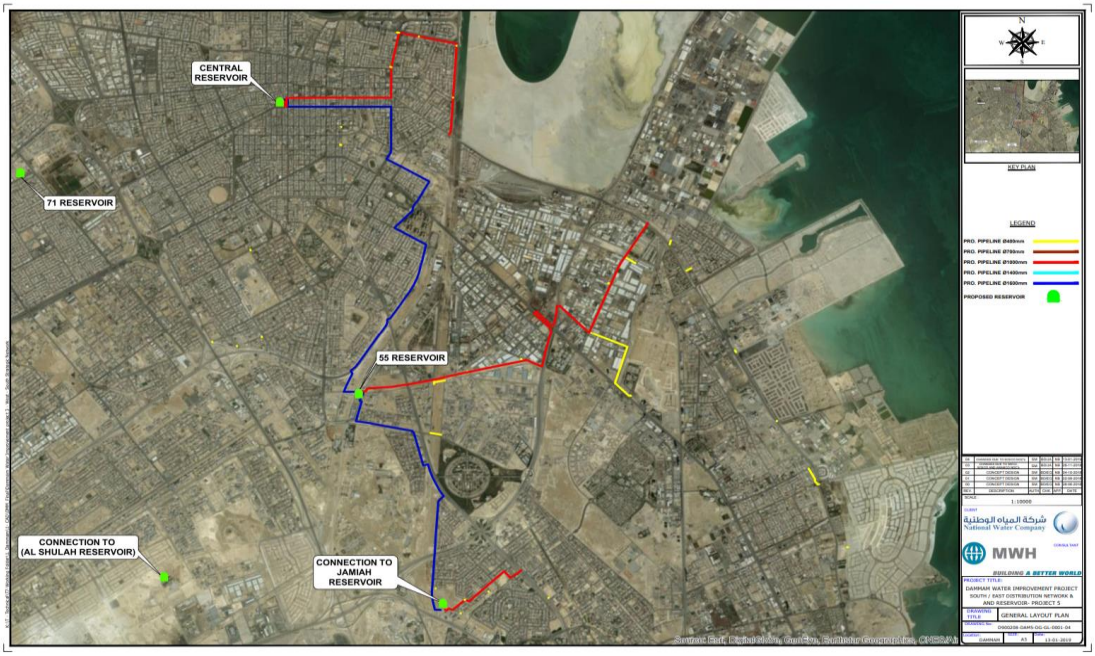

Figure 4: Dammam 5 proposed water network (sources: NWC - Project requirements – Dammam project 2 – Rev Feb 2021)

The length of the proposed is about 17 km of 1400 mm and 1600 mm diameters, from Jamia reservoir to Tanks 55 and central tanks. Also, it includes about 23 km of 400mm and 1,000 mm diameters of distribution lines.

Reservoirs:

A) Central Reservoir

2 service reservoirs, Storage Capacity for each: 45,000 m^3) Total Capacity = total 90,000 m^3.

B) Tank 55

1 service reservoir, Storage Capacity: 25,000 m3).

C) Construction of a new reservoir in Jameah with the capacity of the 100,000 m^3

Pump Stations:
Following in the Table 2 are the specifications of the Pump stations for upgrading/construction in the Dammam 5:

Table 2- Pumps specifications in Dammam 5 (Source: RFP and Master Plan)

Pump Stations Site	Normal Operating Point		Pump type	Nb of pumps
	Flow (l/s)	Head lift (m)		
Central Tank PS	4,500	50	VFD*	3 duty + 1 standby
Tank 55 PS	2400	40	VFD	2 duty + 1 standby
Jameah PS	250	35	VFD	1 duty + 1 standby
Aramco Emergency Booster	350	60	VFD	1 duty + 1 standby

* Variable Frequency Drive (VFD)

3 HYDRAULIC SIMULATION

3.1 Model Modification and Adjustments

Per the submitted technical memo and Request for Information (RFI), the received model did not match exactly the RFP, especially concerning storages, pumps, and Pressure Reducing Valves (PRV) in the water system under the scope of Dammam 2 and Dammam 5 Projects. Therefore, a few major modifications (explained below) are made to the model to match the RFP. Then both the original received model (without changes) and the modified model (with the changes) are simulated. The results are presented below for comparisons and decisions making.

The following three significant modifications are made in the original received model to match the RFP:

1.2.2 Storages

In the original model, Tank 71, Tank Central, and Tank 55 were modelled as the reservoir with constant head. In the RFP, these are tanks, and to match the RFP, these reservoirs have been changed to tanks with their updated dimension supplied by the client. The details are provided in the following Table 3. Please note that the Diameters in Table 3 are equivalent diameters for a set of tanks except Jamiah Tank.

Table 3 - Tanks Details in Dammam 2 and 5

Site	Number of tanks	Networking capacity of each tank (m^3)	Diameter (m)	Tank Height (m)	Water Height (m)	Ground elevation (m)
DHAHYIA_TANK	2	45,000	48.0	25.8	25.4	4.5
JAMIAH_TANK	1	100,000	81.0	20.4	20.0	90.7
TANK 55	1	25,000	40.0	20.9	20.5	35.0
TANK 71	2	45,000	58.6	17.6	17.2	8.0
TANK_CENTRAL	2	45,000	50.0	23.9	23.5	3.9

1.2.3 Pumps

The pump stations in the scope of Dammam 2 and Dammam 5 have been updated according to RFP. The pump curves have been added, and the pumps' Variable Speed Drive (VSD) properties are defined for the operation pumps. It is assumed that the pump can be operated within the range of 60% to 120 % of its rotation speed except for Dhahyia (which is between 40% - 100% of its rotation speed as it is a pump with an enormous capacity). The VSD is controlled by the pressure of a remote junction point in the system ranging between 3.5 to 4 bar. Table 4 and Table 5 provide the details of the pumps.

Table 4 - Pump Details in the model within the Scope of Dammam 2 and 5

Pump Stations	Type of input	Design Head (m)	Design Flow (lps)	Curve ID
Central	Multiple Point Curve	50	4,500.00	CENTRAL_TANK_PS_NRY
Dhahiya Strategic	Multiple Point Curve	150	5,250.00	DHAHIYASTRATEGICOPTION2PS1_NRY
Dhahiya Network	Multiple Point Curve	50	2,350.00	DAHIAY_PUMP_NRY
Jamiah	Multiple Point Curve	35	250	JAMIAH_PS_NRY
Tank 55	Multiple Point Curve	30	2,400.00	MEW_TANK_55_PS_NRY
Tank 71	Multiple Point Curve	40	2,400.00	TANK_71_PS_NRY

Table 5- Details of the VSD properties of the Pumps

Pumps ID	Control Type	Control Setting (bar)	Control Element Node	Maximum Speed	Minimum Speed
CENTRAL_TANK_PS	Junction Pressure	4	DMM_18604	1.2	0.6
DHAHYIA_PUMP	Junction Pressure	4	DMM_JUN_3038	1	0.4
JAMIAH_PS	Junction Pressure	4	DMM_14483	1.2	0.6
MEW_TANK_55_PS	Junction Pressure	4	DMM_JUN_2794	1.2	0.6
TANK_71_PS	Junction Pressure	3.5	DMM_JUN_1966	1.2	0.6

1.2.4 Valves

In the original model, around 68 different Valves were introduced in the scope of Dammam 2 and Dammam 5. However, these valves were not according to the RFP. After modification of the model to match the RFP and the requirements of the Design Bases, only the following Valves are kept active in the model, presented in Table 6. The settings of the valves are kept as the original model, and it is not changed during the modelling phase. Only the PRV (DMAV317) is a newly introduced PRV instead of (PRV-32) in its upstream (coordinates x=414664.17, y=2914254.70). This newly introduced PRV will reduce the pressure in the South part of Jamiah network (towards AL Khobar). The rest of the valves were assumed to be inactive and not considered in the hydraulic modelling.

Table 6- Active valves information in the controlling flow to Dammam 2 and 5 scope

ID	Type	Settings
FCV-3	Flow Control Valve	6,400.00 (l/s)
FCV-2	Flow Control Valve (out of SOW)	5,200.00 (l/s)
FCV_TANK55	Flow Control Valve	2,200.00 (l/s)
FCV_CENTRAL_TANK	Flow Control Valve (out of SOW)	2,000.00 (l/s)
FCV_TANK71	Flow Control Valve (out of SOW)	1,140.00 (l/s)
PRV-7	Pressure Reducing Valve	3.5 (bar)
PRV-5	Pressure Reducing Valve	3.1 (bar)
PRV-20	Pressure Reducing Valve	2.47 (bar)
DMAV317	Pressure Reducing Valve (New valve)	3 (bar)

1.3 Proposed Water Supply System (Option)

As per the multi-criteria evaluation conducted in the master plan of Dammam, Parent Scenario "Option 2 in the model" is the most optimal Option recommended as a future water supply strategy target year 2050 for Dammam City.

The proposed Option 2, with supply from Dhahiya, Jamiah and KFMC strategic reservoirs is the preferred option Figure 5.

Dhahiya strategic reservoir is supplying Dhahiya, Tank 71 and Shulah are operational tanks under normal operating scenario and may supply Central Tanks as well under an emergency scenario. Dhahiya operational tank is supplied directly from the nearby strategic tank and the remaining operational tanks are supplied by pumping.

On the other hand, Jamiah strategic reservoir supplies the nearby operational reservoir and Tank 55 and Central Tanks by gravity under the normal operating scenario. Under an emergency scenario, Jamiah strategic reservoir can supply the seven operational reservoirs by gravity.

KFMC strategic reservoir is only supplying the nearby operational reservoir.

Dhahiya reservoir supplies the transmission loop by pumping, and Jamiah strategic reservoir supplies the loop by gravity. In case of failure of Dhahiya strategic reservoir PS, the transmission loop may be supplied directly from the connection to Jubail Riyadh bulk water transmission line and Jamiah strategic reservoir. Should a major break occur on any section of the transmission loop, water can be delivered from both strategic reservoirs via the other route/sections of the loop.

The primary distribution network from the six main operational tanks (Dhahiya, Tank 71, Central Tank, Tank 55, KFMC and Shulah) consists of a 1000 mm looping

lines; thus the continuity of supply can be ensured should a distribution PS fails or a major break occur on any section Figure 6.

Also, the area supplied by pumping from Jamiah operational tank can alternatively be supplied from operational Tank 55 PS. Similarly, the area supplied from KFMC operational tank can be supplied from either Dhahiya or Shulah operational tanks.

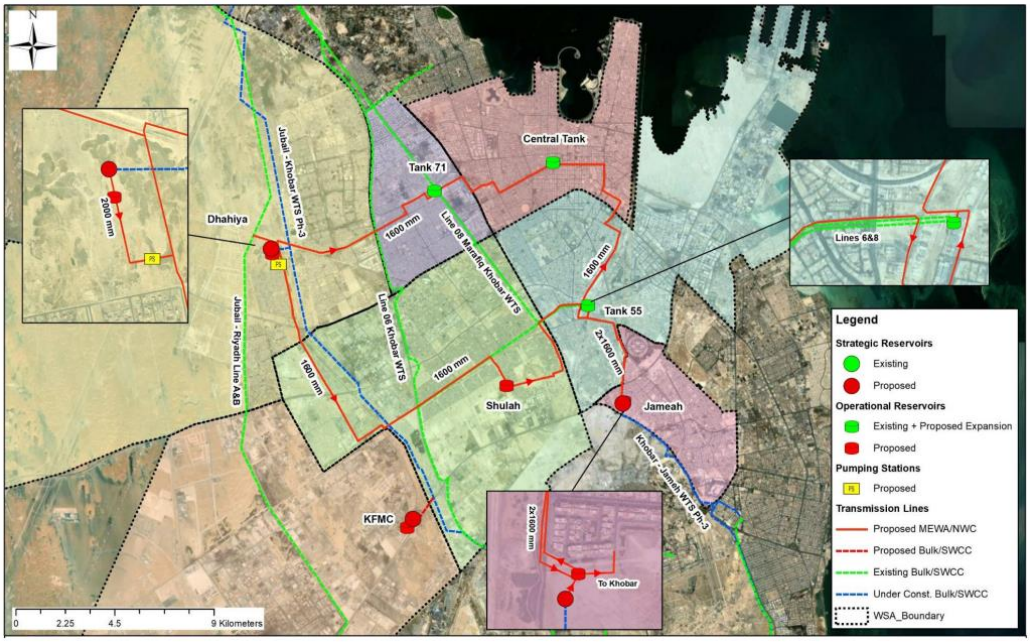

Figure 5- Dammam Proposed Water System Strategy (source: Master Plan)

According to the master plan, in the model within the Option 2 context, the peak daily demand is set to 722073 m^3/day, while for the (2050 ADD + Fire), it was found to be 660492 m^3/day. The demand allocation is not changed during the simulation and is kept as the received model (as stated in the master plan table 5).

Moreover, according to the master plan for the year 2050, the target capacity of the network should be such that the transmission mains should be able to cater to the Peak Daily Demand (PDD) while the distribution system should be able to supply the Peak Hourly Demand for the same year (table 6).

Table 7: 2020 - 2050 Peak Daily Demands PDD (source: Dammam Master Plan)

City	Operational Tank / Water Distribution Complex (WDC)	Operational Tank Capacity in 2050 (m^3)			PDD Demand (m^3/day)						
		Existing	Proposed	Total	2020	2025	2030	2035	2040	2045	2050
Dammam	Dhahiya		90,000 (1)	90,000	67,780	70,423	68,521	70,793	74,651	78,755	83,030
	Tank 71	48,000	90,000 (1)	138,000	80,778	82,844	78,742	81,827	87,062	92,632	98,433
	Central Tanks	22,340	90,000 (1)	112,340	148,802	152,607	145,052	150,734	160,378	170,639	181,325
	Tank 55	25,000	25,000 (1)	50,000	93,126	111,283	123,598	134,492	149,012	165,756	185,002
	Ash Shulah		135,000 (1)	135,000	29,049	30,181	29,366	30,340	31,993	33,752	35,584
	KFMC		100,000	100,000	62,212	63,082	61,355	62,653	64,858	67,203	69,646
	Jameah		100,000 (1)	100,000	56,833	58,286	55,401	57,571	61,254	65,174	69,255
	Total (m3/day)	**95,340**	**630,000**	**725,340**	**538,580**	**568,706**	**562,035**	**588,411**	**629,207**	**673,912**	**722,274**

(1) Proposed part of the Water Quality Improvement Projects

Table 8: Target Capacity of Water Supply System in Dammam (Source: Dammam Master Plan)

Year	Maximum Capacity of Existing System (m^3/day)	Target Capacity of Future Water Supply System (m^3/day)	
		Transmission System	Distribution System
Existing (2020)	**538,580**	-	-
2025	-	568,706	1,182,909
2030	-	562,035	1,169,032
2035	-	588,411	1,223,895
2040	-	629,207	1,308,750
2045	-	673,912	1,401,737
2050	-	722,274	1,502,331

1.4 Scenario One – 2050 Peak Daily Demand (PDD)

For the target year 2050, the proposed Option 2 is simulated with Peak Daily Demand and hourly variable demand pattern. The objective was to evaluate the system's performance against different flow rates during the day, focusing on the peak hourly demand, which will result in minimum pressure and high velocities, and the minimum hourly demand during the day, which will result in maximum pressure in the system and low velocities.

Figure 7 shows the hourly demand pattern with the peak multiplier of 2.08 to simulate the peak hourly demand during the day, and the minimum multiplier of 0.52 to simulate the minimum hourly demand during the day.

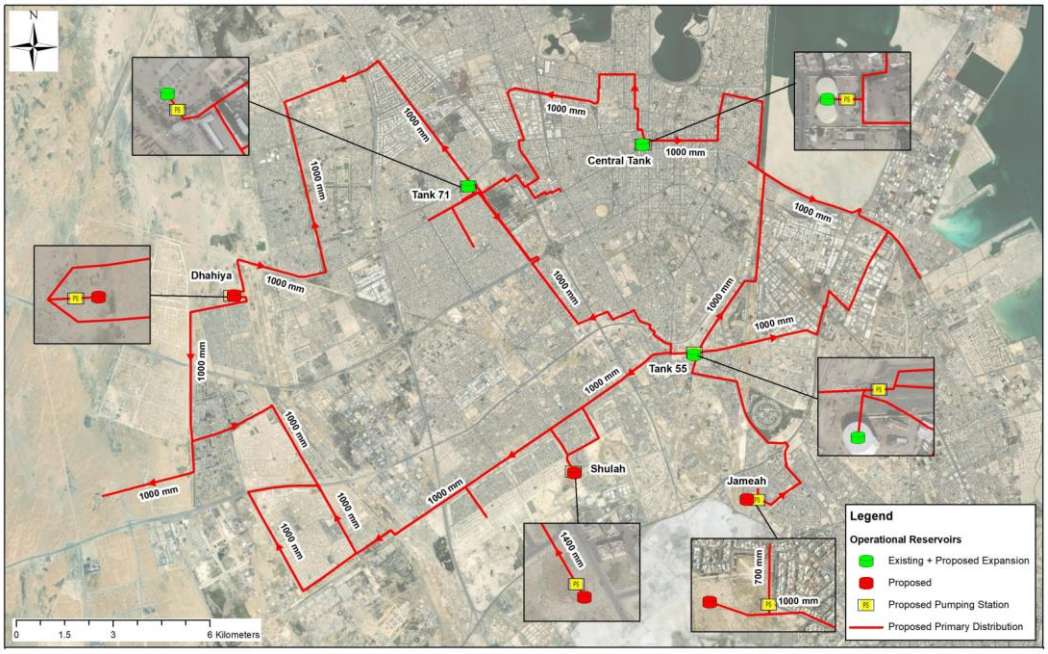

Figure 6: Dammam City Planned/Future Water Distribution Network Main Structure as per Water Quality Improvement Projects (Source: Master Plan)

The values of peak multiplier are based on using peak day factor of 1.2 and the peak hour factor is 2.5, since the base demand in the model is settled to:

Peak Daily Demand – PDD Peak Hourly Demand -PHD

PDD = 1.20 x ADD PHD = 2.50 x ADD

PHD = 2.50 x PDD / 1.20 PHD = 2.08 x PDD

Accordingly, the hourly demand pattern should have a maximum peak multiplier of 2.08 and a minimum of 0.52.

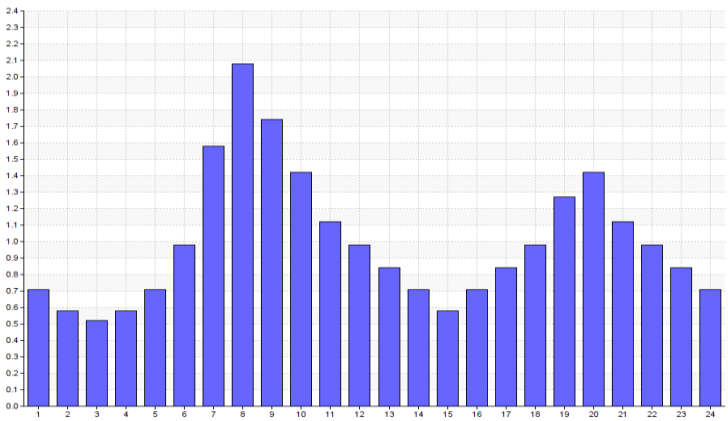

Figure 7: Dammam hourly demand pattern

1.4.1 Minimum Residual Pressure, Maximum Velocity -Peak Hourly Demand

Within Scenario One, the network's minimum residual pressure and maximum velocity were investigated during the Peak hour in the two models.

Figure 8 shows the minimum residual pressure in the original received model (without changing the defined pumps operating points and PRVs), at each node. The minimum achieved residual pressure during peak hourly demand within the scope of the Dammam 2 and 5 projects is around 1.45 bar.

After the mentioned-above modifications, the model has been simulated to evaluate the minimum residual pressure in the system.

Figure 9 shows the minimum residual pressure in the modified model at each node during the peak hourly demand, where the minimum pressure is 1.72 bar for junctions supplied within the scope of work of Dammam 2 and Dammam 5 modified system, excluding a couple of nodes on the suction side of the pump stations. In all Dammam water system, few points with black or blue colors are either closed or at proximity of the pumps. The orange points are slightly above 4 bar pressure which is still acceptable.

A comparison of the two models shows that by removing several PRVs and adding the VSD properties of the pumps with the mentioned above settings, the water system will perform better during the peak hours with overall energy efficiency.

Figure 10 shows the maximum velocities during the peak hour of the original receive model for Dammam water system. The maximum observed velocity within the scope of Dammam project is around 1.92 m/s.

Similarly, Figure 11 presents the maximum velocity during peak hours in the modified model within Dammam 2 and Dammam 5 scopes, which is 1.95 m/s. However, the strategic gravity main 1600mm diameter (purple colored) from Jamiah to Tank 55 has a slightly more constant velocity at around 2.17 m/s.

The velocity comparison of the two models shows that the modifications also slightly increase velocities within the range of design bases. However, some of the pipes in the Dammam 2 and Dammam 5 scopes and most of the pipes in all Dammam system has velocities lower than 0.3 m/s (which is the minimum limit in the design bases).

Tables 8 and 9 show the junction and pipes properties respectively during this scenario.

Figure 8- - Original Model-Minimum residual pressure at nodes during the peak hour (Scenario 1)

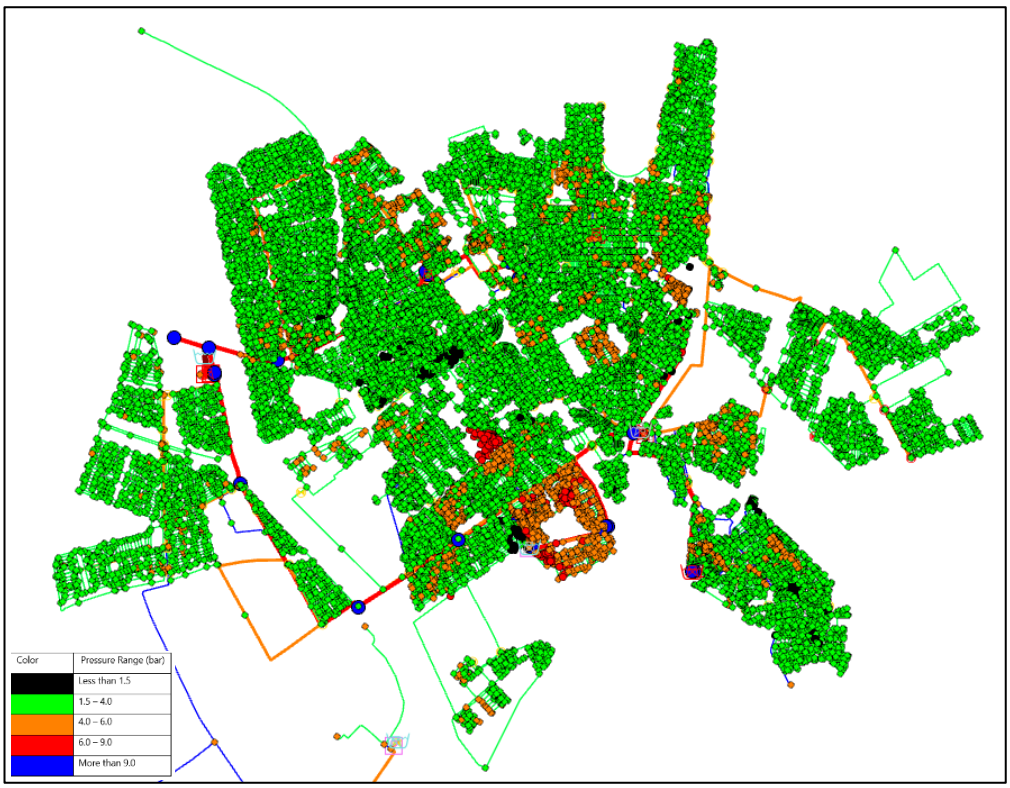

Figure 9- Modified Model-Minimum residual pressure at nodes during the peak hour (Scenario 1)

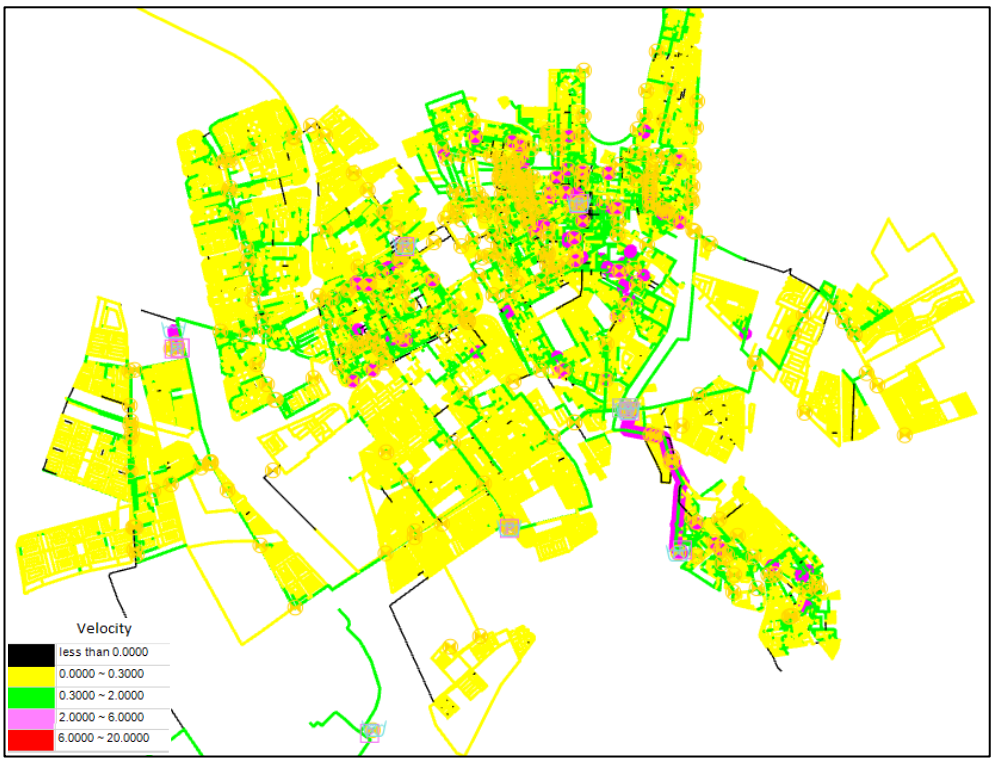

Figure 10- Original Model- Maximum water velocities during the peak hour (Scenario 1)

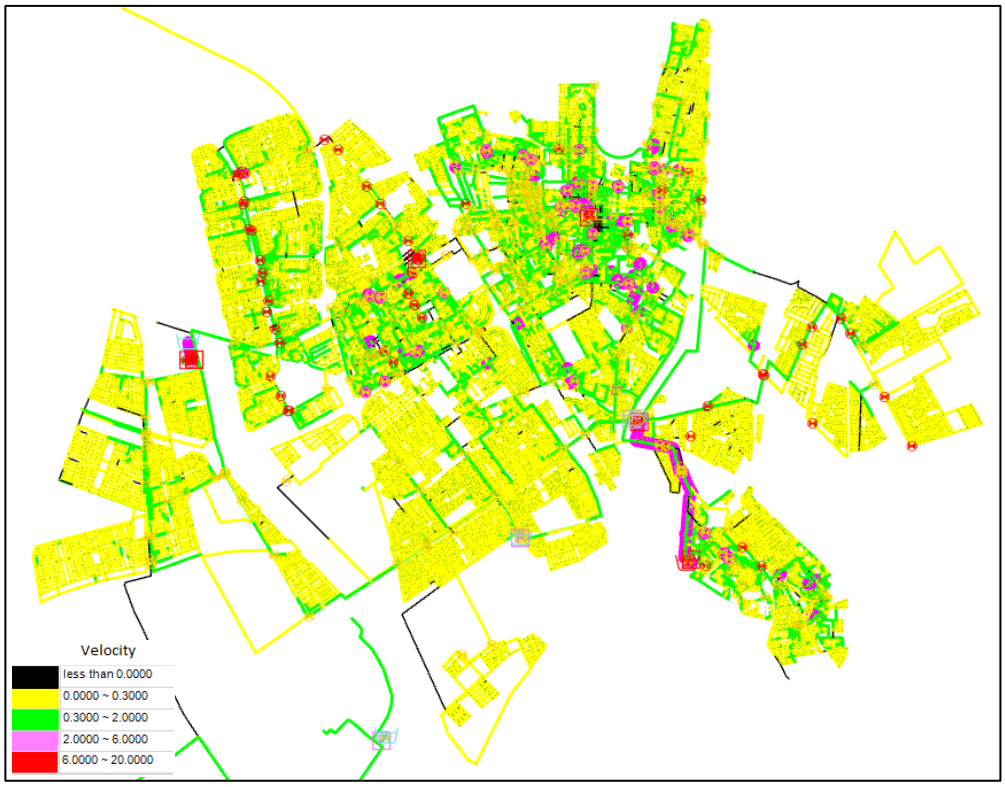

Figure 11- Modified Model- Maximum water velocities during the peak hour (Scenario 1)

Table 9: Table for junctions within Dammam 2 and 5 at the peak demand hour within scenario 1

ID	Demand (L/s)	Elevation (m)	Head (m)	Pressure (bar)
DMM_JUN_2974	0.0000	5.0000	43.9558	3.8174
DMM_JUN_2970	0.0000	5.0000	43.8466	3.8067
DMM_JUN_2972	0.0000	5.0000	43.8822	3.8102
DMM_JUN_3006	0.0299	5.0000	41.9805	3.6238
DMM_JUN_3004	0.1246	4.0000	41.9719	3.7209
DMM_JUN_3002	0.6118	4.0000	41.9746	3.7212
DMM_JUN_2856	0.2326	5.0000	41.9906	3.6248
DMM_JUN_2858	0.8586	2.0000	42.0632	3.9259
DMM_JUN_3000	1.2652	6.0000	42.1387	3.5413
DMM_3879	0.0050	6.0000	42.1384	3.5413
DMM_JUN_2860	1.5997	3.0000	42.3088	3.8520
DMM_JUN_2854	0.5085	6.0000	42.4783	3.5746
DMM_JUN_2996	0.0389	6.0000	42.4988	3.5766
DMM_JUN_2994	0.0200	6.0000	42.4989	3.5766
DMM_JUN_2852	0.1722	4.0000	42.8267	3.8047
DMM_JUN_3374	0.1795	3.0000	42.9980	3.9195
DMM_JUN_3372	0.6022	3.0000	43.0450	3.9241
DMM_JUN_2626	0.4247	3.0000	43.0872	3.9282
DMM_JUN_2638	0.3717	6.0000	43.0431	3.6299
DMM_JUN_3008	0.0414	5.0000	43.0373	3.7274
DMM_JUN_2690	0.5215	7.0000	42.9901	3.5267
DMM_JUN_3010	0.0660	2.0000	42.9893	4.0166
DMM_JUN_3012	0.3108	6.0000	42.9616	3.6219
DMM_JUN_2636	0.3336	4.0000	42.9041	3.8123
DMM_JUN_3014	0.0480	7.0000	41.6544	3.3959
DMM_JUN_3016	0.1966	5.0000	42.8923	3.7132
DMM_JUN_3024	0.3534	7.0000	42.8855	3.5165
DMM_JUN_3026	0.1339	6.0000	42.8645	3.6124
DMM_JUN_2692	0.7153	6.0000	42.8629	3.6123
DMM_JUN_3020	0.2896	6.0000	42.7859	3.6047
DMM_JUN_2740	0.1398	11.0000	42.6245	3.0990
DMM_JUN_3018	0.0174	4.0000	41.0878	3.6343
DMM_7590	0.0702	10.0000	42.6169	3.1962
DMM_JUN_3022	0.1367	4.0000	42.7800	3.8001
DMM_JUN_3028	0.2469	4.0000	42.8306	3.8051

ID	Demand (L/s)	Elevation (m)	Head (m)	Pressure (bar)
DMM_JUN_2634	0.2259	4.0000	42.8288	3.8049
DMM_JUN_3032	0.0162	4.0000	42.8130	3.8034
DMM_JUN_3030	0.0532	6.0000	42.3716	3.5641
DMM_JUN_3038	0.1950	2.0000	42.8086	3.9989
DMM_JUN_2632	0.2114	2.0000	42.8074	3.9988
DMM_JUN_3040	0.0136	2.0000	42.7892	3.9970
DMM_JUN_3034	0.0949	2.0000	42.7992	3.9980
DMM_JUN_2640	0.4888	2.0000	42.8034	3.9984
DMM_JUN_2654	0.3515	3.0000	42.8016	3.9002
DMM_JUN_2630	0.1887	3.0000	42.7697	3.8971
DMM_JUN_3042	0.2766	2.0000	42.7663	3.9948
DMM_JUN_276	0.1220	5.0000	42.6996	3.6943
DMM_JUN_3044	0.1868	4.0000	42.7608	3.7982
DMM_JUN_3046	0.0524	4.0000	42.8012	3.8022
DMM_JUN_3048	0.0740	4.0000	42.5519	3.7778
DMM_JUN_2730	0.1943	4.0000	42.7979	3.8019
J-14	0.4910	4.3951	42.7979	3.7632
DMM_JUN_2656	0.0000	11.0000	44.8555	3.3176
DMM_JUN_2732	0.0744	5.0000	44.8555	3.9055
DMM_JUN_3052	0.0213	4.0000	44.8555	4.0035
DMM_JUN_3054	0.0400	4.0000	44.6193	3.9804
DMM_JUN_2734	0.0872	3.0000	44.8555	4.1015
DMM_JUN_3058	0.0128	2.0000	44.8555	4.1995
DMM_JUN_3378	0.0278	7.0000	44.8555	3.7095
DMM_JUN_3376	0.0130	7.0000	44.7586	3.7000
DMM_JUN_3062	0.0060	3.0000	44.8555	4.1015
DMM_JUN_2736	1.5041	1.0000	44.8557	4.2975
DMM_JUN_3064	0.0935	7.0000	44.8563	3.7096
DMM_JUN_3066	0.0037	7.0000	44.8498	3.7090
DMM_JUN_3070	0.0140	7.0000	44.8493	3.7089
DMM_JUN_3068	0.0162	7.0000	44.8486	3.7089
DMM_JUN_2738	0.3488	18.0000	44.8597	2.6320
DMM_2915	0.0037	12.0000	44.8572	3.2198
DMM_JUN_2976	0.4470	6.0000	44.8648	3.8084
DMM_JUN_2980	0.5388	6.0000	44.8664	3.8086

ID	Demand (L/s)	Elevation (m)	Head (m)	Pressure (bar)
DMM_JUN_2962	0.0000	6.0000	184.6639	17.5077
DMM_JUN_2978	2.2105	6.0000	44.8533	3.8073
J52	0.0000	0.0000	17.0006	1.6659
J54	0.0000	0.0000	16.9992	1.6658
DMM_JUN_2960	0.0000	3.0000	184.6786	17.8031
DMM_JUN_3284	1.0369	10.0000	44.7227	3.4026
DMM_JUN_3282	0.2014	10.0000	44.7249	3.4028
DMM_JUN_2390	0.0229	10.0000	44.7243	3.4027
DMM_JUN_2392	0.0206	15.0000	44.7237	2.9127
DMM_3406	0.0037	15.0000	44.7236	2.9127
DMM_JUN_3348	0.0509	15.0000	44.7236	2.9127
DMM_JUN_3350	0.3793	15.0000	44.7174	2.9121
DMM_JUN_2394	0.0612	15.0000	44.7067	2.9110
DMM_JUN_2814	0.1445	11.0000	44.7210	3.3044
DMM_JUN_3288	0.3113	12.0000	44.7134	3.2057
DMM_JUN_3286	0.2024	12.0000	44.7088	3.2052
DMM_JUN_2816	0.2833	12.0000	44.7118	3.2055
DMM_JUN_3290	0.2874	13.0000	44.7076	3.1071
DMM_JUN_3292	0.2440	13.0000	44.7084	3.1072
J30	0.0000	13.0000	44.2449	3.0618
DMM_JUN_3300	0.1760	10.0000	44.7059	3.4009
DMM_JUN_3298	0.1353	10.0000	44.7049	3.4008
J28	0.0000	10.0000	44.0682	3.3384
DMM_JUN_2818	0.5248	14.0000	44.7057	3.0089
DMM_JUN_2812	0.2905	14.0000	44.7052	3.0089
DMM_JUN_3296	1.4929	14.0000	44.7046	3.0088
DMM_JUN_3294	0.6635	14.0000	44.7024	3.0086
DMM_JUN_3354	0.2385	12.0000	43.3056	3.0677
DMM_JUN_3360	0.0026	11.0000	43.3507	3.1701
DMM_JUN_3358	0.1331	11.0000	43.3503	3.1701
DMM_JUN_3356	0.1284	11.0000	43.3520	3.1702
DMM_JUN_2806	0.8949	9.0000	43.3745	3.3684
DMM_2856	0.3510	12.0000	43.2439	3.0617
DMM_JUN_3380	0.1990	9.0000	43.3955	3.3705
DMM_JUN_3382	0.2858	9.0000	43.3909	3.3700

ID	Demand (L/s)	Elevation (m)	Head (m)	Pressure (bar)
DMM_JUN_3302	0.2857	3.0000	44.1676	4.0341
DMM_JUN_2294	0.0198	3.0000	44.1685	4.0342
DMM_JUN_2810	0.3059	12.0000	43.6918	3.1055
DMM_JUN_3352	0.1100	12.0000	43.6851	3.1049
DMM_846	0.2012	17.0000	45.8962	2.8316
DMM_JUN_3138	0.0445	11.0000	45.9350	3.4234
DMM_JUN_3384	0.0549	4.0000	45.9289	4.1087
DMM_JUN_3142	0.1694	6.0000	45.9668	3.9164
DMM_JUN_2744	0.1843	6.0000	45.9664	3.9164
DMM_JUN_3386	0.1866	6.0000	45.9220	3.9120
DMM_JUN_2746	0.2536	2.0000	46.0212	4.3137
DMM_JUN_3148	0.7557	8.0000	46.1596	3.7393
DMM_JUN_3146	0.0644	8.0000	46.1050	3.7340
DMM_JUN_2762	0.1188	5.0000	46.3562	4.0526
DMM_JUN_3388	0.0917	7.0000	46.3342	3.8544
DMM_2002	0.0481	3.0000	46.2277	4.2360
DMM_JUN_2764	0.0290	6.0000	46.4645	3.9652
DMM_JUN_3150	0.0233	2.0000	46.4303	4.3538
DMM_JUN_2766	0.4083	4.0000	46.5006	4.1647
DMM_JUN_2768	0.0434	5.0000	46.7374	4.0899
DMM_JUN_3152	0.0475	5.0000	46.7212	4.0884
DMM_JUN_2982	0.0455	5.0000	47.2366	4.1389
J58	0.0000	0.0000	15.8992	1.5580
DMM_JUN_2986	0.0436	5.0000	47.2449	4.1397
J56	0.0000	0.0000	15.9014	1.5582
DMM_JUN_2944	0.0000	7.0000	84.3525	7.5799
DMM_JUN_2942	0.0000	10.0000	85.3274	7.3815
DMM_JUN_2940	0.0000	12.0000	85.7706	7.2289
DMM_JUN_2938	0.0000	9.0000	85.9595	7.5414
DMM_JUN_2936	0.0000	16.0000	86.3023	6.8891
DMM_JUN_2934	0.0000	12.0000	86.7360	7.3235
DMM_JUN_2932	0.0000	21.0000	87.5142	6.5179
DMM_JUN_2930	0.0000	29.0000	88.9023	5.8700
DMM_JUN_3280	0.0000	33.0000	89.0504	5.4925
DMM_JUN_2428	0.0000	32.0000	89.0128	5.5868

ID	Demand (L/s)	Elevation (m)	Head (m)	Pressure (bar)
DMM_19836	0.0000	38.0000	88.9837	4.9960
J60	0.0000	37.0000	44.9972	0.7837
J62	0.0000	0.0000	45.0021	4.4098
DMM_JUN_3276	0.0000	37.0000	44.9836	0.7823
DMM_JUN_3278	0.0320	38.0000	67.9501	2.9349
DMM_JUN_3174	0.0173	30.0000	44.9186	1.4619
DMM_1160	0.0118	31.0000	67.9397	3.6198
21665-B	0.0000	27.0000	67.9392	4.0117
DMM_JUN_2794	4.7748	27.0000	67.8086	3.9989
DMM_JUN_2796	0.0197	33.0000	67.8074	3.4109
DMM_JUN_3176	0.0043	31.0000	67.8070	3.6068
DMM_JUN_2678	0.0080	16.0000	67.7553	5.0716
DMM_JUN_3418	0.0034	15.0000	50.9568	3.5235
DMM_JUN_2680	0.0213	14.0000	67.6681	5.2591
DMM_6709	0.5005	19.0000	50.8292	3.1190
DMM_JUN_2790	0.5765	21.0000	67.6495	4.5713
DMM_JUN_3182	0.0309	21.0000	50.9213	2.9321
DMM_JUN_2788	0.1239	10.0000	41.6259	3.0991
J-23	0.0000	10.2337	67.5728	5.6188
DMM_6915	0.0131	15.0000	41.6179	2.6083
DMM_JUN_3186	0.0853	16.0000	41.5349	2.5022
DMM_JUN_2684	0.0480	10.0000	41.4628	3.0831
DMM_JUN_3188	0.0103	5.0000	41.4603	3.5728
DMM_JUN_2682	0.0819	5.0000	41.4304	3.5699
DMM_5853	0.1199	5.0000	41.4281	3.5697
DMM_JUN_3190	0.0636	7.0000	41.3854	3.3695
DMM_JUN_3192	0.0628	2.3782	41.3517	3.8191
DMM_JUN_3194	0.0145	5.5318	41.3469	3.5096
DMM_5301	0.0917	4.0000	41.3274	3.6578
DMM_JUN_2802	0.1319	3.0000	41.3292	3.7560
197	0.0078	5.3500	41.3061	3.5234
10789	0.0377	5.1300	41.3058	3.5449
5447	0.0063	2.0000	41.3002	3.8511
10800	0.0037	2.0000	41.3002	3.8511
10795	0.0000	1.7300	41.3060	3.8781

ID	Demand (L/s)	Elevation (m)	Head (m)	Pressure (bar)
196	0.0000	1.7000	41.3060	3.8811
DMM_JUN_3184	0.0745	9.0000	41.5067	3.1854
DMM_3337	0.0802	7.0000	46.6548	3.8859
DMM_JUN_3320	0.0541	7.0000	46.6481	3.8852
DMM_JUN_2984	0.1553	5.0000	47.2413	4.1393
DMM_JUN_2776	0.8395	11.0000	47.1016	3.5377
DMM_JUN_2778	0.3757	17.0000	47.0202	2.9417
DMM_JUN_3158	0.2683	17.0000	47.0048	2.9402
DMM_JUN_2884	1.1289	17.0000	47.0156	2.9413
DMM_JUN_2780	0.0173	8.0000	46.8596	3.8079
DMM_JUN_3160	0.1470	8.0000	46.8526	3.8072
DMM_1813	0.1888	5.0000	46.8388	4.0999
DMM_17921	0.0707	9.0000	42.3181	3.2649
DMM_JUN_2782	0.1062	5.0000	46.8057	4.0966
DMM_JUN_3162	0.0023	2.0000	46.7811	4.3882
DMM_JUN_3416	0.0640	7.0000	46.7920	3.8993
DMM_JUN_3414	0.0731	7.0000	46.7253	3.8928
DMM_JUN_3164	0.0294	7.0000	46.7900	3.8991
DMM_12447	0.1067	8.0000	37.3333	2.8744
DMM_JUN_3312	0.1956	4.0000	46.7867	4.1928
DMM_JUN_2600	0.0000	4.0000	46.7864	4.1927
DMM_3191	0.2761	7.0000	46.5203	3.8727
DMM_1781	0.4861	8.0000	46.4379	3.7666
DMM_JUN_3316	0.0070	5.0000	46.7817	4.0943
DMM_JUN_3318	0.0470	5.0000	46.7810	4.0942
DMM_JUN_3314	0.0573	4.0000	46.7811	4.1922
DMM_JUN_3156	0.3148	17.0000	46.7492	2.9152
DMM_JUN_3154	0.2548	17.0000	46.6225	2.9028
DMM_JUN_3178	0.0176	37.0000	67.8021	3.0184
DMM_6695	0.0153	38.0000	67.8021	2.9204
DMM_JUN_2926	0.0000	38.0000	89.2352	5.0207
DMM_JUN_2928	0.0000	35.0000	89.4170	5.3324
DMM_JUN_2924	0.0000	35.0000	89.5797	5.3484
DMM_JUN_2922	0.0000	42.0000	90.7364	4.7758
DMM_JUN_2918	0.0000	40.0000	96.1545	5.5027

ID	Demand (L/s)	Elevation (m)	Head (m)	Pressure (bar)
DMM_JUN_2920	0.0000	80.0000	100.6761	2.0261
DMM_14474	0.0176	89.0000	115.2824	2.5755
DMM_JUN_2846	1.0038	89.0000	115.2824	2.5755
DMM_6953	0.0327	42.0000	67.9449	2.5424
DMM_JUN_3260	230.1531	80.0000	100.6494	2.0235
DMM_JUN_2844	0.0170	89.0000	115.3187	2.5790
DMM_5840	0.0000	89.0000	115.3187	2.5790
DMM_5339	0.1200	91.0000	115.2961	2.3808
DMM_JUN_2840	0.3604	95.0000	115.2963	1.9889
DMM_5340	0.1147	74.0000	115.1601	4.0334
DMM_JUN_2838	0.6111	71.0000	115.1601	4.3273
DMM_JUN_2842	0.0460	53.0000	83.3984	2.9788
DMM_5812	0.0198	51.0000	76.8195	2.5301
J-49	0.1208	53.0000	83.6053	2.9991

Table 10: Table for pipes within Dammam 2 and 5 at the peak demand hour within scenario 1

ID	From Node	To Node	Length (m)	Diameter (mm)	Roughness (mm)	Flow (L/s)	Velocity (m/s)	Headloss (m)	HL/1000 (m/k-m)	Status
P-30	FCV-3	DHAHYIA_TANK	158.1679	2,000.0000	0.3000	14,016.7762	4.4617	0.9092	5.7483	Open
P-29	HIYASTRATEGICT/	FCV-3	420.1012	2,000.0000	0.3000	14,016.7762	4.4617	2.4149	5.7483	Open
DHAHIYA_OUTLET	DHAHYIA_TANK	DHAHYIA_PUMP	90.4825	1,400.0000	0.3000	1,801.9848	1.1706	0.0659	0.7282	Open
P11	DHAHYIA_TANK	ASTRATEGICOPTIC	105.0086	1,600.0000	0.3000	3,700.0655	1.8403	0.1585	1.5098	Open
P15	DHAHYIA_TANK	ASTRATEGICOPTIC	104.0323	1,600.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Closed
P17	ASTRATEGICOPTIC	J-68	109.0136	1,600.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Closed
P13	ASTRATEGICOPTIC	DMM_JUN_2900	108.7711	1,600.0000	0.3000	3,700.0655	1.8403	0.1642	1.5097	Open
DMM_PIP_3041	DMM_VAL_8180	DMM_JUN_2974	88.9742	1,400.0000	0.3000	1,801.9848	1.1706	0.0648	0.7282	Open
DMM_PIP_3039	DHAHYIA_PUMP	DMM_VAL_8180	86.3150	1,400.0000	0.3000	1,801.9848	1.1706	0.0629	0.7282	Open
DMM_PIP_2095	DMM_JUN_2974	DMM_VAL_8188	328.9556	1,000.0000	0.3000	1,183.7512	1.5072	0.5912	1.7971	Open
DMM_PIP_2143	DMM_JUN_2974	DMM_VAL_8190	312.4777	1,000.0000	0.3000	618.2335	0.7872	0.1574	0.5036	Open
DMM_PIP_3059	DMM_VAL_8190	DMM_JUN_2972	193.3053	1,000.0000	0.3000	618.2335	0.7872	0.0973	0.5036	Open
DMM_PIP_3057	DMM_VAL_8188	DMM_JUN_2970	165.8876	1,000.0000	0.3000	1,183.7512	1.5072	0.2981	1.7971	Open
P19	J-68	DMM_JUN_2900	11.0483	1,600.0000	0.3000	-1,139.9998	0.5670	0.0017	0.1515	Open
DMM_PIP_3109A	DMAV34	DMM_JUN_3002	151.4414	400.0000	0.3000	38.4727	0.3062	0.0380	0.2511	Open
DMM_PIP_3109	DMM_JUN_3006	DMAV34	23.4707	400.0000	0.3000	38.4727	0.3062	0.0059	0.2512	Open
DMM_PIP_3107	DMM_JUN_3006	DMAV35	17.5910	400.0000	0.3000	80.7682	0.6427	0.0184	1.0438	Open
DMM_PIP_2761	DMM_JUN_2856	DMM_JUN_3006	35.6976	400.0000	0.3000	119.3284	0.9496	0.0796	2.2305	Open
DMM_PIP_3107A	DMAV35	DMM_JUN_3004	46.7041	400.0000	0.3000	80.7682	0.6427	0.0487	1.0437	Open
DMM_PIP_2747	DMM_JUN_2858	DMM_JUN_2856	255.6478	400.0000	0.3000	120.0098	0.9550	0.5766	2.2555	Open
DMM_PIP_3099	DMM_JUN_3000	DMM_JUN_2858	255.0532	400.0000	0.3000	122.5252	0.9750	0.5991	2.3488	Open
DMM_PIP_3101	DMM_JUN_3000	DMAV33	2.5392	400.0000	0.3000	34.6718	0.2759	0.0005	0.2061	Open
DMM_PIP_2749	DMM_JUN_2860	DMM_JUN_3000	342.7624	400.0000	0.3000	160.9035	1.2804	1.3727	4.0048	Open
DMM_PIP_3101A	DMAV33	DMM_3879	5.0712	400.0000	0.3000	34.6718	0.2759	0.0010	0.2059	Open
DMM_8544	DMM_3563	DMM_3879	0.6716	197.3000	0.3000	-34.6570	1.1336	0.0051	7.6143	Open
DMM_PIP_2745	DMM_JUN_2854	DMM_JUN_2860	323.1590	400.0000	0.3000	165.5900	1.3177	1.3692	4.2370	Open
DMM_PIP_3093	DMM_JUN_2996	DMM_JUN_2854	38.4895	400.0000	0.3000	167.0796	1.3296	0.1660	4.3122	Open
DMM_PIP_3095	DMM_JUN_2996	DMAV32	5.2456	400.0000	0.3000	-11.8430	0.0942	0.0001	0.0275	Open
DMM_PIP_2743	DMM_JUN_2852	DMM_JUN_2996	698.8017	400.0000	0.3000	155.3505	1.2362	2.6122	3.7382	Open
DMM_PIP_3095A	DMAV32	DMM_JUN_2994	18.5296	400.0000	0.3000	-11.8430	0.0942	0.0005	0.0279	Open
DMM_PIP_3675	DMM_JUN_3372	DMM_JUN_2852	462.3809	400.0000	0.3000	155.8550	1.2403	1.7395	3.7620	Open
DMM_PIP_3089	DMM_JUN_3372	DMAV30	55.0482	400.0000	0.3000	88.4548	0.7039	0.0685	1.2450	Open
DMM_PIP_3089A	DMAV30	DMM_JUN_3374	241.1596	400.0000	0.3000	88.4548	0.7039	0.3003	1.2450	Open
DMM_PIP_2137	DMM_JUN_2626	DMM_JUN_3372	37.2392	400.0000	0.3000	246.0741	1.9582	0.3441	9.2401	Open
DMM_PIP_3113	DMM_JUN_2638	DMAV42	22.7195	400.0000	0.3000	54.0336	0.4300	0.0109	0.4805	Open

ID	From Node	To Node	Length (m)	Diameter (mm)	Roughness (mm)	Flow (L/s)	Velocity (m/s)	Headloss (m)	HL/1000 (m/k-m)	Status
DMM_PIP_2109	DMM_JUN_2638	DMM_JUN_2690	593.2417	1,000.0000	0.3000	774.5679	0.9862	0.4639	0.7819	Open
DMM_PIP_2097	DMM_JUN_2626	DMM_JUN_2638	429.6359	1,000.0000	0.3000	829.6906	1.0564	0.3843	0.8945	Open
DMM_PIP_3113A	DMAV42	DMM_JUN_3008	70.4685	400.0000	0.3000	54.0336	0.4300	0.0339	0.4806	Open
DMM_PIP_3117	DMM_JUN_2690	DMAV37	125.8354	400.0000	0.3000	41.7338	0.3321	0.0369	0.2932	Open
DMM_PIP_2277	DMM_JUN_2690	DMM_JUN_3012	326.2218	1,000.0000	0.3000	731.3064	0.9311	0.2280	0.6989	Open
DMM_PIP_3117A	DMAV37	DMM_JUN_3010	430.3304	400.0000	0.3000	41.7338	0.3321	0.1262	0.2932	Open
DMM_PIP_3123	DMM_JUN_3012	DMAV43	25.0933	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Open
DMM_PIP_3119	DMM_JUN_3012	DMM_JUN_2636	658.4426	1,000.0000	0.3000	730.3959	0.9300	0.4590	0.6972	Open
DMM_PIP_3127	DMM_JUN_2636	DMAV38	69.2475	400.0000	0.3000	56.2169	0.4474	0.0359	0.5186	Open
DMM_PIP_2107	DMM_JUN_2636	DMM_JUN_3024	249.0059	1,000.0000	0.3000	673.2016	0.8571	0.1480	0.5946	Open
DMM_PIP_3127A	DMAV38	DMM_JUN_3016	103.8293	400.0000	0.3000	56.2169	0.4474	0.0538	0.5186	Open
DMM_PIP_3123A	DMAV43	DMM_JUN_3014	70.4380	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Open
DMM_PIP_3139	DMM_JUN_3024	DMAV44	31.2033	400.0000	0.3000	101.1415	0.8049	0.0504	1.6157	Open
DMM_PIP_3139A	DMAV44	DMM_JUN_3026	71.4614	400.0000	0.3000	101.1415	0.8049	0.1155	1.6157	Open
DMM_PIP_3135	DMM_JUN_3024	DMM_JUN_2692	412.3026	1,000.0000	0.3000	571.0248	0.7271	0.1779	0.4314	Open
DMM_PIP_2427	DMM_JUN_2692	DMAV45	52.7775	400.0000	0.3000	130.3314	1.0371	0.1399	2.6502	Open
DMM_PIP_2287	DMM_JUN_2692	DMM_JUN_3028	972.3816	1,000.0000	0.3000	438.5979	0.5584	0.2514	0.2586	Open
DMM_PIP_2427A	DMAV45	DMM_JUN_3020	179.8362	400.0000	0.3000	130.3314	1.0371	0.4766	2.6502	Open
DMM_PIP_3131	DMM_JUN_3020	DMM_JUN_2740	1,541.3807	400.0000	0.3000	70.9943	0.5650	1.2534	0.8131	Open
DMM_PIP_2289	DMM_JUN_3020	DMM_JUN_3022	79.8294	400.0000	0.3000	58.4886	0.4654	0.0447	0.5596	Open
DMM_PIP_2431	DMM_JUN_2740	DMM_JUN_3018	109.8553	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Closed
DMM_PIP_2429	DMM_JUN_2740	DMM_7590	73.1603	400.0000	0.3000	70.5848	0.5617	0.0588	0.8041	Open
DMM_PIP_3145	DMM_JUN_3028	DMAV46	25.3978	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Open
DMM_PIP_3141	DMM_JUN_3028	DMM_JUN_2634	55.3791	1,000.0000	0.3000	437.8746	0.5575	0.0143	0.2577	Open
DMM_PIP_3145A	DMAV46	DMM_JUN_3030	81.4981	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Open
DMM_PIP_2129	DMM_JUN_2634	DMAV39	48.3822	400.0000	0.3000	67.5614	0.5376	0.0358	0.7389	Open
DMM_PIP_2105	DMM_JUN_2634	DMM_JUN_3038	838.2071	1,000.0000	0.3000	369.6514	0.4707	0.1558	0.1859	Open
DMM_PIP_2129A	DMAV39	DMM_JUN_3032	117.4084	400.0000	0.3000	67.5614	0.5376	0.0868	0.7389	Open
DMM_PIP_3151	DMM_JUN_3038	DMM_JUN_2632	68.6345	1,000.0000	0.3000	318.1160	0.4050	0.0096	0.1393	Open
DMM_PIP_2125	DMM_JUN_3038	DMAV40	50.4294	400.0000	0.3000	50.9642	0.4056	0.0217	0.4296	Open
DMM_PIP_2125A	DMAV40	DMM_JUN_3034	115.9837	400.0000	0.3000	50.9642	0.4056	0.0498	0.4296	Open
DMM_PIP_2127	DMM_JUN_2632	DMAV48	12.0192	400.0000	0.3000	90.8460	0.7229	0.0158	1.3110	Open
DMM_PIP_2103	DMM_JUN_2632	DMM_JUN_2640	551.5128	1,000.0000	0.3000	226.6506	0.2886	0.0401	0.0728	Open
DMM_PIP_2127A	DMAV48	DMM_JUN_3040	48.4536	400.0000	0.3000	90.8460	0.7229	0.0635	1.3113	Open
DMM_PIP_2121	DMM_JUN_2640	DMM_JUN_2654	255.3563	1,000.0000	0.3000	225.2186	0.2868	0.0184	0.0719	Open

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DMM_PIP_2183	DMM_JUN_2654	DMM_JUN_3046	257.0146	1,000.0000	0.3000	107.5707	0.1370	0.0046	0.0179	Open
DMM_PIP_2181	DMM_JUN_2654	DMAV41	40.2069	400.0000	0.3000	116.6180	0.9280	0.0857	2.1327	Open
DMM_PIP_2181A	DMAV41	DMM_JUN_2630	94.8501	400.0000	0.3000	116.6180	0.9280	0.2023	2.1327	Open
DMM_PIP_2101	DMM_JUN_2630	DMM_JUN_3042	61.5293	400.0000	0.3000	50.1943	0.3994	0.0257	0.4172	Open
P761	DMM_JUN_2630	DMAV294	194.9822	300.0000	0.1000	65.8710	0.9319	0.5014	2.5713	Open
DMM_PIP_3159	DMM_JUN_3042	DMM_JUN_3044	104.0888	400.0000	0.3000	49.3840	0.3930	0.0421	0.4045	Open
P763	DMAV294	DMM_JUN_276	61.9644	300.0000	0.1000	65.8710	0.9319	0.1593	2.5713	Open
DMM_PIP_3165	DMM_JUN_3046	DMAV49	18.3973	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Open
DMM_PIP_3161	DMM_JUN_3046	DMM_JUN_2730	2,128.0051	1,000.0000	0.3000	107.4174	0.1368	0.0379	0.0178	Open
DMM_PIP_3165A	DMAV49	DMM_JUN_3048	53.9475	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Open
DMM_PIP_3169	DMM_JUN_2730	DMM_JUN_3050	52.1965	400.0000	0.3000	81.0398	0.6449	0.0548	1.0505	Open
DMM_PIP_2397(1)	DMM_JUN_2730	J-14	249.3805	1,000.0000	0.3000	25.8083	0.0329	0.0003	0.0013	Open
DMM_PIP_2245	DMM_VAL_8152	DMM_JUN_2656	170.1767	1,000.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Open
DMM_PIP_2397(2)	J-14	DMM_VAL_8152	381.3947	1,000.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Closed
DMM_PIP_2185	DMM_JUN_2656	DMM_JUN_2732	209.3597	1,000.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Open
DMM_PIP_2407	DMM_JUN_2732	DMM_JUN_3052	288.7430	1,000.0000	0.3000	-0.2179	0.0003	0.0000	0.0000	Open
DMM_PIP_3171	DMM_JUN_3052	DMM_JUN_2734	660.2352	1,000.0000	0.3000	-0.2803	0.0004	0.0000	0.0000	Open
DMM_PIP_2409	DMM_JUN_3052	DMAV292	15.8176	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Open
P757	DMAV292	DMM_JUN_3054	12.9162	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Open
DMM_PIP_2411	DMM_JUN_2734	DMM_JUN_3058	335.9824	1,000.0000	0.3000	-0.5359	0.0007	0.0000	0.0000	Open
DMM_PIP_3177	DMM_JUN_3058	DMM_JUN_3378	483.5338	1,000.0000	0.3000	-0.5735	0.0007	0.0000	0.0000	Open
DMM_PIP_3681	DMM_JUN_3378	DMM_JUN_3062	700.9806	1,000.0000	0.3000	-0.6549	0.0008	0.0000	0.0000	Open
DMM_PIP_3179	DMM_JUN_3378	DMAV293	6.8567	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Open
P759	DMAV293	DMM_JUN_3376	18.9144	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Open
DMM_PIP_3185	DMM_JUN_3062	DMAV51	13.7876	400.0000	0.3000	55.3359	0.4403	0.0069	0.5033	Open
DMM_PIP_3185A	DMAV51	DMM_JUN_3060	25.2030	400.0000	0.3000	55.3359	0.4403	0.0127	0.5030	Open
DMM_PIP_3183	DMM_JUN_3062	DMM_JUN_2736	204.8566	1,000.0000	0.3000	-56.0084	0.0713	0.0011	0.0053	Open
DMM_PIP_2417	DMM_JUN_2736	DMM_JUN_3064	679.5434	1,000.0000	0.3000	-60.4148	0.0769	0.0042	0.0062	Open
DMM_PIP_3193	DMM_JUN_3064	DMM_JUN_3066	27.3053	400.0000	0.3000	109.3662	0.8703	0.0514	1.8816	Open
DMM_PIP_3187	DMM_JUN_3064	DMM_JUN_2738	593.0266	1,000.0000	0.3000	-170.0548	0.2165	0.0250	0.0422	Open
DMM_PIP_3197	DMM_JUN_3066	DMM_JUN_3070	11.8099	400.0000	0.3000	40.7887	0.3246	0.0033	0.2808	Open
DMM_PIP_3195	DMM_JUN_3066	DMM_JUN_3068	11.9030	400.0000	0.3000	68.5666	0.5456	0.0091	0.7604	Open
DMM_PIP_3199	DMM_JUN_2738	DMAV53	14.2963	400.0000	0.3000	46.7926	0.3724	0.0052	0.3647	Open
DMM_JUN_2738A	DMAV53	DMM_2915	37.0639	400.0000	0.3000	46.7926	0.3724	0.0135	0.3648	Open
DMM_PIP_3053	DMM_VAL_8184	DMM_JUN_2976	42.8756	1,000.0000	0.3000	219.1789	0.2791	0.0029	0.0682	Open

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DMM_PIP_2421	DMM_JUN_2738	DMM_JUN_2976	572.1145	1,000.0000	0.3000	-217.8694	0.2774	0.0386	0.0675	Open
DMM_PIP_3043	DMM_JUN_2980	DMM_VAL_8184	132.4107	1,000.0000	0.3000	219.1789	0.2791	0.0090	0.0683	Open
TANK71OUTLET	DMM_VAL_8182	DMM_JUN_2980	24.8994	1,400.0000	0.3000	2,369.2962	1.5391	0.0310	1.2468	Open
DMM_PIP_3049	TANK_71_PS	DMM_VAL_8182	13.6756	1,400.0000	0.3000	2,369.2962	1.5391	0.0171	1.2471	Open
DMM_PIP_2201	DMM_JUN_2980	DMM_VAL_8186	31.3356	1,200.0000	0.3000	2,148.5389	1.8997	0.0713	2.2740	Open
P813	J54	TANK_71_PS	15.5040	1,400.0000	0.3000	2,369.2962	1.5391	0.0193	1.2468	Open
DMM_PIP_3055	DMM_VAL_8186	DMM_JUN_2978	16.1688	1,200.0000	0.3000	2,148.5389	1.8997	0.0368	2.2738	Open
DMM_PIP_3529	DMM_JUN_2978	DMM_JUN_3282	590.1604	1,000.0000	0.3000	1,171.9829	1.4922	1.0399	1.7621	Open
DMM_PIP_3537	DMM_VAL_8246	DMM_JUN_3284	11.5117	1,000.0000	0.3000	665.9427	0.8479	0.0067	0.5818	Open
DMM_PIP_3535	DMM_JUN_3282	DMM_VAL_8246	18.0664	1,000.0000	0.3000	665.9427	0.8479	0.0105	0.5823	Open
DMM_PIP_3533	DMM_JUN_3284	DMM_JUN_2394	36.0959	700.0000	0.3000	662.9049	1.7225	0.1302	3.6084	Open
DMM_PIP_3531	DMM_JUN_3282	DMM_JUN_2390	13.3610	1,000.0000	0.3000	505.4500	0.6436	0.0045	0.3404	Open
DMM_PIP_1137	DMM_JUN_2390	DMM_JUN_2392	31.7794	1,200.0000	0.3000	505.3831	0.4469	0.0043	0.1348	Open
DMM_PIP_1143	DMM_JUN_2392	DMM_3406	6.5543	1,200.0000	0.3000	505.3228	0.4468	0.0009	0.1348	Open
DMM_PIP_2617	DMM_3406	DMM_JUN_3348	0.7164	1,000.0000	0.3000	444.9731	0.5666	0.0002	0.2662	Open
DMM_PIP_3631	DMM_JUN_3348	DMM_VAL_8248	19.9899	400.0000	0.3000	84.6198	0.6734	0.0228	1.1424	Open
DMM_PIP_3627	DMM_JUN_3348	DMM_JUN_2814	113.1321	1,000.0000	0.3000	360.2042	0.4586	0.0200	0.1768	Open
DMM_PIP_3633	DMM_VAL_8248	DMM_JUN_3350	23.1385	400.0000	0.3000	84.6198	0.6734	0.0264	1.1425	Open
DMM_PIP_2621	DMM_JUN_2814	DMM_JUN_3288	333.1554	1,000.0000	0.3000	359.7810	0.4581	0.0588	0.1764	Open
DMM_PIP_3541	DMM_JUN_3288	DMM_JUN_2816	149.5690	1,000.0000	0.3000	239.4174	0.3048	0.0121	0.0808	Open
DMM_PIP_2627	DMM_JUN_3288	DMM_JUN_3286	16.0531	400.0000	0.3000	119.4516	0.9506	0.0359	2.2352	Open
DMM_PIP_2623	DMM_JUN_2816	DMM_JUN_3292	321.1077	1,000.0000	0.3000	238.5874	0.3038	0.0258	0.0803	Open
DMM_PIP_2629	DMM_JUN_3292	DMAV67	4.3482	400.0000	0.3000	48.6721	0.3873	0.0017	0.3936	Open
DMM_PIP_2629A	DMAV67	DMM_JUN_3290	10.7088	400.0000	0.3000	48.6721	0.3873	0.0042	0.3930	Open
DMM_PIP_3545	DMM_JUN_3292	DMM_JUN_3300	415.2813	1,000.0000	0.3000	172.8698	0.2201	0.0181	0.0435	Open
P217	DMM_JUN_3292	DMAV63	421.9033	140.3000	0.1000	16.3308	1.0563	3.5059	8.3096	Open
P219	DMAV63	J30	11.4384	140.3000	0.1000	16.3308	1.0563	0.0951	8.3097	Open
P211	DMM_JUN_3300	DMAV62	1,252.6060	197.3000	0.1000	27.2433	0.8911	4.9405	3.9442	Open
P213	DMAV62	J28	14.4390	197.3000	0.1000	27.2433	0.8911	0.0570	3.9445	Open
DMM_PIP_3553	DMM_JUN_3300	DMM_JUN_2818	111.3169	1,000.0000	0.3000	87.9201	0.1119	0.0014	0.0123	Open
DMM_PIP_2631	DMM_JUN_3300	DMAV68	4.3771	400.0000	0.3000	57.1908	0.4551	0.0023	0.5355	Open
DMM_PIP_2631A	DMAV68	DMM_JUN_3298	10.4896	400.0000	0.3000	57.1908	0.4551	0.0056	0.5360	Open
DMM_PIP_2625	DMM_JUN_2818	DMAV61	339.4440	1,000.0000	0.3000	86.3828	0.1100	0.0040	0.0119	Open
DMM_PIP_2625A	DMAV61	DMM_JUN_2812	13.4230	1,000.0000	0.3000	86.3828	0.1100	0.0002	0.0121	Open
DMM_PIP_2637	DMM_JUN_2812	DMM_JUN_3294	73.7163	400.0000	0.3000	40.8993	0.3255	0.0208	0.2821	Open

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DMM_PIP_2635	DMM_JUN_2812	DMM_JUN_3296	13.7738	400.0000	0.3000	44.6326	0.3552	0.0046	0.3333	Open
DMM_PIP_3647	DMM_JUN_3360	DMM_JUN_3354	602.0642	400.0000	0.3000	59.0416	0.4698	0.3431	0.5699	Open
DMM_PIP_3645	DMM_JUN_3360	DMM_JUN_3358	8.7225	400.0000	0.3000	47.2574	0.3761	0.0032	0.3716	Open
DMM_PIP_3643A	DMAV86	DMM_JUN_3360	3.6893	400.0000	0.3000	106.3066	0.8460	0.0066	1.7806	Open
DMM_PIP_3643	DMM_JUN_3356	DMAV86	2.2199	400.0000	0.3000	106.3066	0.8460	0.0040	1.7798	Open
P265	DMM_JUN_2806	DMAV78	52.3986	140.3000	0.1000	17.8476	1.1545	0.5160	9.8478	Open
P267	DMAV78	DMM_2856	49.1738	140.3000	0.1000	17.8476	1.1545	0.4843	9.8478	Open
DMM_PIP_2601	DMM_JUN_3380	DMM_JUN_3382	13.9159	400.0000	0.3000	129.5921	1.0313	0.0365	2.6209	Open
DMM_PIP_2611	DMM_JUN_2294	DMM_JUN_3302	20.9171	400.0000	0.3000	43.7891	0.3485	0.0067	0.3215	Open
DMM_PIP_2609	DMM_JUN_2810	DMM_JUN_3352	10.6103	400.0000	0.3000	181.3979	1.4435	0.0538	5.0681	Open
DMM_PIP_3305	DMM_JUN_3138	DMM_846	1,898.6678	1,000.0000	0.3000	342.2753	0.4358	0.3043	0.1603	Open
DMM_PIP_2785	DMM_JUN_3138	DMAV182	51.7184	400.0000	0.3000	51.4996	0.4098	0.0227	0.4383	Open
DMM_PIP_2441	DMM_JUN_2744	DMM_JUN_3138	1,181.4428	1,000.0000	0.3000	393.9053	0.5015	0.2482	0.2101	Open
P523	DMAV182	DMM_JUN_3384	55.2520	400.0000	0.3000	51.4996	0.4098	0.0242	0.4383	Open
DMM_PIP_3309	DMM_JUN_3142	DMM_JUN_2746	749.4691	1,000.0000	0.3000	-666.9663	0.8492	0.4376	0.5839	Open
DMM_PIP_2443	DMM_JUN_3142	DMM_JUN_3386	32.7767	400.0000	0.3000	272.0247	2.1647	0.3692	11.2626	Open
DMM_PIP_2437	DMM_JUN_2744	DMM_JUN_3142	15.1349	1,000.0000	0.3000	-394.4454	0.5022	0.0032	0.2105	Open
DMM_PIP_2439	DMM_JUN_2746	DMM_JUN_3148	1,902.8049	1,000.0000	0.3000	-667.7091	0.8502	1.1134	0.5851	Open
DMM_PIP_3317	DMM_JUN_3148	DMM_JUN_3146	65.6665	400.0000	0.3000	209.5586	1.6676	0.4421	6.7323	Open
DMM_PIP_3315	DMM_JUN_3148	DMM_JUN_2762	1,588.9784	1,000.0000	0.3000	-879.4817	1.1198	1.5933	1.0027	Open
DMM_PIP_2501	DMM_JUN_2762	DMM_JUN_3388	122.5552	400.0000	0.3000	92.1316	0.7332	0.1651	1.3475	Open
DMM_PIP_2497	DMM_JUN_2762	DMM_JUN_2764	656.1777	1,000.0000	0.3000	-1,018.2615	1.2965	0.8771	1.3366	Open
P359	DMM_JUN_2762	DMAV113	22.7184	197.3000	0.1000	46.3004	1.5144	0.2476	10.8969	Open
P361	DMAV113	DMM_2002	63.9446	197.3000	0.1000	46.3004	1.5144	0.6968	10.8968	Open
DMM_PIP_2511	DMM_JUN_2764	DMM_JUN_3150	25.7386	400.0000	0.3000	260.8733	2.0760	0.2669	10.3691	Open
DMM_PIP_2499	DMM_JUN_2764	DMM_JUN_2766	139.0197	1,000.0000	0.3000	-1,279.2200	1.6288	0.2911	2.0936	Open
DMM_PIP_2505	DMM_JUN_2766	DMM_JUN_2768	911.8123	1,000.0000	0.3000	-1,280.4163	1.6303	1.9125	2.0974	Open
DMM_PIP_3323	DMM_JUN_2768	DMM_JUN_3152	14.3290	400.0000	0.3000	243.6438	1.9389	0.1298	9.0613	Open
DMM_PIP_2507	DMM_JUN_2768	DMM_JUN_2982	1,369.2132	1,000.0000	0.3000	-1,524.1870	1.9407	4.0493	2.9574	Open
DMM_PIP_3071	DMM_VAL_8194	DMM_JUN_2982	7.3654	1,000.0000	0.3000	1,524.3204	1.9408	0.0218	2.9584	Open
DMM_PIP_3061	DMM_JUN_2986	DMM_VAL_8194	15.5373	1,000.0000	0.3000	1,524.3204	1.9408	0.0460	2.9580	Open
CT_OUTLET	DMM_VAL_8192	DMM_JUN_2986	9.2608	1,600.0000	0.3000	4,365.8940	2.1714	0.0194	2.0927	Open
DMM_PIP_3067	CENTRAL_TANK_PS	DMM_VAL_8192	11.2199	1,600.0000	0.3000	4,365.8940	2.1714	0.0235	2.0933	Open
P821	J58	CENTRAL_TANK_PS	4.7147	1,600.0000	0.3000	4,365.8940	2.1714	0.0099	2.0930	Open
P-33	DMM_JUN_2946	CV_CENTRAL_TAN	47.3153	1,600.0000	0.3000	1,999.9859	0.9947	0.0213	0.4506	Open

ID	From Node	To Node	Length (m)	Diameter (mm)	Roughness (mm)	Flow (L/s)	Velocity (m/s)	Headloss (m)	HL/1000 (m/k-m)	Status
P-34	CV_CENTRAL_TAN	J56	12.3051	1,600.0000	0.3000	1,999.9859	0.9947	0.0055	0.4507	Open
DMM_PIP_2977	DMM_JUN_2944	DMM_JUN_2948	296.6949	1,600.0000	0.3000	1,999.9857	0.9947	0.1337	0.4507	Open
DMM_PIP_2975	DMM_JUN_2942	DMM_JUN_2944	2,163.0970	1,600.0000	0.3000	1,999.9857	0.9947	0.9749	0.4507	Open
DMM_PIP_2973	DMM_JUN_2942	DMM_JUN_2940	983.4080	1,600.0000	0.3000	-1,999.9857	0.9947	0.4432	0.4507	Open
DMM_PIP_2971	DMM_JUN_2938	DMM_JUN_2940	419.0785	1,600.0000	0.3000	1,999.9857	0.9947	0.1889	0.4507	Open
DMM_PIP_2969	DMM_JUN_2936	DMM_JUN_2938	760.6230	1,600.0000	0.3000	1,999.9857	0.9947	0.3428	0.4507	Open
DMM_PIP_2967	DMM_JUN_2934	DMM_JUN_2936	962.3452	1,600.0000	0.3000	1,999.9857	0.9947	0.4337	0.4507	Open
DMM_PIP_2965	DMM_JUN_2932	DMM_JUN_2934	1,726.5588	1,600.0000	0.3000	1,999.9857	0.9947	0.7781	0.4507	Open
DMM_PIP_2963	DMM_JUN_2930	DMM_JUN_2932	3,079.9867	1,600.0000	0.3000	1,999.9857	0.9947	1.3881	0.4507	Open
DMM_PIP_2961	DMM_JUN_3280	DMM_JUN_2930	328.4499	1,600.0000	0.3000	1,999.9857	0.9947	0.1480	0.4507	Open
DMM_PIP_3527	DMM_JUN_3280	DMM_JUN_2926	95.3555	1,600.0000	0.3000	-4,199.9700	2.0889	0.1849	1.9390	Open
DMM_PIP_1271	DMM_JUN_2428	DMM_JUN_3280	34.8838	1,400.0000	0.3000	-2,199.9845	1.4291	0.0376	1.0775	Open
DMM_PIP_1193	DMM_VAL_8024	DMM_JUN_2428	13.6552	1,400.0000	0.3000	-2,199.9845	1.4291	0.0147	1.0776	Open
DMM_5089	DMM_19836	DMM_VAL_8024	13.3400	1,400.0000	0.3000	-2,199.9845	1.4291	0.0144	1.0773	Open
P-35	DMM_19836	FCV_TANK55	6.9463	1,600.0000	0.3000	2,199.9845	1.0942	0.0038	0.5437	Open
P-36	FCV_TANK55	J62	7.8302	1,600.0000	0.3000	2,199.9845	1.0942	0.0043	0.5435	Open
DMM_PIP_3517	DMM_JUN_3276	MEW_TANK_55_PS	71.6074	1,400.0000	0.3000	2,342.2877	1.5216	0.0873	1.2190	Open
DMM_PIP_2659	MEW_TANK_55_PS	DMM_JUN_3278	21.5346	1,400.0000	0.3000	2,342.2877	1.5216	0.0263	1.2189	Open
DMM_PIP_3521	DMM_JUN_3278	DMM_1160	63.0371	1,400.0000	0.3000	2,261.4840	1.4691	0.0717	1.1377	Open
P23	DMM_JUN_3174	DMM_1160	4.4425	1,000.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Closed
DMM_PIP_2571(2)	DMM_JUN_2794	21665-B	1,558.0150	1,000.0000	0.3000	-513.7563	0.6541	0.5474	0.3513	Open
DMM_VAL_8038_U	DMM_1160	DMM_VAL_8038	3.0752	1,000.0000	0.3000	513.7563	0.6541	0.0011	0.3509	Open
DMM_VAL_8038_D	DMM_VAL_8038	21665-B	3.4913	1,000.0000	0.3000	513.7563	0.6541	0.0012	0.3517	Open
DMM_PIP_2249	DMM_JUN_2678	DMM_JUN_2794	674.3797	1,000.0000	0.3000	-492.6349	0.6272	0.2184	0.3239	Open
DMM_PIP_2573	DMM_JUN_2794	DMM_JUN_2796	746.3929	400.0000	0.3000	7.1331	0.0568	0.0083	0.0111	Open
DMM_PIP_2577(1)	DMM_JUN_2796	PRV-8	178.8718	400.0000	0.3000	7.0756	0.0563	0.0020	0.0109	Open
DMM_PIP_2577(2)	PRV-8	DMM_JUN_3176	40.6283	400.0000	0.3000	7.0756	0.0563	0.0004	0.0109	Open
DMM_PIP_2255(1)	DMM_JUN_2678	PRV-7	56.1034	400.0000	0.3000	32.7537	0.2606	0.0104	0.1850	Open
DMM_PIP_2255(2)	PRV-7	DMM_JUN_3418	18.6748	400.0000	0.3000	32.7537	0.2606	0.0035	0.1850	Open
DMM_PIP_2251	DMM_JUN_2680	DMM_JUN_2678	1,207.9848	1,000.0000	0.3000	-459.8577	0.5855	0.3423	0.2834	Open
DMM_PIP_2567	DMM_JUN_2790	DMM_JUN_2680	257.8840	1,000.0000	0.3000	-459.7952	0.5854	0.0731	0.2833	Open
DMM_PIP_2253	DMM_JUN_2680	DMM_6709	43.9786	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Closed
DMM_PIP_2569	DMM_JUN_2790	DMM_JUN_3182	28.9899	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Closed
DMM_PIP_3249(1)	DMM_JUN_2790	J-23	1,069.3960	1,000.0000	0.3000	458.1062	0.5833	0.3008	0.2813	Open
DMM_PIP_2597	DMM_JUN_2788	DMM_JUN_3186	1,416.0236	1,000.0000	0.3000	420.8044	0.5358	0.3380	0.2387	Open

ID	From Node	To Node	Length (m)	Diameter (mm)	Roughness (mm)	Flow (L/s)	Velocity (m/s)	Headloss (m)	HL/1000 (m/k-m)	Status
DMM_PIP_2565	DMM_JUN_2788	DMAV111	35.9430	400.0000	0.3000	36.9388	0.2940	0.0084	0.2325	Open
P-43	J-23	PRV-5	11.6063	1,000.0000	0.3000	458.1062	0.5833	0.0033	0.2813	Open
P-44	PRV-5	DMM_JUN_2788	11.6103	1,000.0000	0.3000	458.1062	0.5833	0.0033	0.2812	Open
DMM_PIP_2565A	DMAV111	DMM_6915	217.6934	400.0000	0.3000	36.9388	0.2940	0.0506	0.2324	Open
DMM_PIP_3359	DMM_JUN_3186	DMAV108	2,085.5044	400.0000	0.3000	20.2673	0.1613	0.1566	0.0751	Open
DMM_PIP_2259	DMM_JUN_2684	DMM_JUN_3186	1,204.0585	1,000.0000	0.3000	-400.2872	0.5097	0.2609	0.2167	Open
DMM_PIP_2263	DMM_JUN_2684	DMAV109	17.7265	400.0000	0.3000	37.8686	0.3014	0.0043	0.2437	Open
DMM_PIP_2257	DMM_JUN_2682	DMM_JUN_2684	619.1663	1,000.0000	0.3000	-362.2781	0.4613	0.1107	0.1788	Open
DMM_PIP_2263A	DMAV109	DMM_JUN_3188	53.9229	400.0000	0.3000	37.8686	0.3014	0.0131	0.2437	Open
DMM_PIP_2261	DMM_JUN_2682	DMAV110	13.2038	400.0000	0.3000	21.6322	0.1721	0.0011	0.0845	Open
DMM_PIP_2265	DMM_JUN_2682	DMM_JUN_3190	909.0325	1,000.0000	0.3000	340.4061	0.4334	0.1441	0.1586	Open
DMM_PIP_2261A	DMAV110	DMM_5853	267.3479	400.0000	0.3000	21.6322	0.1721	0.0227	0.0848	Open
DMM_12544	DMM_JUN_1186	DMM_5853	229.3976	197.3000	0.3000	-7.5493	0.2469	0.0930	0.4052	Open
DMM_PIP_2267	DMM_JUN_3192	DMAV107	26.6324	400.0000	0.3000	39.5202	0.3145	0.0070	0.2644	Open
DMM_PIP_2267A	DMAV107	DMM_JUN_3194	91.9454	400.0000	0.3000	39.5202	0.3145	0.0243	0.2643	Open
DMM_PIP_2591	DMM_JUN_2802	DMAV106	36.8191	400.0000	0.3000	25.2121	0.2006	0.0042	0.1131	Open
DMM_PIP_2591A	DMAV106	DMM_5301	105.8917	400.0000	0.3000	25.2121	0.2006	0.0120	0.1130	Open
25452	197	DMAV102	9.1541	400.0000	0.3000	19.4561	0.1548	0.0006	0.0696	Open
25452A	DMAV102	10789	20.7717	400.0000	0.3000	19.4561	0.1548	0.0014	0.0694	Open
25458	10800	5447	7.3498	400.0000	0.3000	3.9933	0.0318	0.0000	0.0038	Open
25450	196	DMAV103	2.4820	400.0000	0.3000	7.6337	0.0607	0.0000	0.0131	Open
25450A	DMAV103	10795	5.7802	400.0000	0.3000	7.6337	0.0607	0.0001	0.0129	Open
DMM_PIP_3359A	DMAV108	DMM_JUN_3184	102.6905	400.0000	0.3000	20.2673	0.1613	0.0077	0.0751	Open
DMM_PIP_2821	DMM_3337	DMAV179	4.7012	400.0000	0.3000	158.5974	1.2621	0.0183	3.8929	Open
P517	DMAV179	DMM_JUN_3320	9.3109	400.0000	0.3000	158.5974	1.2621	0.0362	3.8927	Open
DMM_PIP_3073	DMM_VAL_8196	DMM_JUN_2984	13.4179	1,000.0000	0.3000	1,031.8949	1.3139	0.0184	1.3719	Open
DMM_PIP_2203	DMM_JUN_2986	DMM_VAL_8196	8.9744	1,000.0000	0.3000	1,031.8949	1.3139	0.0123	1.3723	Open
DMM_PIP_3063	DMM_JUN_2984	DMM_JUN_2776	854.3405	1,000.0000	0.3000	1,031.4400	1.3133	1.1711	1.3708	Open
DMM_PIP_2535	DMM_JUN_2776	DMM_JUN_2778	499.8027	1,000.0000	0.3000	1,028.9808	1.3101	0.6819	1.3644	Open
DMM_PIP_2541	DMM_JUN_2778	DMM_JUN_3158	15.9318	400.0000	0.3000	222.3164	1.7691	0.1205	7.5638	Open
DMM_PIP_2537	DMM_JUN_2778	DMM_JUN_2884	46.5671	1,000.0000	0.3000	805.5637	1.0257	0.0393	0.8443	Open
DMM_PIP_2817	DMM_JUN_2884	DMM_JUN_2780	1,581.9928	1,000.0000	0.3000	802.2566	1.0215	1.3250	0.8376	Open
DMM_PIP_2545	DMM_JUN_2780	DMM_JUN_3160	17.7056	400.0000	0.3000	150.2681	1.1958	0.0620	3.5023	Open
DMM_PIP_2543	DMM_JUN_2780	DMM_JUN_2782	806.1272	1,000.0000	0.3000	651.9377	0.8301	0.4502	0.5585	Open
P409	DMAV133	DMM_17921	37.9889	197.3000	0.1000	0.0000	0.0000	0.0000	0.0000	Open

ID	From Node	To Node	Length (m)	Diameter (mm)	Roughness (mm)	Flow (L/s)	Velocity (m/s)	Headloss (m)	HL/1000 (m/k-m)	Status
P407	DMM_1813	DMAV133	30.8326	197.3000	0.1000	0.0000	0.0000	0.0000	0.0000	Open
DMM_PIP_2549	DMM_JUN_2782	DMM_JUN_3162	37.9330	400.0000	0.3000	205.0087	1.6314	0.2446	6.4475	Open
DMM_PIP_3717	DMM_JUN_3416	DMM_JUN_3164	313.5694	1,000.0000	0.3000	178.4659	0.2272	0.0145	0.0462	Open
DMM_PIP_3337	DMM_JUN_3416	DMM_JUN_3414	49.1183	400.0000	0.3000	267.9645	2.1324	0.5370	10.9331	Open
DMM_PIP_2547	DMM_JUN_2782	DMM_JUN_3416	396.3835	1,000.0000	0.3000	446.6180	0.5687	0.1062	0.2678	Open
P381	DMAV121	DMM_12447	17.4475	260.4000	0.1000	0.0000	0.0000	0.0000	0.0000	Open
P379	DMM_JUN_3164	DMAV121	19.2322	260.4000	0.1000	0.0000	0.0000	0.0000	0.0000	Open
DMM_PIP_3201	DMM_JUN_3164	DMM_JUN_3312	543.8372	1,000.0000	0.3000	178.3798	0.2271	0.0251	0.0462	Open
DMM_PIP_3587	DMM_JUN_3312	DMM_JUN_2600	9.3955	400.0000	0.3000	33.4058	0.2658	0.0018	0.1921	Open
DMM_PIP_3579	DMM_JUN_3312	DMM_JUN_3316	1,192.9900	1,000.0000	0.3000	144.4011	0.1839	0.0370	0.0310	Open
P415	DMM_3191	DMAV136	30.0804	276.6000	0.1000	92.1320	1.5333	0.2221	7.3819	Open
P419	DMAV136	DMM_1781	56.3494	276.6000	0.1000	92.1320	1.5333	0.4160	7.3821	Open
DMM_PIP_3343	DMM_JUN_3316	DMM_JUN_3318	3.4290	400.0000	0.3000	118.2539	0.9410	0.0075	2.1905	Open
DMM_PIP_3583	DMM_JUN_3316	DMM_JUN_3314	839.1509	1,000.0000	0.3000	26.1266	0.0333	0.0011	0.0013	Open
DMM_PIP_2819	DMM_JUN_3156	DMAV177	4.5805	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Open
P511	DMAV177	DMM_JUN_3154	5.1596	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Open
DMM_PIP_2579	DMM_6695	DMM_JUN_3178	241.7037	400.0000	0.3000	-0.3962	0.0032	0.0000	0.0001	Open
DMM_PIP_2959	DMM_JUN_2928	DMM_JUN_2926	93.7455	1,600.0000	0.3000	4,199.9700	2.0889	0.1818	1.9388	Open
DMM_PIP_2957	DMM_JUN_2924	DMM_JUN_2928	83.9169	1,600.0000	0.3000	4,199.9700	2.0889	0.1627	1.9389	Open
DMM_PIP_2955	DMM_JUN_2922	DMM_JUN_2924	596.5691	1,600.0000	0.3000	4,199.9700	2.0889	1.1567	1.9389	Open
DMM_PIP_2953	DMM_JUN_2918	DMM_JUN_2922	2,794.4302	1,600.0000	0.3000	4,199.9700	2.0889	5.4181	1.9389	Open
DMM_PIP_2951	DMM_JUN_2920	DMM_JUN_2918	2,332.0760	1,600.0000	0.3000	4,199.9700	2.0889	4.5216	1.9389	Open
DMM_PIP_3013	JAMIAH_TANK	DMM_JUN_2920	12.3237	1,600.0000	0.3000	4,199.9700	2.0889	0.0239	1.9390	Open
DMM_PIP_2731	DMM_JUN_2846	DMM_14474	6.1337	400.0000	0.3000	6.0994	0.0485	0.0000	0.0076	Open
DMM_PIP_1393	DMM_6953	DMM_VAL_8124	20.7269	600.0000	0.3000	0.0320	0.0001	0.0000	0.0000	Open
JAMEAH_OUTLET	JAMIAH_TANK	DMM_JUN_3260	117.8040	1,000.0000	0.3000	1,669.8550	2.1261	0.4172	3.5414	Open
DMM_PIP_3469	DMM_JUN_3260	JAMIAH_PS	85.4643	600.0000	0.3000	503.8458	1.7820	0.3981	4.6585	Open
DMM_PIP_3465	DMM_JUN_3260	DMAV317	2,356.1574	1,000.0000	0.3000	491.7580	0.6261	0.7604	0.3227	Open
DMM_PIP_3471	JAMIAH_PS	DMM_JUN_2848	56.3945	600.0000	0.3000	503.8458	1.7820	0.2627	4.6584	Open
DMM_PIP_2727	DMM_JUN_2844	DMAV16	0.5643	400.0000	0.3000	43.8281	0.3488	0.0002	0.3132	Open
DMM_PIP_2727A	DMAV16	DMM_5840	0.5850	400.0000	0.3000	43.8281	0.3488	0.0002	0.3180	Open
DMM_PIP_2693	DMM_JUN_2840	DMM_5339	5.0960	400.0000	0.3000	42.1207	0.3352	0.0015	0.2994	Open
DMM_PIP_2689	DMM_JUN_2838	DMM_5340	9.6406	400.0000	0.3000	-1.9136	0.0152	0.0000	0.0010	Open
DMM_PIP_2707(1)	DMM_JUN_2842	PRV-20	33.6368	400.0000	0.3000	29.0629	0.2313	0.0050	0.1477	Open
DMM_PIP_2707(2)	PRV-20	DMM_5812	13.5305	400.0000	0.3000	29.0629	0.2313	0.0020	0.1478	Open

1.4.2 Maximum Pressure, Minimum Velocity - Minimum Hourly Demand

The maximum pressure in the system has been investigated within Option 2 Scenario for both models.

Figure 12 shows the maximum pressure from the original model in the system at each node during the minimum hourly demand. Within Dammam project, the maximum achieved pressure is around 6.83 bar. A few points with black or blue colours are either closed or the proximity to the pumps.

Figure 13 shows the maximum pressure from the modified model in the system at each node during the minimum hourly demand. The overall water system pressure is less than 4 bar. Most of the system has a pressure lower than 4 bar (green color). The orange points are very close to 4 bar which is acceptable. A few points with black or blue colors are either closed or the proximity to the pumps. Within Dammam 2 and Dammam 5 scopes, the maximum achieved pressure is less than 4 bar except for the gravity main 1600 mm, which can go as high as around 7 bar.

Comparing the two models, it is obvious that by modifying the model, overall, the system pressure reduces. This behaviour of the water system is primarily due to the VSD characteristics of the pumps.

Regarding the minimum flow rate during the day, the minimum hourly demand was investigated within Option 2 scenario.

Figure 14 presents the minimum velocities during minimum hourly demand in the original model. Again, most of the pipes in the system have a low velocity of less than 0.3 m/s (except the gravity main 1600 mm Diameter from Jamiah to Tank 55, which has a higher velocity of around 2.18 m/s).

Concerning the minimum velocity during minimum hourly demand in the modified model, some of the pipes in the scopes of Dammam 2 and Dammam 5 and most of the pipes in the all the Dammam system have a low velocity of less than 0.3 m/s (except the gravity main purple coloured 1600mm diameter from Jamiah to Tank 55 which has higher velocity around 2.08 m/s). Figure 15 presents the minimum water velocities in the system during minimum demand hour.

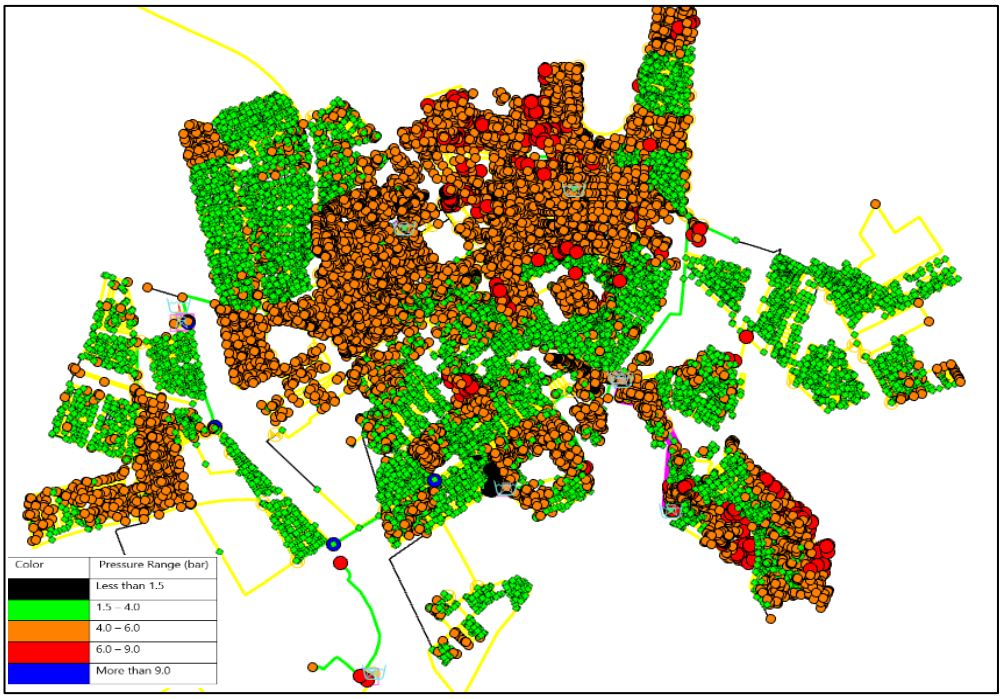

Figure 12- Original Model - System Maximum Pressure during the minimum hourly demand (Scenario 1)

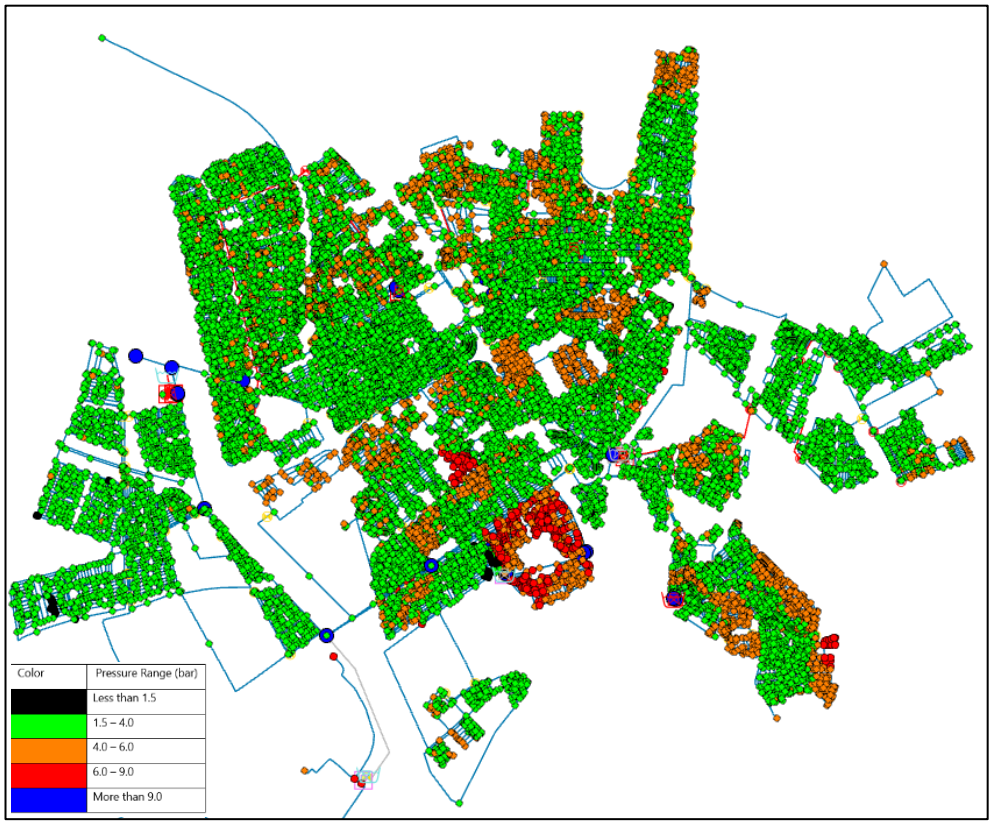

Figure 13- Modified Model - System Maximum Pressure during the minimum hourly demand (Scenario 1)

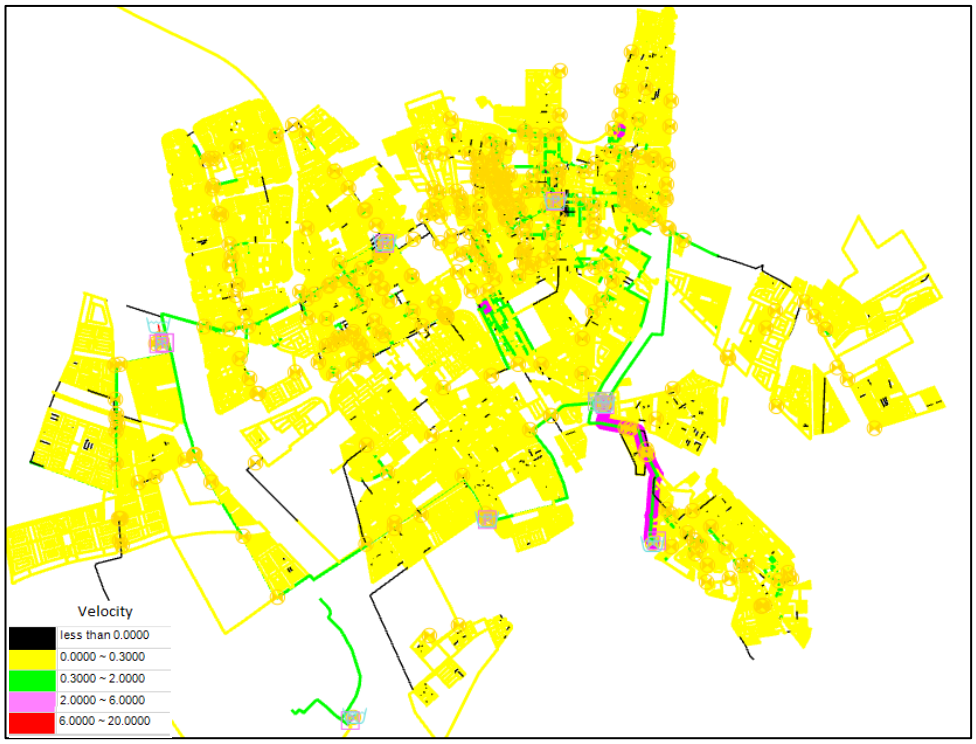

Figure 14- Original Model - Water velocities during minimum hourly demand (Scenario 1)

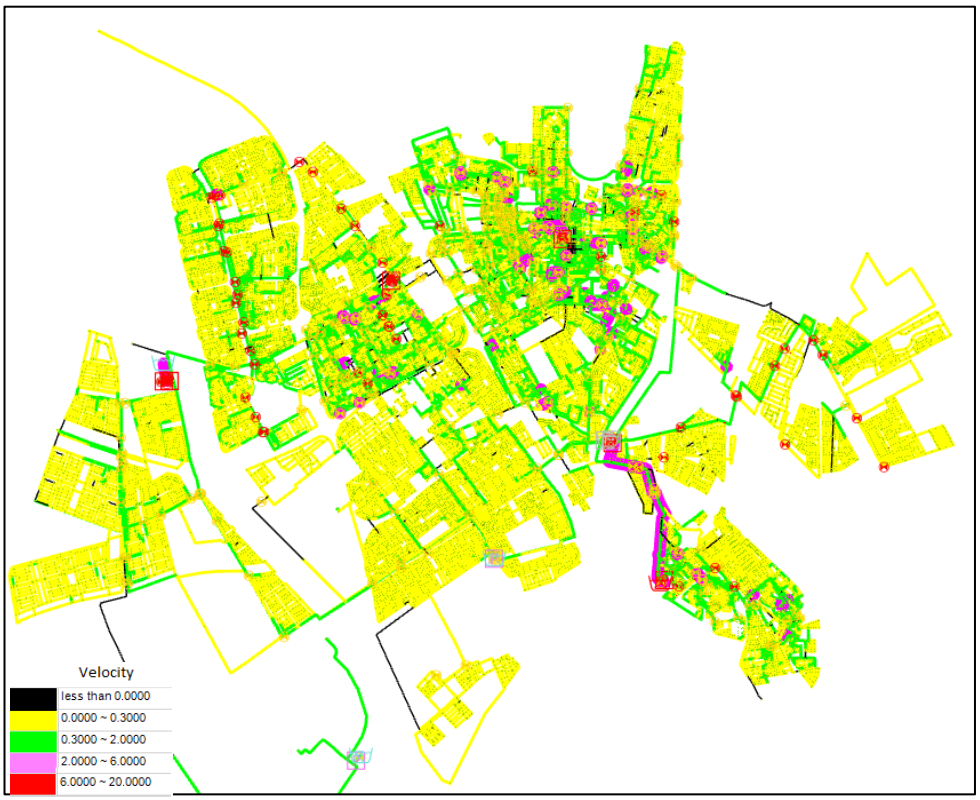

Figure 15- Modified Model - Water velocities during minimum hourly demand (Scenario 1)

Tables 11 and 12 show the junction and pipes properties respectively during the minimum demand hour for this scenario.

Table 11: Table for junctions within Dammam 2 and 5 at the minimum demand hour within scenario 1

ID	Demand (L/s)	Elevation (m)	Head (m)	Pressure (bar)
DMM_JUN_2974	0.0000	5.0000	43.5869	3.7812
DMM_JUN_2970	0.0000	5.0000	43.5130	3.7740
DMM_JUN_2972	0.0000	5.0000	43.5250	3.7751
DMM_JUN_3006	0.0244	5.0000	42.2458	3.6498
DMM_JUN_3004	0.1018	4.0000	42.2399	3.7472
DMM_JUN_3002	0.4998	4.0000	42.2417	3.7474
DMM_JUN_2856	0.1900	5.0000	42.2527	3.6505
DMM_JUN_2858	0.7014	2.0000	42.3022	3.9493
DMM_JUN_3000	1.0336	6.0000	42.3536	3.5624
DMM_3879	0.0041	6.0000	42.3535	3.5624
DMM_JUN_2860	1.3068	3.0000	42.4691	3.8677
DMM_JUN_2854	0.4154	6.0000	42.5842	3.5850
DMM_JUN_2996	0.0317	6.0000	42.5981	3.5863
DMM_JUN_2994	0.0164	6.0000	42.5982	3.5863
DMM_JUN_2852	0.1407	4.0000	42.8213	3.8042
DMM_JUN_3374	0.1466	3.0000	42.9378	3.9136
DMM_JUN_3372	0.4920	3.0000	42.9699	3.9167
DMM_JUN_2626	0.3470	3.0000	42.9985	3.9195
DMM_JUN_2638	0.3037	6.0000	42.9685	3.6226
DMM_JUN_3008	0.0338	5.0000	42.9644	3.7202
DMM_JUN_2690	0.4260	7.0000	42.9324	3.5211
DMM_JUN_3010	0.0539	2.0000	42.9318	4.0110
DMM_JUN_3012	0.2539	6.0000	42.9130	3.6172
DMM_JUN_2636	0.2725	4.0000	42.8738	3.8093
DMM_JUN_3014	0.0392	7.0000	42.0246	3.4321
DMM_JUN_3016	0.1606	5.0000	42.8658	3.7105
DMM_JUN_3024	0.2887	7.0000	42.8612	3.5141
DMM_JUN_3026	0.1094	6.0000	42.8469	3.6107
DMM_JUN_2692	0.5843	6.0000	42.8458	3.6106
DMM_JUN_3020	0.2366	6.0000	42.7934	3.6055
DMM_JUN_2740	0.1142	11.0000	42.6828	3.1047
DMM_JUN_3018	0.0142	4.0000	41.6362	3.6881
DMM_7590	0.0573	10.0000	42.6776	3.2021
DMM_JUN_3022	0.1116	4.0000	42.7894	3.8011
DMM_JUN_3028	0.2017	4.0000	42.8237	3.8044

ID	Demand (L/s)	Elevation (m)	Head (m)	Pressure (bar)
DMM_JUN_2634	0.1846	4.0000	42.8225	3.8043
DMM_JUN_3032	0.0132	4.0000	42.8116	3.8032
DMM_JUN_3030	0.0435	6.0000	42.5104	3.5777
DMM_JUN_3038	0.1593	2.0000	42.8086	3.9989
DMM_JUN_2632	0.1727	2.0000	42.8078	3.9988
DMM_JUN_3040	0.0111	2.0000	42.7954	3.9976
DMM_JUN_3034	0.0775	2.0000	42.8022	3.9983
DMM_JUN_2640	0.3993	2.0000	42.8050	3.9986
DMM_JUN_2654	0.2872	3.0000	42.8038	3.9005
DMM_JUN_2630	0.1541	3.0000	42.7820	3.8983
DMM_JUN_3042	0.2259	2.0000	42.7797	3.9961
DMM_JUN_276	0.0996	5.0000	42.7337	3.6976
DMM_JUN_3044	0.1526	4.0000	42.7759	3.7997
DMM_JUN_3046	0.0428	4.0000	42.8035	3.8024
DMM_JUN_3048	0.0605	4.0000	42.6336	3.7858
DMM_JUN_2730	0.1587	4.0000	42.8012	3.8022
J-14	0.4011	4.3951	42.8012	3.7635
DMM_JUN_2656	0.0000	11.0000	44.8078	3.3129
DMM_JUN_2732	0.0608	5.0000	44.8078	3.9008
DMM_JUN_3052	0.0174	4.0000	44.8078	3.9988
DMM_JUN_3054	0.0326	4.0000	44.6409	3.9825
DMM_JUN_2734	0.0713	3.0000	44.8078	4.0968
DMM_JUN_3058	0.0105	2.0000	44.8078	4.1948
DMM_JUN_3378	0.0227	7.0000	44.8078	3.7049
DMM_JUN_3376	0.0106	7.0000	44.7393	3.6982
DMM_JUN_3062	0.0049	3.0000	44.8078	4.0968
DMM_JUN_2736	1.2287	1.0000	44.8079	4.2928
DMM_JUN_3064	0.0764	7.0000	44.8083	3.7049
DMM_JUN_3066	0.0030	7.0000	44.8039	3.7045
DMM_JUN_3070	0.0114	7.0000	44.8036	3.7045
DMM_JUN_3068	0.0132	7.0000	44.8030	3.7044
DMM_JUN_2738	0.2850	18.0000	44.8107	2.6272
DMM_2915	0.0030	12.0000	44.8090	3.2150
DMM_JUN_2976	0.3652	6.0000	44.8142	3.8035
DMM_JUN_2980	0.4402	6.0000	44.8153	3.8036

ID	Demand (L/s)	Elevation (m)	Head (m)	Pressure (bar)
DMM_JUN_2962	0.0000	6.0000	195.3457	18.5544
DMM_JUN_2978	1.8058	6.0000	44.8064	3.8027
J52	0.0000	0.0000	17.9087	1.7549
J54	0.0000	0.0000	17.9076	1.7548
DMM_JUN_2960	0.0000	3.0000	195.3604	18.8498
DMM_JUN_3284	0.8471	10.0000	44.7179	3.4021
DMM_JUN_3282	0.1645	10.0000	44.7194	3.4022
DMM_JUN_2390	0.0187	10.0000	44.7190	3.4022
DMM_JUN_2392	0.0168	15.0000	44.7186	2.9122
DMM_3406	0.0030	15.0000	44.7185	2.9122
DMM_JUN_3348	0.0416	15.0000	44.7185	2.9122
DMM_JUN_3350	0.3099	15.0000	44.7142	2.9118
DMM_JUN_2394	0.0500	15.0000	44.7070	2.9111
DMM_JUN_2814	0.1180	11.0000	44.7167	3.3040
DMM_JUN_3288	0.2543	12.0000	44.7115	3.2055
DMM_JUN_3286	0.1653	12.0000	44.7083	3.2052
DMM_JUN_2816	0.2314	12.0000	44.7104	3.2054
DMM_JUN_3290	0.2348	13.0000	44.7075	3.1071
DMM_JUN_3292	0.1993	13.0000	44.7080	3.1071
J30	0.0000	13.0000	44.3908	3.0761
DMM_JUN_3300	0.1438	10.0000	44.7064	3.4009
DMM_JUN_3298	0.1105	10.0000	44.7056	3.4009
J28	0.0000	10.0000	44.2706	3.3583
DMM_JUN_2818	0.4287	14.0000	44.7062	3.0090
DMM_JUN_2812	0.2373	14.0000	44.7058	3.0089
DMM_JUN_3296	1.2195	14.0000	44.7054	3.0089
DMM_JUN_3294	0.5420	14.0000	44.7039	3.0087
DMM_JUN_3354	0.1948	12.0000	43.7558	3.1118
DMM_JUN_3360	0.0021	11.0000	43.7868	3.2128
DMM_JUN_3358	0.1088	11.0000	43.7865	3.2128
DMM_JUN_3356	0.1049	11.0000	43.7877	3.2129
DMM_JUN_2806	0.7310	9.0000	43.8031	3.4104
DMM_2856	0.2867	12.0000	43.7134	3.1077
DMM_JUN_3380	0.1626	9.0000	43.8175	3.4118
DMM_JUN_3382	0.2335	9.0000	43.8144	3.4115

ID	Demand (L/s)	Elevation (m)	Head (m)	Pressure (bar)
DMM_JUN_3302	0.2334	3.0000	44.3417	4.0512
DMM_JUN_2294	0.0162	3.0000	44.3423	4.0512
DMM_JUN_2810	0.2499	12.0000	44.0192	3.1376
DMM_JUN_3352	0.0898	12.0000	44.0147	3.1372
DMM_846	0.1644	17.0000	45.8677	2.8288
DMM_JUN_3138	0.0364	11.0000	45.8941	3.4193
DMM_JUN_3384	0.0448	4.0000	45.8900	4.1049
DMM_JUN_3142	0.1384	6.0000	45.9158	3.9114
DMM_JUN_2744	0.1506	6.0000	45.9155	3.9114
DMM_JUN_3386	0.1524	6.0000	45.8855	3.9085
DMM_JUN_2746	0.2071	2.0000	45.9526	4.3070
DMM_JUN_3148	0.6174	8.0000	46.0464	3.7282
DMM_JUN_3146	0.0526	8.0000	46.0093	3.7246
DMM_JUN_2762	0.0970	5.0000	46.1795	4.0353
DMM_JUN_3388	0.0749	7.0000	46.1642	3.8378
DMM_2002	0.0393	3.0000	46.0885	4.2223
DMM_JUN_2764	0.0237	6.0000	46.2531	3.9445
DMM_JUN_3150	0.0190	2.0000	46.2293	4.3341
DMM_JUN_2766	0.3336	4.0000	46.2776	4.1429
DMM_JUN_2768	0.0354	5.0000	46.4390	4.0607
DMM_JUN_3152	0.0388	5.0000	46.4280	4.0596
DMM_JUN_2982	0.0372	5.0000	46.7786	4.0940
J58	0.0000	0.0000	17.9176	1.7558
DMM_JUN_2986	0.0357	5.0000	46.7843	4.0945
J56	0.0000	0.0000	17.9195	1.7560
DMM_JUN_2944	0.0000	7.0000	85.1574	7.6588
DMM_JUN_2942	0.0000	10.0000	86.1323	7.4604
DMM_JUN_2940	0.0000	12.0000	86.5755	7.3078
DMM_JUN_2938	0.0000	9.0000	86.7644	7.6203
DMM_JUN_2936	0.0000	16.0000	87.1072	6.9679
DMM_JUN_2934	0.0000	12.0000	87.5410	7.4024
DMM_JUN_2932	0.0000	21.0000	88.3191	6.5967
DMM_JUN_2930	0.0000	29.0000	89.7073	5.9488
DMM_JUN_3280	0.0000	33.0000	89.8553	5.5714
DMM_JUN_2428	0.0000	32.0000	89.8177	5.6657

ID	Demand (L/s)	Elevation (m)	Head (m)	Pressure (bar)
DMM_19836	0.0000	38.0000	89.7886	5.0749
J60	0.0000	37.0000	47.1034	0.9901
J62	0.0000	0.0000	47.1079	4.6162
DMM_JUN_3276	0.0000	37.0000	47.0924	0.9890
DMM_JUN_3278	0.0261	38.0000	67.9222	2.9321
DMM_JUN_3174	0.0141	30.0000	47.0260	1.6684
DMM_1160	0.0096	31.0000	67.9147	3.6174
21665-B	0.0000	27.0000	67.9143	4.0093
DMM_JUN_2794	3.9006	27.0000	67.8086	3.9989
DMM_JUN_2796	0.0161	33.0000	67.8078	3.4109
DMM_JUN_3176	0.0035	31.0000	67.8075	3.6068
DMM_JUN_2678	0.0066	16.0000	67.7652	5.0726
DMM_JUN_3418	0.0028	15.0000	50.9570	3.5235
DMM_JUN_2680	0.0174	14.0000	67.6937	5.2616
DMM_6709	0.4089	19.0000	50.8689	3.1229
DMM_JUN_2790	0.4710	21.0000	67.6784	4.5741
DMM_JUN_3182	0.0253	21.0000	50.9326	2.9332
DMM_JUN_2788	0.1012	10.0000	41.6260	3.0991
J-23	0.0000	10.2337	67.6153	5.6229
DMM_6915	0.0107	15.0000	41.6205	2.6086
DMM_JUN_3186	0.0697	16.0000	41.5504	2.5037
DMM_JUN_2684	0.0392	10.0000	41.4904	3.0858
DMM_JUN_3188	0.0084	5.0000	41.4885	3.5756
DMM_JUN_2682	0.0669	5.0000	41.4629	3.5731
DMM_5853	0.0979	5.0000	41.4617	3.5730
DMM_JUN_3190	0.0520	7.0000	41.4246	3.3733
DMM_JUN_3192	0.0513	2.3782	41.3957	3.8234
DMM_JUN_3194	0.0118	5.5318	41.3923	3.5140
DMM_5301	0.0749	4.0000	41.3751	3.6625
DMM_JUN_2802	0.1077	3.0000	41.3762	3.7606
197	0.0064	5.3500	41.3563	3.5283
10789	0.0308	5.1300	41.3561	3.5499
5447	0.0052	2.0000	41.3522	3.8562
10800	0.0030	2.0000	41.3522	3.8562
10795	0.0000	1.7300	41.3563	3.8831

ID	Demand (L/s)	Elevation (m)	Head (m)	Pressure (bar)
196	0.0000	1.7000	41.3563	3.8860
DMM_JUN_3184	0.0609	9.0000	41.5294	3.1876
DMM_3337	0.0655	7.0000	46.3854	3.8595
DMM_JUN_3320	0.0442	7.0000	46.3808	3.8590
DMM_JUN_2984	0.1269	5.0000	46.7818	4.0943
DMM_JUN_2776	0.6857	11.0000	46.6884	3.4972
DMM_JUN_2778	0.3069	17.0000	46.6339	2.9039
DMM_JUN_3158	0.2192	17.0000	46.6233	2.9028
DMM_JUN_2884	0.9222	17.0000	46.6309	2.9036
DMM_JUN_2780	0.0142	8.0000	46.5272	3.7754
DMM_JUN_3160	0.1201	8.0000	46.5226	3.7749
DMM_1813	0.1542	5.0000	46.5138	4.0680
DMM_17921	0.0578	9.0000	42.4418	3.2770
DMM_JUN_2782	0.0867	5.0000	46.4913	4.0658
DMM_JUN_3162	0.0019	2.0000	46.4770	4.3584
DMM_JUN_3416	0.0523	7.0000	46.4817	3.8689
DMM_JUN_3414	0.0597	7.0000	46.4343	3.8643
DMM_JUN_3164	0.0240	7.0000	46.4803	3.8688
DMM_12447	0.0871	8.0000	37.6459	2.9051
DMM_JUN_3312	0.1598	4.0000	46.4780	4.1625
DMM_JUN_2600	0.0000	4.0000	46.4778	4.1625
DMM_3191	0.2256	7.0000	46.2959	3.8507
DMM_1781	0.3971	8.0000	46.2394	3.7472
DMM_JUN_3316	0.0057	5.0000	46.4746	4.0642
DMM_JUN_3318	0.0384	5.0000	46.4742	4.0641
DMM_JUN_3314	0.0468	4.0000	46.4741	4.1621
DMM_JUN_3156	0.2571	17.0000	46.4495	2.8858
DMM_JUN_3154	0.2082	17.0000	46.3632	2.8774
DMM_JUN_3178	0.0144	37.0000	67.8041	3.0186
DMM_6695	0.0125	38.0000	67.8041	2.9206
DMM_JUN_2926	0.0000	38.0000	90.0402	5.0995
DMM_JUN_2928	0.0000	35.0000	90.2219	5.4113
DMM_JUN_2924	0.0000	35.0000	90.3846	5.4273
DMM_JUN_2922	0.0000	42.0000	91.5413	4.8547
DMM_JUN_2918	0.0000	40.0000	96.9594	5.5816

ID	Demand (L/s)	Elevation (m)	Head (m)	Pressure (bar)
DMM_JUN_2920	0.0000	80.0000	101.4810	2.1050
DMM_14474	0.0144	89.0000	115.1312	2.5607
DMM_JUN_2846	0.8200	89.0000	115.1312	2.5607
DMM_6953	0.0267	42.0000	67.9186	2.5398
DMM_JUN_3260	188.0124	80.0000	101.4707	2.1040
DMM_JUN_2844	0.0139	89.0000	115.1557	2.5631
DMM_5840	0.0000	89.0000	115.1557	2.5631
DMM_5339	0.0980	91.0000	115.1401	2.3655
DMM_JUN_2840	0.2944	95.0000	115.1402	1.9736
DMM_5340	0.0937	74.0000	115.0475	4.0223
DMM_JUN_2838	0.4992	71.0000	115.0475	4.3163
DMM_JUN_2842	0.0376	53.0000	83.4653	2.9854
DMM_5812	0.0162	51.0000	76.8196	2.5301
J-49	0.0987	53.0000	83.6057	2.9991

Table 12: Table for pipes within Dammam 2 and 5 at the minimum demand hour within scenario 1

ID	From Node	To Node	Length (m)	Diameter (mm)	Roughness (mm)	Flow (L/s)	Velocity (m/s)	Headloss (m)	HL/1000 (m/k-m)	Status
P-30	FCV-3	DHAHYIA_TANK	158.1679	2,000.0000	0.3000	11,989.7892	3.8165	0.7708	4.8736	Open
P-29	HIYASTRATEGICT	FCV-3	420.1012	2,000.0000	0.3000	11,989.7892	3.8165	2.0474	4.8736	Open
DHAHIYA_OUTLET	DHAHYIA_TANK	DHAHYIA_PUMP	90.4825	1,400.0000	0.3000	627.6751	0.4077	0.0085	0.0938	Open
P11	DHAHYIA_TANK	ASTRATEGICOPTI	105.0086	1,600.0000	0.3000	3,699.9998	1.8402	0.1585	1.5097	Open
P15	DHAHYIA_TANK	ASTRATEGICOPTI	104.0323	1,600.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Closed
P17	ASTRATEGICOPTI	J-68	109.0136	1,600.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Closed
P13	ASTRATEGICOPTI	DMM_JUN_2900	108.7711	1,600.0000	0.3000	3,699.9998	1.8402	0.1642	1.5097	Open
DMM_PIP_3041	DMM_VAL_8180	DMM_JUN_2974	88.9742	1,400.0000	0.3000	627.6751	0.4077	0.0083	0.0938	Open
DMM_PIP_3039	DHAHYIA_PUMP	DMM_VAL_8180	86.3150	1,400.0000	0.3000	627.6751	0.4077	0.0081	0.0938	Open
DMM_PIP_2095	DMM_JUN_2974	DMM_VAL_8188	328.9556	1,000.0000	0.3000	330.0845	0.4203	0.0492	0.1495	Open
DMM_PIP_2143	DMM_JUN_2974	DMM_VAL_8190	312.4777	1,000.0000	0.3000	297.5906	0.3789	0.0383	0.1225	Open
DMM_PIP_3059	DMM_VAL_8190	DMM_JUN_2972	193.3053	1,000.0000	0.3000	297.5906	0.3789	0.0237	0.1225	Open
DMM_PIP_3057	DMM_VAL_8188	DMM_JUN_2970	165.8876	1,000.0000	0.3000	330.0845	0.4203	0.0248	0.1495	Open
P19	J-68	DMM_JUN_2900	11.0483	1,600.0000	0.3000	-1,139.9942	0.5670	0.0017	0.1499	Open
DMM_PIP_3109A	DMAV34	DMM_JUN_3002	151.4414	400.0000	0.3000	10.7975	0.0859	0.0036	0.0235	Open
DMM_PIP_3109	DMM_JUN_3006	DMAV34	23.4707	400.0000	0.3000	10.7975	0.0859	0.0005	0.0234	Open
DMM_PIP_3107	DMM_JUN_3006	DMAV35	17.5910	400.0000	0.3000	22.5506	0.1795	0.0016	0.0915	Open
DMM_PIP_2761	DMM_JUN_2856	DMM_JUN_3006	35.6976	400.0000	0.3000	33.3725	0.2656	0.0068	0.1918	Open
DMM_PIP_3107A	DMAV35	DMM_JUN_3004	46.7041	400.0000	0.3000	22.5506	0.1795	0.0043	0.0917	Open
DMM_PIP_2747	DMM_JUN_2858	DMM_JUN_2856	255.6478	400.0000	0.3000	33.5625	0.2671	0.0495	0.1938	Open
DMM_PIP_3099	DMM_JUN_3000	DMM_JUN_2858	255.0532	400.0000	0.3000	34.2639	0.2727	0.0514	0.2015	Open
DMM_PIP_3101	DMM_JUN_3000	DMAV33	2.5392	400.0000	0.3000	9.5986	0.0764	0.0001	0.0201	Open
DMM_PIP_2749	DMM_JUN_2860	DMM_JUN_3000	342.7624	400.0000	0.3000	44.8960	0.3573	0.1155	0.3370	Open
DMM_PIP_3101A	DMAV33	DMM_3879	5.0712	400.0000	0.3000	9.5986	0.0764	0.0001	0.0183	Open
DMM_8544	DMM_3563	DMM_3879	0.6716	197.3000	0.3000	-9.5944	0.3138	0.0004	0.6371	Open
DMM_PIP_2745	DMM_JUN_2854	DMM_JUN_2860	323.1590	400.0000	0.3000	46.2028	0.3677	0.1151	0.3561	Open
DMM_PIP_3093	DMM_JUN_2996	DMM_JUN_2854	38.4895	400.0000	0.3000	46.6182	0.3710	0.0139	0.3621	Open
DMM_PIP_3095	DMM_JUN_2996	DMAV32	5.2456	400.0000	0.3000	-3.0062	0.0239	0.0000	0.0027	Open
DMM_PIP_2743	DMM_JUN_2852	DMM_JUN_2996	698.8017	400.0000	0.3000	43.6438	0.3473	0.2232	0.3193	Open
DMM_PIP_3095A	DMAV32	DMM_JUN_2994	18.5296	400.0000	0.3000	-3.0062	0.0239	0.0000	0.0025	Open
DMM_PIP_3675	DMM_JUN_3372	DMM_JUN_2852	462.3809	400.0000	0.3000	43.7845	0.3484	0.1486	0.3213	Open
DMM_PIP_3089	DMM_JUN_3372	DMAV30	55.0482	400.0000	0.3000	24.6366	0.1961	0.0060	0.1081	Open
DMM_PIP_3089A	DMAV30	DMM_JUN_3374	241.1596	400.0000	0.3000	24.6366	0.1961	0.0261	0.1082	Open
DMM_PIP_2137	DMM_JUN_2626	DMM_JUN_3372	37.2392	400.0000	0.3000	68.9130	0.5484	0.0286	0.7677	Open
DMM_PIP_3113	DMM_JUN_2638	DMAV42	22.7195	400.0000	0.3000	15.0671	0.1199	0.0010	0.0434	Open

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DMM_PIP_2109	DMM_JUN_2638	DMM_JUN_2690	593.2417	1,000.0000	0.3000	206.2540	0.2626	0.0361	0.0609	Open
DMM_PIP_2097	DMM_JUN_2626	DMM_JUN_2638	429.6359	1,000.0000	0.3000	221.6247	0.2822	0.0300	0.0697	Open
DMM_PIP_3113A	DMAV42	DMM_JUN_3008	70.4685	400.0000	0.3000	15.0671	0.1199	0.0031	0.0433	Open
DMM_PIP_3117	DMM_JUN_2690	DMAV37	125.8354	400.0000	0.3000	1.9060	0.0152	0.0001	0.0011	Open
DMM_PIP_2277	DMM_JUN_2690	DMM_JUN_3012	326.2218	1,000.0000	0.3000	203.9220	0.2596	0.0194	0.0595	Open
DMM_PIP_3117A	DMAV37	DMM_JUN_3010	430.3304	400.0000	0.3000	1.9060	0.0152	0.0005	0.0011	Open
DMM_PIP_3123	DMM_JUN_3012	DMAV43	25.0933	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Open
DMM_PIP_3119	DMM_JUN_3012	DMM_JUN_2636	658.4426	1,000.0000	0.3000	203.6681	0.2593	0.0391	0.0594	Open
DMM_PIP_3127	DMM_JUN_2636	DMAV38	69.2475	400.0000	0.3000	15.6759	0.1247	0.0032	0.0466	Open
DMM_PIP_2107	DMM_JUN_2636	DMM_JUN_3024	249.0059	1,000.0000	0.3000	187.7197	0.2390	0.0127	0.0509	Open
DMM_PIP_3127A	DMAV38	DMM_JUN_3016	103.8293	400.0000	0.3000	15.6759	0.1247	0.0048	0.0466	Open
DMM_PIP_3123A	DMAV43	DMM_JUN_3014	70.4380	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Open
DMM_PIP_3139	DMM_JUN_3024	DMAV44	31.2033	400.0000	0.3000	28.2029	0.2244	0.0043	0.1394	Open
DMM_PIP_3139A	DMAV44	DMM_JUN_3026	71.4614	400.0000	0.3000	28.2029	0.2244	0.0100	0.1395	Open
DMM_PIP_3135	DMM_JUN_3024	DMM_JUN_2692	412.3026	1,000.0000	0.3000	159.2281	0.2027	0.0154	0.0373	Open
DMM_PIP_2427	DMM_JUN_2692	DMAV45	52.7775	400.0000	0.3000	36.3424	0.2892	0.0119	0.2253	Open
DMM_PIP_2287	DMM_JUN_2692	DMM_JUN_3028	972.3816	1,000.0000	0.3000	122.3013	0.1557	0.0221	0.0227	Open
DMM_PIP_2427A	DMAV45	DMM_JUN_3020	179.8362	400.0000	0.3000	36.3424	0.2892	0.0405	0.2254	Open
DMM_PIP_3131	DMM_JUN_3020	DMM_JUN_2740	1,541.3807	400.0000	0.3000	19.7780	0.1574	0.1106	0.0717	Open
DMM_PIP_2289	DMM_JUN_3020	DMM_JUN_3022	79.8294	400.0000	0.3000	16.3278	0.1299	0.0040	0.0503	Open
DMM_PIP_2431	DMM_JUN_2740	DMM_JUN_3018	109.8553	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Closed
DMM_PIP_2429	DMM_JUN_2740	DMM_7590	73.1603	400.0000	0.3000	19.6638	0.1565	0.0052	0.0709	Open
DMM_PIP_3145	DMM_JUN_3028	DMAV46	25.3978	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Open
DMM_PIP_3141	DMM_JUN_3028	DMM_JUN_2634	55.3791	1,000.0000	0.3000	122.0996	0.1555	0.0013	0.0227	Open
DMM_PIP_3145A	DMAV46	DMM_JUN_3030	81.4981	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Open
DMM_PIP_2129	DMM_JUN_2634	DMAV39	48.3822	400.0000	0.3000	18.8392	0.1499	0.0032	0.0656	Open
DMM_PIP_2105	DMM_JUN_2634	DMM_JUN_3038	838.2071	1,000.0000	0.3000	103.0759	0.1312	0.0138	0.0165	Open
DMM_PIP_2129A	DMAV39	DMM_JUN_3032	117.4084	400.0000	0.3000	18.8392	0.1499	0.0077	0.0655	Open
DMM_PIP_3151	DMM_JUN_3038	DMM_JUN_2632	68.6345	1,000.0000	0.3000	88.7054	0.1129	0.0009	0.0125	Open
DMM_PIP_2125	DMM_JUN_3038	DMAV40	50.4294	400.0000	0.3000	14.2112	0.1131	0.0020	0.0389	Open
DMM_PIP_2125A	DMAV40	DMM_JUN_3034	115.9837	400.0000	0.3000	14.2112	0.1131	0.0045	0.0389	Open
DMM_PIP_2127	DMM_JUN_2632	DMAV48	12.0192	400.0000	0.3000	34.5810	0.2752	0.0025	0.2051	Open
DMM_PIP_2103	DMM_JUN_2632	DMM_JUN_2640	551.5128	1,000.0000	0.3000	53.9517	0.0687	0.0028	0.0050	Open
DMM_PIP_2127A	DMAV48	DMM_JUN_3040	48.4536	400.0000	0.3000	34.5810	0.2752	0.0099	0.2051	Open
DMM_PIP_2121	DMM_JUN_2640	DMM_JUN_2654	255.3563	1,000.0000	0.3000	53.5524	0.0682	0.0013	0.0049	Open

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DMM_PIP_2183	DMM_JUN_2654	DMM_JUN_3046	257.0146	1,000.0000	0.3000	22.8476	0.0291	0.0003	0.0011	Open
DMM_PIP_2181	DMM_JUN_2654	DMAV41	40.2069	400.0000	0.3000	30.4176	0.2421	0.0065	0.1609	Open
DMM_PIP_2181A	DMAV41	DMM_JUN_2630	94.8501	400.0000	0.3000	30.4176	0.2421	0.0153	0.1608	Open
DMM_PIP_2101	DMM_JUN_2630	DMM_JUN_3042	61.5293	400.0000	0.3000	13.9965	0.1114	0.0023	0.0379	Open
P761	DMM_JUN_2630	DMAV294	194.9822	300.0000	0.1000	16.2670	0.2301	0.0367	0.1881	Open
DMM_PIP_3159	DMM_JUN_3042	DMM_JUN_3044	104.0888	400.0000	0.3000	13.7706	0.1096	0.0038	0.0367	Open
P763	DMAV294	DMM_JUN_276	61.9644	300.0000	0.1000	16.2670	0.2301	0.0117	0.1880	Open
DMM_PIP_3165	DMM_JUN_3046	DMAV49	18.3973	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Open
DMM_PIP_3161	DMM_JUN_3046	DMM_JUN_2730	2,128.0051	1,000.0000	0.3000	22.8048	0.0290	0.0022	0.0011	Open
DMM_PIP_3165A	DMAV49	DMM_JUN_3048	53.9475	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Open
DMM_PIP_3169	DMM_JUN_2730	DMM_JUN_3050	52.1965	400.0000	0.3000	15.4495	0.1229	0.0024	0.0454	Open
DMM_PIP_2397(1)	DMM_JUN_2730	J-14	249.3805	1,000.0000	0.3000	7.1965	0.0092	0.0000	0.0001	Open
DMM_PIP_2245	DMM_VAL_8152	DMM_JUN_2656	170.1767	1,000.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Open
DMM_PIP_2397(2)	J-14	DMM_VAL_8152	381.3947	1,000.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Closed
DMM_PIP_2185	DMM_JUN_2656	DMM_JUN_2732	209.3597	1,000.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Open
DMM_PIP_2407	DMM_JUN_2732	DMM_JUN_3052	288.7430	1,000.0000	0.3000	-0.0608	0.0001	0.0000	0.0000	Open
DMM_PIP_3171	DMM_JUN_3052	DMM_JUN_2734	660.2352	1,000.0000	0.3000	-0.0782	0.0001	0.0000	0.0000	Open
DMM_PIP_2409	DMM_JUN_3052	DMAV292	15.8176	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Open
P757	DMAV292	DMM_JUN_3054	12.9162	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Open
DMM_PIP_2411	DMM_JUN_2734	DMM_JUN_3058	335.9824	1,000.0000	0.3000	-0.1494	0.0002	0.0000	0.0000	Open
DMM_PIP_3177	DMM_JUN_3058	DMM_JUN_3378	483.5338	1,000.0000	0.3000	-0.1599	0.0002	0.0000	0.0000	Open
DMM_PIP_3681	DMM_JUN_3378	DMM_JUN_3062	700.9806	1,000.0000	0.3000	-0.1826	0.0002	0.0000	0.0000	Open
DMM_PIP_3179	DMM_JUN_3378	DMAV293	6.8567	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Open
P759	DMAV293	DMM_JUN_3376	18.9144	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Open
DMM_PIP_3185	DMM_JUN_3062	DMAV51	13.7876	400.0000	0.3000	15.4302	0.1228	0.0006	0.0452	Open
DMM_PIP_3185A	DMAV51	DMM_JUN_3060	25.2030	400.0000	0.3000	15.4302	0.1228	0.0011	0.0452	Open
DMM_PIP_3183	DMM_JUN_3062	DMM_JUN_2736	204.8566	1,000.0000	0.3000	-15.6177	0.0199	0.0001	0.0005	Open
DMM_PIP_2417	DMM_JUN_2736	DMM_JUN_3064	679.5434	1,000.0000	0.3000	-16.8464	0.0215	0.0004	0.0006	Open
DMM_PIP_3193	DMM_JUN_3064	DMM_JUN_3066	27.3053	400.0000	0.3000	30.6325	0.2438	0.0045	0.1630	Open
DMM_PIP_3187	DMM_JUN_3064	DMM_JUN_2738	593.0266	1,000.0000	0.3000	-47.5553	0.0605	0.0024	0.0040	Open
DMM_PIP_3197	DMM_JUN_3066	DMM_JUN_3070	11.8099	400.0000	0.3000	11.2848	0.0898	0.0003	0.0256	Open
DMM_PIP_3195	DMM_JUN_3066	DMM_JUN_3068	11.9030	400.0000	0.3000	19.3447	0.1539	0.0008	0.0688	Open
DMM_PIP_3199	DMM_JUN_2738	DMAV53	14.2963	400.0000	0.3000	12.9118	0.1027	0.0005	0.0325	Open
DMM_JUN_2738A	DMAV53	DMM_2915	37.0639	400.0000	0.3000	12.9118	0.1027	0.0012	0.0326	Open
DMM_PIP_3053	DMM_VAL_8184	DMM_JUN_2976	42.8756	1,000.0000	0.3000	61.1172	0.0778	0.0003	0.0063	Open

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DMM_PIP_2421	DMM_JUN_2738	DMM_JUN_2976	572.1145	1,000.0000	0.3000	-60.7520	0.0774	0.0036	0.0062	Open
DMM_PIP_3043	DMM_JUN_2980	DMM_VAL_8184	132.4107	1,000.0000	0.3000	61.1172	0.0778	0.0008	0.0063	Open
TANK71OUTLET	DMM_VAL_8182	DMM_JUN_2980	24.8994	1,400.0000	0.3000	660.6691	0.4292	0.0026	0.1035	Open
DMM_PIP_3049	TANK_71_PS	DMM_VAL_8182	13.6756	1,400.0000	0.3000	660.6691	0.4292	0.0014	0.1037	Open
DMM_PIP_2201	DMM_JUN_2980	DMM_VAL_8186	31.3356	1,200.0000	0.3000	599.1118	0.5297	0.0059	0.1872	Open
P813	J54	TANK_71_PS	15.5040	1,400.0000	0.3000	660.6691	0.4292	0.0016	0.1035	Open
DMM_PIP_3055	DMM_VAL_8186	DMM_JUN_2978	16.1688	1,200.0000	0.3000	599.1118	0.5297	0.0030	0.1873	Open
DMM_PIP_3529	DMM_JUN_2978	DMM_JUN_3282	590.1604	1,000.0000	0.3000	327.8766	0.4175	0.0871	0.1475	Open
DMM_PIP_3537	DMM_VAL_8246	DMM_JUN_3284	11.5117	1,000.0000	0.3000	186.4447	0.2374	0.0006	0.0505	Open
DMM_PIP_3535	DMM_JUN_3282	DMM_VAL_8246	18.0664	1,000.0000	0.3000	186.4447	0.2374	0.0009	0.0502	Open
DMM_PIP_3533	DMM_JUN_3284	DMM_JUN_2394	36.0959	700.0000	0.3000	185.5977	0.4823	0.0109	0.3009	Open
DMM_PIP_3531	DMM_JUN_3282	DMM_JUN_2390	13.3610	1,000.0000	0.3000	141.2674	0.1799	0.0004	0.0299	Open
DMM_PIP_1137	DMM_JUN_2390	DMM_JUN_2392	31.7794	1,200.0000	0.3000	141.2487	0.1249	0.0004	0.0120	Open
DMM_PIP_1143	DMM_JUN_2392	DMM_3406	6.5543	1,200.0000	0.3000	141.2319	0.1249	0.0001	0.0121	Open
DMM_PIP_2617	DMM_3406	DMM_JUN_3348	0.7164	1,000.0000	0.3000	123.9589	0.1578	0.0000	0.0195	Open
DMM_PIP_3631	DMM_JUN_3348	DMM_VAL_8248	19.9899	400.0000	0.3000	23.4083	0.1863	0.0020	0.0984	Open
DMM_PIP_3627	DMM_JUN_3348	DMM_JUN_2814	113.1321	1,000.0000	0.3000	100.5090	0.1280	0.0018	0.0157	Open
DMM_PIP_3633	DMM_VAL_8248	DMM_JUN_3350	23.1385	400.0000	0.3000	23.4083	0.1863	0.0023	0.0983	Open
DMM_PIP_2621	DMM_JUN_2814	DMM_JUN_3288	333.1554	1,000.0000	0.3000	100.3910	0.1278	0.0052	0.0157	Open
DMM_PIP_3541	DMM_JUN_3288	DMM_JUN_2816	149.5690	1,000.0000	0.3000	66.5020	0.0847	0.0011	0.0073	Open
DMM_PIP_2627	DMM_JUN_3288	DMM_JUN_3286	16.0531	400.0000	0.3000	33.6347	0.2677	0.0031	0.1947	Open
DMM_PIP_2623	DMM_JUN_2816	DMM_JUN_3292	321.1077	1,000.0000	0.3000	66.2705	0.0844	0.0023	0.0073	Open
DMM_PIP_2629	DMM_JUN_3292	DMAV67	4.3482	400.0000	0.3000	13.6328	0.1085	0.0002	0.0364	Open
DMM_PIP_2629A	DMAV67	DMM_JUN_3290	10.7088	400.0000	0.3000	13.6328	0.1085	0.0004	0.0360	Open
DMM_PIP_3545	DMM_JUN_3292	DMM_JUN_3300	415.2813	1,000.0000	0.3000	47.9757	0.0611	0.0017	0.0040	Open
P217	DMM_JUN_3292	DMAV63	421.9033	140.3000	0.1000	4.4628	0.2887	0.3089	0.7321	Open
P219	DMAV63	J30	11.4384	140.3000	0.1000	4.4628	0.2887	0.0084	0.7319	Open
P211	DMM_JUN_3300	DMAV62	1,252.6060	197.3000	0.1000	7.3697	0.2411	0.4308	0.3439	Open
P213	DMAV62	J28	14.4390	197.3000	0.1000	7.3697	0.2411	0.0050	0.3440	Open
DMM_PIP_3553	DMM_JUN_3300	DMM_JUN_2818	111.3169	1,000.0000	0.3000	24.5162	0.0312	0.0001	0.0012	Open
DMM_PIP_2631	DMM_JUN_3300	DMAV68	4.3771	400.0000	0.3000	15.9460	0.1269	0.0002	0.0478	Open
DMM_PIP_2631A	DMAV68	DMM_JUN_3298	10.4896	400.0000	0.3000	15.9460	0.1269	0.0005	0.0483	Open
DMM_PIP_2625	DMM_JUN_2818	DMAV61	339.4440	1,000.0000	0.3000	24.0875	0.0307	0.0004	0.0012	Open
DMM_PIP_2625A	DMAV61	DMM_JUN_2812	13.4230	1,000.0000	0.3000	24.0875	0.0307	0.0000	0.0010	Open
DMM_PIP_2637	DMM_JUN_2812	DMM_JUN_3294	73.7163	400.0000	0.3000	11.4060	0.0908	0.0019	0.0260	Open

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DMM_PIP_2635	DMM_JUN_2812	DMM_JUN_3296	13.7738	400.0000	0.3000	12.4442	0.0990	0.0004	0.0304	Open
DMM_PIP_3647	DMM_JUN_3360	DMM_JUN_3354	602.0642	400.0000	0.3000	16.5565	0.1318	0.0310	0.0516	Open
DMM_PIP_3645	DMM_JUN_3360	DMM_JUN_3358	8.7225	400.0000	0.3000	13.1189	0.1044	0.0003	0.0336	Open
DMM_PIP_3643A	DMAV86	DMM_JUN_3360	3.6893	400.0000	0.3000	29.6775	0.2362	0.0006	0.1538	Open
DMM_PIP_3643	DMM_JUN_3356	DMAV86	2.2199	400.0000	0.3000	29.6775	0.2362	0.0003	0.1529	Open
P265	DMM_JUN_2806	DMAV78	52.3986	140.3000	0.1000	4.9428	0.3197	0.0463	0.8832	Open
P267	DMAV78	DMM_2856	49.1738	140.3000	0.1000	4.9428	0.3197	0.0434	0.8832	Open
DMM_PIP_2601	DMM_JUN_3380	DMM_JUN_3382	13.9159	400.0000	0.3000	36.3203	0.2890	0.0031	0.2253	Open
DMM_PIP_2611	DMM_JUN_2294	DMM_JUN_3302	20.9171	400.0000	0.3000	12.3606	0.0984	0.0006	0.0302	Open
DMM_PIP_2609	DMM_JUN_2810	DMM_JUN_3352	10.6103	400.0000	0.3000	50.8067	0.4043	0.0045	0.4269	Open
DMM_PIP_3305	DMM_JUN_3138	DMM_846	1,898.6678	1,000.0000	0.3000	94.0327	0.1197	0.0264	0.0139	Open
DMM_PIP_2785	DMM_JUN_3138	DMAV182	51.7184	400.0000	0.3000	14.1912	0.1129	0.0020	0.0388	Open
DMM_PIP_2441	DMM_JUN_2744	DMM_JUN_3138	1,181.4428	1,000.0000	0.3000	108.2603	0.1378	0.0214	0.0181	Open
P523	DMAV182	DMM_JUN_3384	55.2520	400.0000	0.3000	14.1912	0.1129	0.0021	0.0388	Open
DMM_PIP_3309	DMM_JUN_3142	DMM_JUN_2746	749.4691	1,000.0000	0.3000	-184.3627	0.2347	0.0369	0.0492	Open
DMM_PIP_2443	DMM_JUN_3142	DMM_JUN_3386	32.7767	400.0000	0.3000	75.8134	0.6033	0.0303	0.9233	Open
DMM_PIP_2437	DMM_JUN_2744	DMM_JUN_3142	15.1349	1,000.0000	0.3000	-108.4108	0.1380	0.0003	0.0181	Open
DMM_PIP_2439	DMM_JUN_2746	DMM_JUN_3148	1,902.8049	1,000.0000	0.3000	-184.5698	0.2350	0.0938	0.0493	Open
DMM_PIP_3317	DMM_JUN_3148	DMM_JUN_3146	65.6665	400.0000	0.3000	58.7719	0.4677	0.0371	0.5649	Open
DMM_PIP_3315	DMM_JUN_3148	DMM_JUN_2762	1,588.9784	1,000.0000	0.3000	-243.9591	0.3106	0.1331	0.0838	Open
DMM_PIP_2501	DMM_JUN_2762	DMM_JUN_3388	122.5552	400.0000	0.3000	26.6028	0.2117	0.0153	0.1250	Open
DMM_PIP_2497	DMM_JUN_2762	DMM_JUN_2764	656.1777	1,000.0000	0.3000	-284.1534	0.3618	0.0736	0.1121	Open
P359	DMM_JUN_2762	DMAV113	22.7184	197.3000	0.1000	13.4946	0.4414	0.0239	1.0502	Open
P361	DMAV113	DMM_2002	63.9446	197.3000	0.1000	13.4946	0.4414	0.0672	1.0504	Open
DMM_PIP_2511	DMM_JUN_2764	DMM_JUN_3150	25.7386	400.0000	0.3000	75.8697	0.6038	0.0238	0.9246	Open
DMM_PIP_2499	DMM_JUN_2764	DMM_JUN_2766	139.0197	1,000.0000	0.3000	-360.0467	0.4584	0.0246	0.1767	Open
DMM_PIP_2505	DMM_JUN_2766	DMM_JUN_2768	911.8123	1,000.0000	0.3000	-360.3803	0.4589	0.1614	0.1770	Open
DMM_PIP_3323	DMM_JUN_2768	DMM_JUN_3152	14.3290	400.0000	0.3000	68.8242	0.5477	0.0110	0.7657	Open
DMM_PIP_2507	DMM_JUN_2768	DMM_JUN_2982	1,369.2132	1,000.0000	0.3000	-429.2399	0.5465	0.3396	0.2480	Open
DMM_PIP_3071	DMM_VAL_8194	DMM_JUN_2982	7.3654	1,000.0000	0.3000	429.2771	0.5466	0.0018	0.2482	Open
DMM_PIP_3061	DMM_JUN_2986	DMM_VAL_8194	15.5373	1,000.0000	0.3000	429.2771	0.5466	0.0039	0.2479	Open
CT_OUTLET	DMM_VAL_8192	DMM_JUN_2986	9.2608	1,600.0000	0.3000	1,217.4127	0.6055	0.0016	0.1718	Open
DMM_PIP_3067	ENTRAL_TANK_P	DMM_VAL_8192	11.2199	1,600.0000	0.3000	1,217.4127	0.6055	0.0019	0.1712	Open
P821	J58	ENTRAL_TANK_P	4.7147	1,600.0000	0.3000	1,217.4127	0.6055	0.0008	0.1714	Open
P-33	DMM_JUN_2946	CV_CENTRAL_TAN	47.3153	1,600.0000	0.3000	1,999.9859	0.9947	0.0213	0.4506	Open

ID	From Node	To Node	Length (m)	Diameter (mm)	Roughness (mm)	Flow (L/s)	Velocity (m/s)	Headloss (m)	HL/1000 (m/k-m)	Status
P-34	CV_CENTRAL_TAN	J56	12.3051	1,600.0000	0.3000	1,999.9859	0.9947	0.0055	0.4507	Open
DMM_PIP_2977	DMM_JUN_2944	DMM_JUN_2948	296.6949	1,600.0000	0.3000	1,999.9857	0.9947	0.1337	0.4507	Open
DMM_PIP_2975	DMM_JUN_2942	DMM_JUN_2944	2,163.0970	1,600.0000	0.3000	1,999.9857	0.9947	0.9749	0.4507	Open
DMM_PIP_2973	DMM_JUN_2942	DMM_JUN_2940	983.4080	1,600.0000	0.3000	-1,999.9857	0.9947	0.4432	0.4507	Open
DMM_PIP_2971	DMM_JUN_2938	DMM_JUN_2940	419.0785	1,600.0000	0.3000	1,999.9857	0.9947	0.1889	0.4507	Open
DMM_PIP_2969	DMM_JUN_2936	DMM_JUN_2938	760.6230	1,600.0000	0.3000	1,999.9857	0.9947	0.3428	0.4507	Open
DMM_PIP_2967	DMM_JUN_2934	DMM_JUN_2936	962.3452	1,600.0000	0.3000	1,999.9857	0.9947	0.4337	0.4507	Open
DMM_PIP_2965	DMM_JUN_2932	DMM_JUN_2934	1,726.5588	1,600.0000	0.3000	1,999.9857	0.9947	0.7781	0.4507	Open
DMM_PIP_2963	DMM_JUN_2930	DMM_JUN_2932	3,079.9867	1,600.0000	0.3000	1,999.9857	0.9947	1.3881	0.4507	Open
DMM_PIP_2961	DMM_JUN_3280	DMM_JUN_2930	328.4499	1,600.0000	0.3000	1,999.9857	0.9947	0.1480	0.4507	Open
DMM_PIP_3527	DMM_JUN_3280	DMM_JUN_2926	95.3555	1,600.0000	0.3000	-4,199.9700	2.0889	0.1849	1.9390	Open
DMM_PIP_1271	DMM_JUN_3280	DMM_JUN_2428	34.8838	1,400.0000	0.3000	-2,199.9845	1.4291	0.0376	1.0775	Open
DMM_PIP_1193	DMM_VAL_8024	DMM_JUN_2428	13.6552	1,400.0000	0.3000	-2,199.9845	1.4291	0.0147	1.0776	Open
DMM_5089	DMM_19836	DMM_VAL_8024	13.3400	1,400.0000	0.3000	-2,199.9845	1.4291	0.0144	1.0773	Open
P-35	DMM_19836	FCV_TANK55	6.9463	1,600.0000	0.3000	2,199.9845	1.0942	0.0038	0.5437	Open
P-36	FCV_TANK55	J62	7.8302	1,600.0000	0.3000	2,199.9845	1.0942	0.0043	0.5435	Open
DMM_PIP_3517	DMM_JUN_3276	MEW_TANK_55_PS	71.6074	1,400.0000	0.3000	728.2600	0.4731	0.0089	0.1249	Open
DMM_PIP_2659	MEW_TANK_55_PS	DMM_JUN_3278	21.5346	1,400.0000	0.3000	728.2600	0.4731	0.0027	0.1250	Open
DMM_PIP_3521	DMM_JUN_3278	DMM_1160	63.0371	1,400.0000	0.3000	705.7282	0.4585	0.0074	0.1175	Open
P23	DMM_JUN_3174	DMM_1160	4.4425	1,000.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Closed
DMM_PIP_2571(2)	DMM_JUN_2794	21665-B	1,558.0150	1,000.0000	0.3000	-218.3810	0.2781	0.1057	0.0678	Open
DMM_VAL_8038_U	DMM_1160	DMM_VAL_8038	3.0752	1,000.0000	0.3000	218.3810	0.2781	0.0002	0.0681	Open
DMM_VAL_8038_D	DMM_VAL_8038	21665-B	3.4913	1,000.0000	0.3000	218.3810	0.2781	0.0002	0.0679	Open
DMM_PIP_2249	DMM_JUN_2678	DMM_JUN_2794	674.3797	1,000.0000	0.3000	-212.4914	0.2706	0.0434	0.0644	Open
DMM_PIP_2573	DMM_JUN_2794	DMM_JUN_2796	746.3929	400.0000	0.3000	1.9891	0.0158	0.0009	0.0012	Open
DMM_PIP_2577(1)	DMM_JUN_2796	PRV-8	178.8718	400.0000	0.3000	1.9730	0.0157	0.0002	0.0011	Open
DMM_PIP_2577(2)	PRV-8	DMM_JUN_3176	40.6283	400.0000	0.3000	1.9730	0.0157	0.0000	0.0011	Open
DMM_PIP_2255(1)	DMM_JUN_2678	PRV-7	56.1034	400.0000	0.3000	9.1332	0.0727	0.0010	0.0173	Open
DMM_PIP_2255(2)	PRV-7	DMM_JUN_3418	18.6748	400.0000	0.3000	9.1332	0.0727	0.0003	0.0172	Open
DMM_PIP_2251	DMM_JUN_2680	DMM_JUN_2678	1,207.9848	1,000.0000	0.3000	-203.3516	0.2589	0.0715	0.0592	Open
DMM_PIP_2567	DMM_JUN_2790	DMM_JUN_2680	257.8840	1,000.0000	0.3000	-203.3342	0.2589	0.0153	0.0592	Open
DMM_PIP_2253	DMM_JUN_2680	DMM_6709	43.9786	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Closed
DMM_PIP_2569	DMM_JUN_2790	DMM_JUN_3182	28.9899	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Closed
DMM_PIP_3249(1)	DMM_JUN_2790	J-23	1,069.3960	1,000.0000	0.3000	202.8632	0.2583	0.0631	0.0590	Open
DMM_PIP_2597	DMM_JUN_2788	DMM_JUN_3186	1,416.0236	1,000.0000	0.3000	192.4618	0.2451	0.0756	0.0534	Open

ID	From Node	To Node	Length (m)	Diameter (mm)	Roughness (mm)	Flow (L/s)	Velocity (m/s)	Headloss (m)	HL/1000 (m/k-m)	Status
DMM_PIP_2565	DMM_JUN_2788	DMAV111	35.9430	400.0000	0.3000	10.3003	0.0820	0.0008	0.0216	Open
P-43	J-23	PRV-5	11.6063	1,000.0000	0.3000	202.8632	0.2583	0.0007	0.0589	Open
P-44	PRV-5	DMM_JUN_2788	11.6103	1,000.0000	0.3000	202.8632	0.2583	0.0007	0.0589	Open
DMM_PIP_2565A	DMAV111	DMM_6915	217.6934	400.0000	0.3000	10.3003	0.0820	0.0047	0.0216	Open
DMM_PIP_3359	DMM_JUN_3186	DMAV108	2,085.5044	400.0000	0.3000	6.5979	0.0525	0.0201	0.0096	Open
DMM_PIP_2259	DMM_JUN_2684	DMM_JUN_3186	1,204.0585	1,000.0000	0.3000	-185.7942	0.2366	0.0601	0.0499	Open
DMM_PIP_2263	DMM_JUN_2684	DMAV109	17.7265	400.0000	0.3000	11.3446	0.0903	0.0005	0.0257	Open
DMM_PIP_2257	DMM_JUN_2682	DMM_JUN_2684	619.1663	1,000.0000	0.3000	-174.4104	0.2221	0.0274	0.0443	Open
DMM_PIP_2263A	DMAV109	DMM_JUN_3188	53.9229	400.0000	0.3000	11.3446	0.0903	0.0014	0.0257	Open
DMM_PIP_2261	DMM_JUN_2682	DMAV110	13.2038	400.0000	0.3000	4.3006	0.0342	0.0001	0.0046	Open
DMM_PIP_2265	DMM_JUN_2682	DMM_JUN_3190	909.0325	1,000.0000	0.3000	170.0430	0.2165	0.0384	0.0422	Open
DMM_PIP_2261A	DMAV110	DMM_5853	267.3479	400.0000	0.3000	4.3006	0.0342	0.0012	0.0045	Open
DMM_12544	DMM_JUN_1186	DMM_5853	229.3976	197.3000	0.3000	-1.5033	0.0492	0.0049	0.0211	Open
DMM_PIP_2267	DMM_JUN_3192	DMAV107	26.6324	400.0000	0.3000	12.1895	0.0970	0.0008	0.0293	Open
DMM_PIP_2267A	DMAV107	DMM_JUN_3194	91.9454	400.0000	0.3000	12.1895	0.0970	0.0027	0.0293	Open
DMM_PIP_2591	DMM_JUN_2802	DMAV106	36.8191	400.0000	0.3000	5.8608	0.0466	0.0003	0.0078	Open
DMM_PIP_2591A	DMAV106	DMM_5301	105.8917	400.0000	0.3000	5.8608	0.0466	0.0008	0.0078	Open
25452	197	DMAV102	9.1541	400.0000	0.3000	5.4115	0.0431	0.0001	0.0066	Open
25452A	DMAV102	10789	20.7717	400.0000	0.3000	5.4115	0.0431	0.0001	0.0067	Open
25458	10800	5447	7.3498	400.0000	0.3000	1.1005	0.0088	0.0000	0.0006	Open
25450	196	DMAV103	2.4820	400.0000	0.3000	2.1424	0.0170	0.0000	0.0019	Open
25450A	DMAV103	10795	5.7802	400.0000	0.3000	2.1424	0.0170	0.0000	0.0016	Open
DMM_PIP_3359A	DMAV108	DMM_JUN_3184	102.6905	400.0000	0.3000	6.5979	0.0525	0.0010	0.0096	Open
DMM_PIP_2821	DMM_3337	DMAV179	4.7012	400.0000	0.3000	44.1121	0.3510	0.0015	0.3265	Open
P517	DMAV179	DMM_JUN_3320	9.3109	400.0000	0.3000	44.1121	0.3510	0.0030	0.3257	Open
DMM_PIP_3073	DMM_VAL_8196	DMM_JUN_2984	13.4179	1,000.0000	0.3000	280.6509	0.3573	0.0015	0.1095	Open
DMM_PIP_2203	DMM_JUN_2986	DMM_VAL_8196	8.9744	1,000.0000	0.3000	280.6509	0.3573	0.0010	0.1093	Open
DMM_PIP_3063	DMM_JUN_2984	DMM_JUN_2776	854.3405	1,000.0000	0.3000	280.5240	0.3572	0.0935	0.1094	Open
DMM_PIP_2535	DMM_JUN_2776	DMM_JUN_2778	499.8027	1,000.0000	0.3000	279.8383	0.3563	0.0544	0.1089	Open
DMM_PIP_2541	DMM_JUN_2778	DMM_JUN_3158	15.9318	400.0000	0.3000	64.1967	0.5109	0.0107	0.6694	Open
DMM_PIP_2537	DMM_JUN_2778	DMM_JUN_2884	46.5671	1,000.0000	0.3000	215.3346	0.2742	0.0031	0.0660	Open
DMM_PIP_2817	DMM_JUN_2884	DMM_JUN_2780	1,581.9928	1,000.0000	0.3000	214.4125	0.2730	0.1036	0.0655	Open
DMM_PIP_2545	DMM_JUN_2780	DMM_JUN_3160	17.7056	400.0000	0.3000	39.4772	0.3142	0.0047	0.2637	Open
DMM_PIP_2543	DMM_JUN_2780	DMM_JUN_2782	806.1272	1,000.0000	0.3000	174.9211	0.2227	0.0359	0.0445	Open
P409	DMAV133	DMM_17921	37.9889	197.3000	0.1000	0.0000	0.0000	0.0000	0.0000	Open

ID	From Node	To Node	Length (m)	Diameter (mm)	Roughness (mm)	Flow (L/s)	Velocity (m/s)	Headloss (m)	HL/1000 (m/k-m)	Status
P407	DMM_1813	DMAV133	30.8326	197.3000	0.1000	0.0000	0.0000	0.0000	0.0000	Open
DMM_PIP_2549	DMM_JUN_2782	DMM_JUN_3162	37.9330	400.0000	0.3000	47.7220	0.3798	0.0144	0.3787	Open
DMM_PIP_3717	DMM_JUN_3416	DMM_JUN_3164	313.5694	1,000.0000	0.3000	49.5221	0.0631	0.0013	0.0043	Open
DMM_PIP_3337	DMM_JUN_3416	DMM_JUN_3414	49.1183	400.0000	0.3000	77.5379	0.6170	0.0474	0.9643	Open
DMM_PIP_2547	DMM_JUN_2782	DMM_JUN_3416	396.3835	1,000.0000	0.3000	127.1123	0.1618	0.0097	0.0244	Open
P381	DMAV121	DMM_12447	17.4475	260.4000	0.1000	0.0000	0.0000	0.0000	0.0000	Open
P379	DMM_JUN_3164	DMAV121	19.2322	260.4000	0.1000	0.0000	0.0000	0.0000	0.0000	Open
DMM_PIP_3201	DMM_JUN_3164	DMM_JUN_3312	543.8372	1,000.0000	0.3000	49.4981	0.0630	0.0023	0.0043	Open
DMM_PIP_3587	DMM_JUN_3312	DMM_JUN_2600	9.3955	400.0000	0.3000	9.5039	0.0756	0.0002	0.0188	Open
DMM_PIP_3579	DMM_JUN_3312	DMM_JUN_3316	1,192.9900	1,000.0000	0.3000	39.8344	0.0507	0.0034	0.0029	Open
P415	DMM_3191	DMAV136	30.0804	276.6000	0.1000	25.6907	0.4275	0.0196	0.6529	Open
P419	DMAV136	DMM_1781	56.3494	276.6000	0.1000	25.6907	0.4275	0.0368	0.6529	Open
DMM_PIP_3343	DMM_JUN_3316	DMM_JUN_3318	3.4290	400.0000	0.3000	24.0189	0.1911	0.0004	0.1031	Open
DMM_PIP_3583	DMM_JUN_3316	DMM_JUN_3314	839.1509	1,000.0000	0.3000	15.8098	0.0201	0.0005	0.0005	Open
DMM_PIP_2819	DMM_JUN_3156	DMAV177	4.5805	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Open
P511	DMAV177	DMM_JUN_3154	5.1596	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Open
DMM_PIP_2579	DMM_6695	DMM_JUN_3178	241.7037	400.0000	0.3000	-0.1141	0.0009	0.0000	0.0000	Open
DMM_PIP_2959	DMM_JUN_2928	DMM_JUN_2926	93.7455	1,600.0000	0.3000	4,199.9700	2.0889	0.1818	1.9388	Open
DMM_PIP_2957	DMM_JUN_2924	DMM_JUN_2928	83.9169	1,600.0000	0.3000	4,199.9700	2.0889	0.1627	1.9389	Open
DMM_PIP_2955	DMM_JUN_2922	DMM_JUN_2924	596.5691	1,600.0000	0.3000	4,199.9700	2.0889	1.1567	1.9389	Open
DMM_PIP_2953	DMM_JUN_2918	DMM_JUN_2922	2,794.4302	1,600.0000	0.3000	4,199.9700	2.0889	5.4181	1.9389	Open
DMM_PIP_2951	DMM_JUN_2920	DMM_JUN_2918	2,332.0760	1,600.0000	0.3000	4,199.9700	2.0889	4.5216	1.9389	Open
DMM_PIP_3013	JAMIAH_TANK	DMM_JUN_2920	12.3237	1,600.0000	0.3000	4,199.9700	2.0889	0.0239	1.9390	Open
DMM_PIP_2731	DMM_JUN_2846	DMM_14474	6.1337	400.0000	0.3000	1.6991	0.0135	0.0000	0.0000	Open
DMM_PIP_1393	DMM_6953	DMM_VAL_8124	20.7269	600.0000	0.3000	0.0089	0.0000	0.0000	0.0000	Open
JAMEAH_OUTLET	JAMIAH_TANK	DMM_JUN_3260	117.8040	1,000.0000	0.3000	465.6327	0.5929	0.0342	0.2903	Open
DMM_PIP_3469	DMM_JUN_3260	JAMIAH_PS	85.4643	600.0000	0.3000	140.4955	0.4969	0.0329	0.3850	Open
DMM_PIP_3465	DMM_JUN_3260	DMAV317	2,356.1574	1,000.0000	0.3000	137.1248	0.1746	0.0663	0.0281	Open
DMM_PIP_3471	JAMIAH_PS	DMM_JUN_2848	56.3945	600.0000	0.3000	140.4955	0.4969	0.0217	0.3851	Open
DMM_PIP_2727	DMM_JUN_2844	DMAV16	0.5643	400.0000	0.3000	12.2213	0.0973	0.0000	0.0165	Open
DMM_PIP_2727A	DMAV16	DMM_5840	0.5850	400.0000	0.3000	12.2213	0.0973	0.0000	0.0318	Open
DMM_PIP_2693	DMM_JUN_2840	DMM_5339	5.0960	400.0000	0.3000	11.7452	0.0935	0.0001	0.0274	Open
DMM_PIP_2689	DMM_JUN_2838	DMM_5340	9.6406	400.0000	0.3000	-0.5336	0.0042	0.0000	0.0000	Open
DMM_PIP_2707(1)	DMM_JUN_2842	PRV-20	33.6368	400.0000	0.3000	8.1040	0.0645	0.0005	0.0138	Open
DMM_PIP_2707(2)	PRV-20	DMM_5812	13.5305	400.0000	0.3000	8.1040	0.0645	0.0002	0.0141	Open

1.4.3 Pumps Operating Speeds

As mentioned above the pumps nominal curves have been added to the system and the VSD properties of the pumps are defined in the model (Table 4 and Table 5).

The following figures show the speed and operating points of each pump for 24 hours simulation period.

Figure 16 presents the operating speeds and operation points of the Dhahyia pump.

Op. Max = maximum operating speed along the extended period simulation (red)

Op. Min = minimum operating speed along the extended period simulation (yellow)

Ref. Max = Reference maximum speed (10% higher than Op. Max, blue)

Ref. Min = Reference minimum speed (10% lower than Op. Min, pink, which is not visible in this case by chance as Ref. Min and Op. Min is the same and it is exactly under the yellow minimum operation curve, it can be seen in following pumps figures)

Duty = introduced pump curve

Operating Points = Points of operation during the extended period simulation (Crayon).

As it is obvious the pump is operating within the range of 0.48 and 0.73 of its operating speeds (between curves colour red and yellow). Hence the chosen pump is big for the system, and it is not Energy efficient. This might be also one the reasons that several PRVs are introduced in the Dammam 2 scopes.

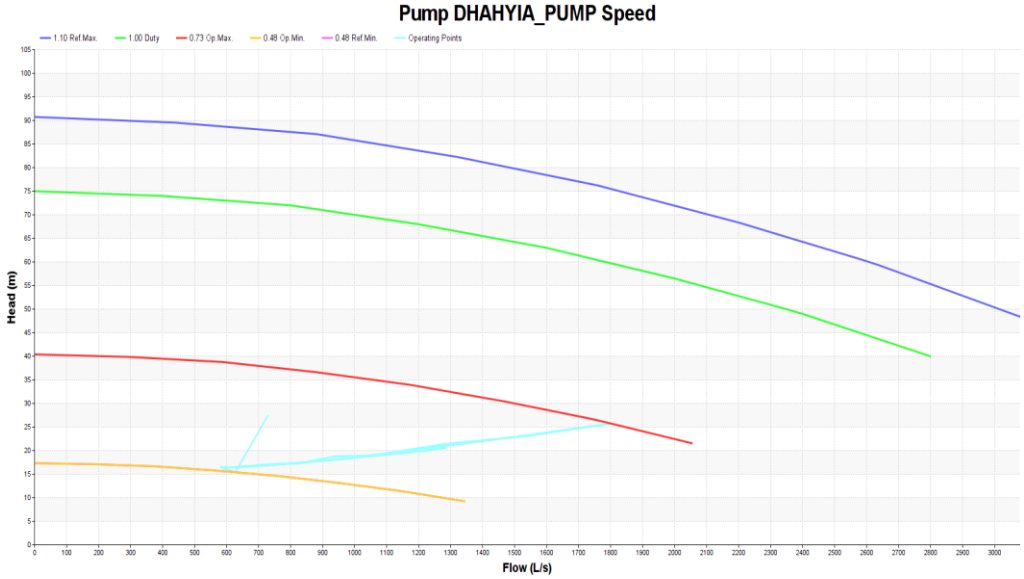


Figure 16- Dhayia Pump operating speeds and operation points

Also, Figure 17 presents the Tank 71 pump operating speeds and operation points. This pump also works within the range of 0.71 to 0.89 of its operating speed to maintain the maximum 3.5 bar pressure at the control junction mentioned in Table 5.

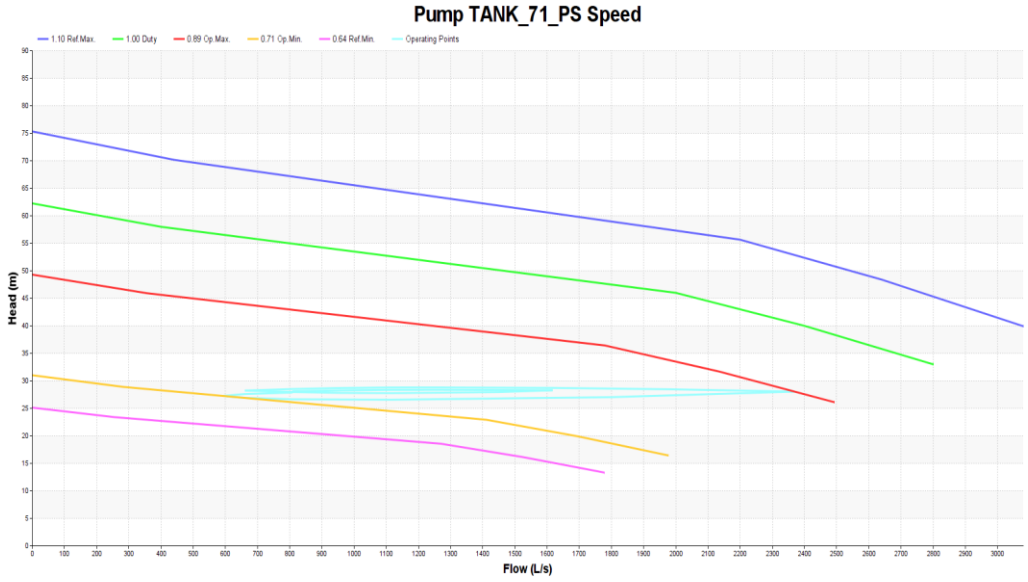


Figure 17- Tank 71 Pump operating speeds and operation points

Moreover, Figure 18 presents the Central Tank Pump operating speeds and operation points. This pump is operating in the range of 0.65-0.92 of its operating speed to maintain the 4 bars pressure in the mentioned above control junction.

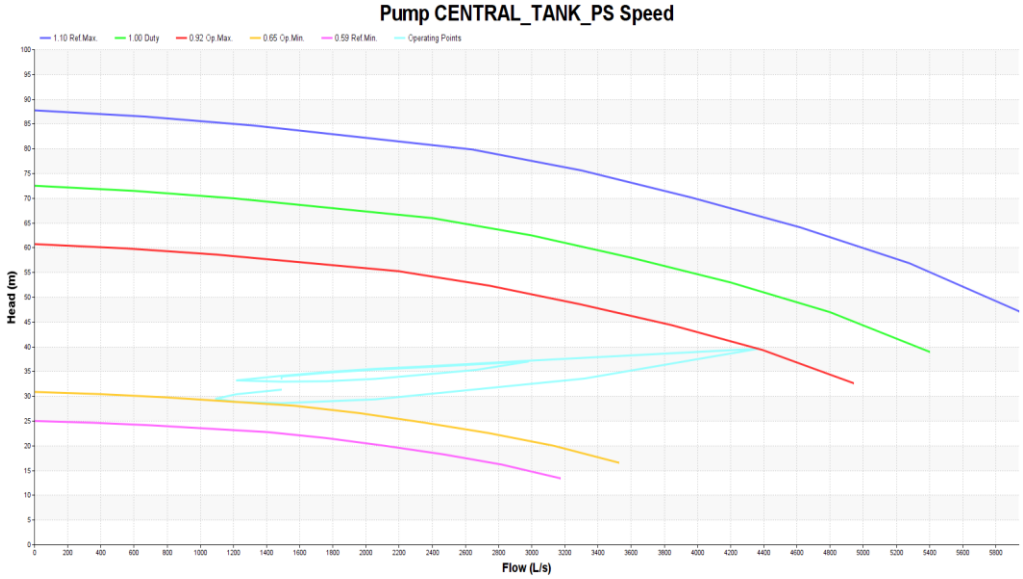


Figure 18- Central Tank Pump operating speeds and operation points

Furthermore, Figure 19 presents the MEW-Tank 55 pump operating speed and operation points. Similarly, this pump is operating in the range of 0.73-0.89 of its operating speed to maintain the 4 bars pressure in the mentioned above control junction.

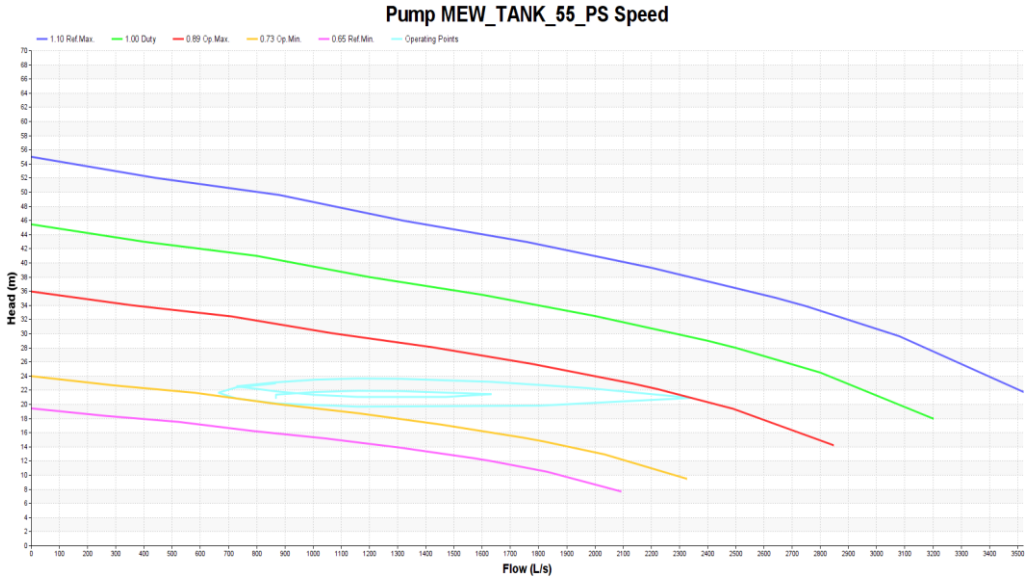


Figure 19- MEW-Tank 55 Pump operating speeds and operation points

Finally, Figure 20 presents the Jamiah pump operating speed and operation points. Similarly, this pump is operating in the range of 0.61-0.83 of its operating speed to maintain the 4 bars pressure in the mentioned above control junction.

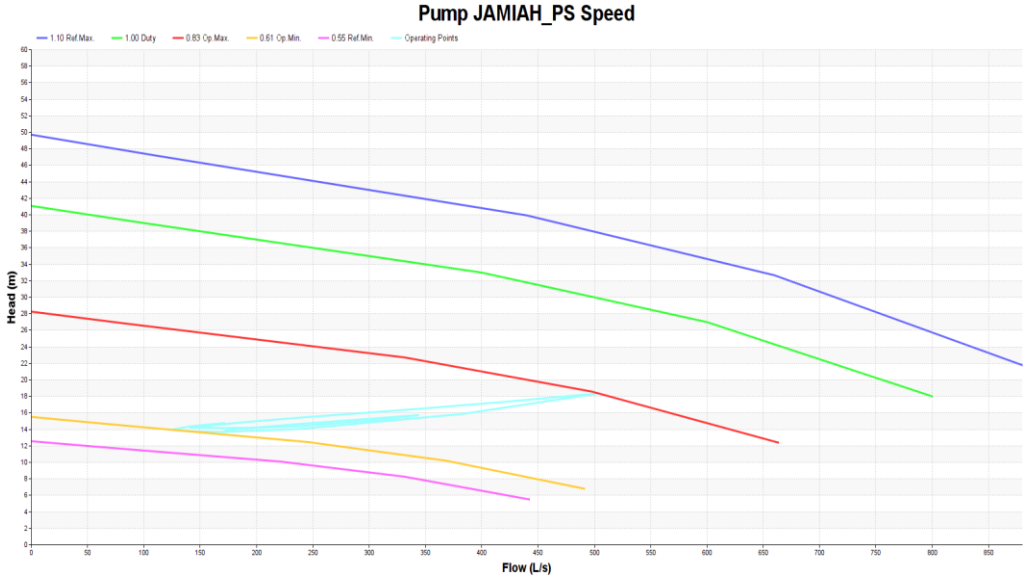
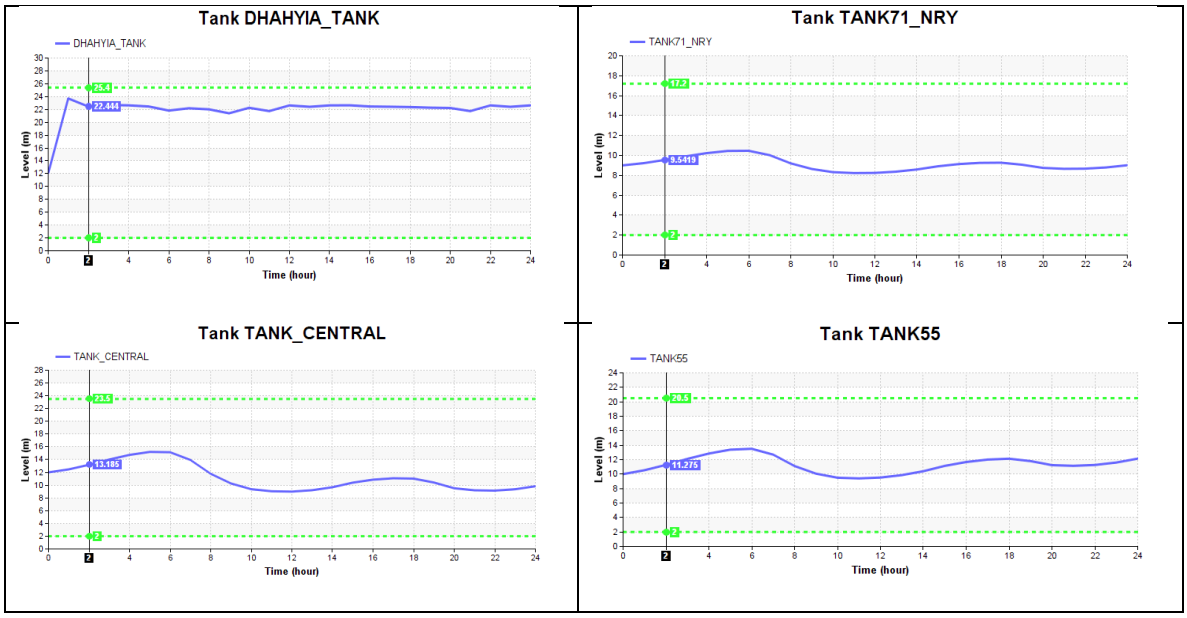


Figure 20- Jamiah Pump operating speeds and operation points

1.4.4 Tanks Levels

Within the Option 2 Scenario, the tank levels have been evaluated. It is assumed that the initial level of the tanks is around half their height. Figure 21 presents the level of the five tanks in the scope of the Dammam 2 and Dammam 5 projects.

As it is evident, the tanks have large capacities to supply the Dammam water system.



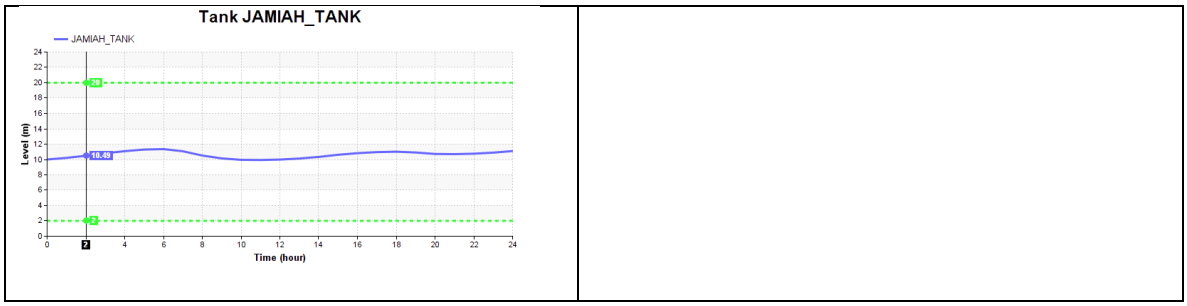


Figure 21- Tanks levels in Dammam 2 and Dammam 5

3.4 Scenario Two – 2050 Average Daily Demand + Fire Flow (2050 ADD+FF)

A second scenario within the proposed Option two setting with Average Daily Demand + Fire Flow has been used to evaluate the performance of the system. The settings remained the same except for the demand. Both the modified and original models are tested against this scenario, and the results are presented in the followings.

3.4.1 Minimal Residual Pressure – Average Daily Demand + Fire Flow

Figure 22 presents the minimum residual pressure at each node under scenario ADD+FF of the original model. The minimum residual pressure in the system is more than 1.5 bar for more than 99 percent of the system. In Dammam projects, the minimum pressure is more than 1.5 bar and the maximum pressure is around 6 bar. Few points with black or blue colours are either extremely near to 1.5 bar, closed or at proximity of the pumps.

Similarly, Figure 23 presents the minimum residual pressure at each node under the scenario 2 modified model. The minimum residual pressure in the system is more than 1.5 bar for more than 99 percent of the system. In Dammam project, the minimum pressure is more than 1.5 bar and the maximum pressure is around 4 bar except for the gravity main 1600 mm from Jamiah where the pressure goes as high as 7 bar.

Comparing the two the model, it can be concluded the modified model performs better in terms of minimum and maximum pressure, head losses, and overall water system energy efficiency.

Figure 24 shows the velocities in the original model for the second scenario. Most of the pipes still have a velocity below 0.3 m/s. Within the scope of the Dammam project, the maximum velocity is 1.4 m/s, while most of the pipes have velocities lower than 0.3 m/s.

Similarly, Figure 25 shows velocities in the modified model for the second scenario. Modification of the model slightly increases the velocity of the overall system within the design criteria. However, most of the system still has a velocity of less

than 0.3 m/s. Within the project scope in Dammam 2 and Dammam 5, the maximum velocity is 1.8 m/s, where few pipes have velocities lower than 0.3 m/s.

Tables 13 and 14 show the junction and pipes properties respectively during this scenario.

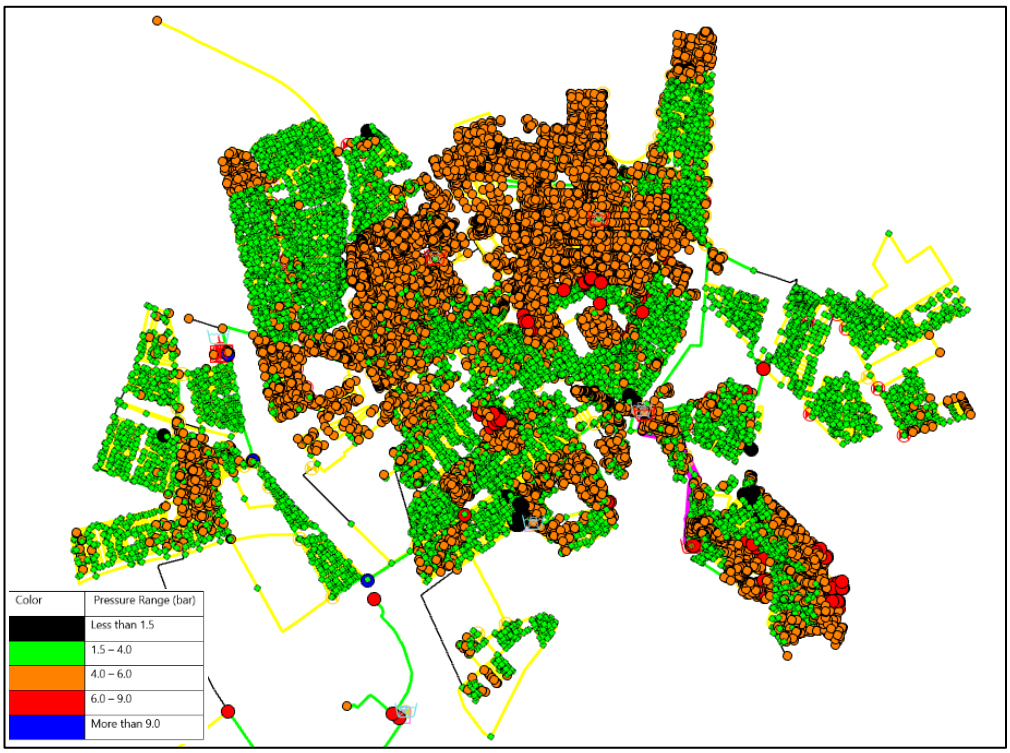


Figure 22- Original Model - Minimum residual pressure of the system (Scenario 2)

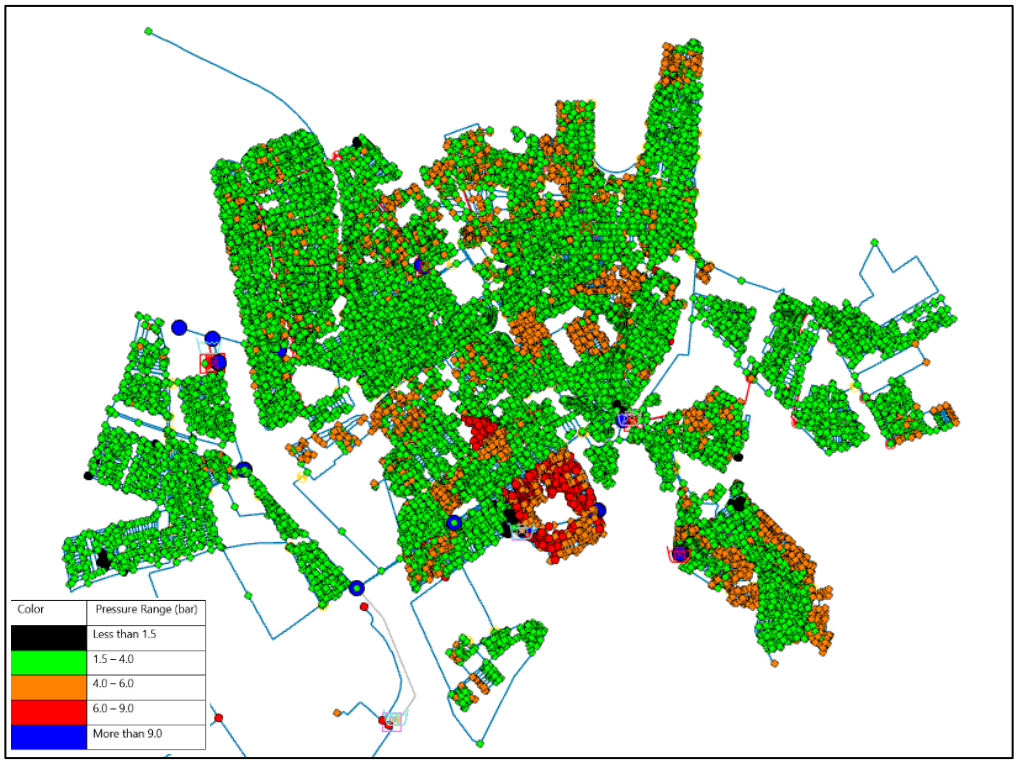


Figure 23- Modified Model - Minimum residual pressure of the system (Scenario 2)

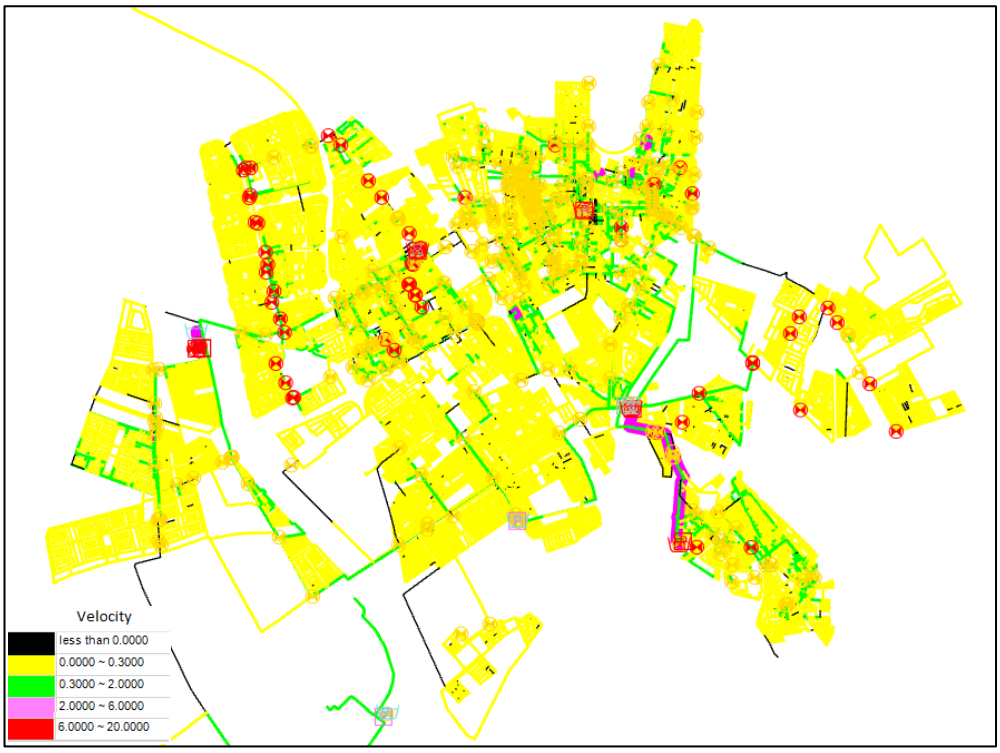


Figure 24- Original Model - Water velocities of Dammam system (Scenario 2)

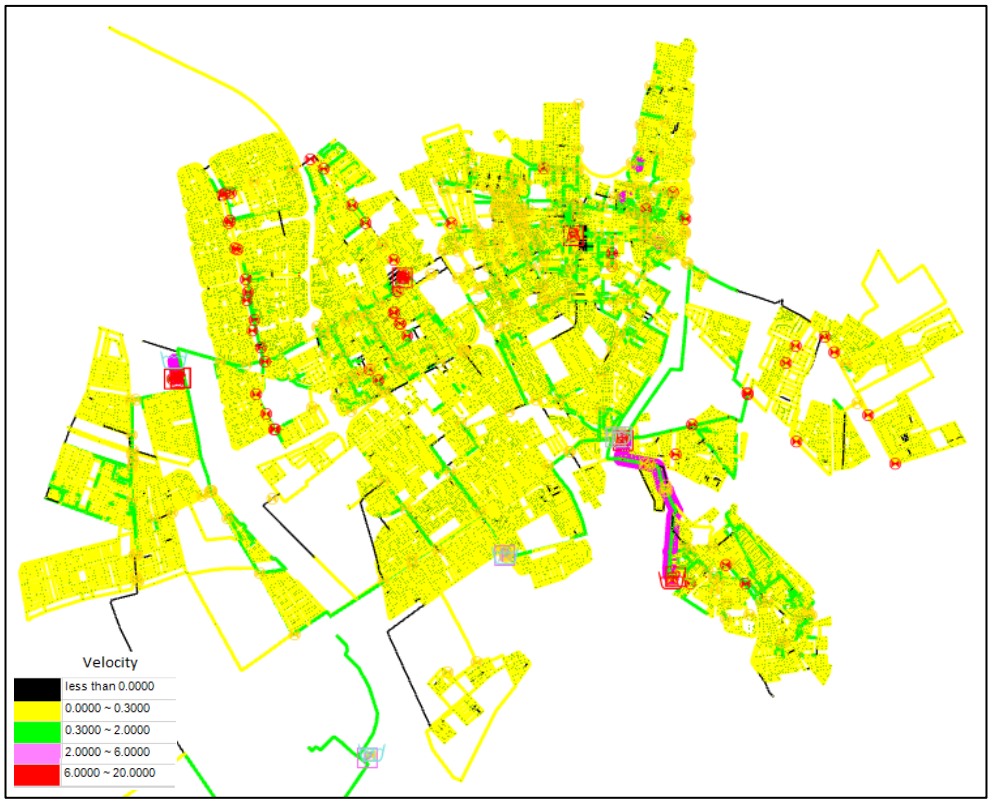


Figure 25- Modified Model - Water velocities of Dammam system (Scenario 2)

Table 13: Table for junctions within Dammam 2 and 5 within scenario 2

ID	Demand (L/s)	Elevation (m)	Head (m)	Pressure (bar)
DMM_JUN_2974	0.0000	5.0000	44.3704	3.8580
DMM_JUN_2970	0.0000	5.0000	44.2215	3.8434
DMM_JUN_2972	0.0000	5.0000	44.2546	3.8466
DMM_JUN_3006	0.0351	5.0000	41.6825	3.5946
DMM_JUN_3004	0.1463	4.0000	41.6708	3.6914
DMM_JUN_3002	0.7181	4.0000	41.6745	3.6918
DMM_JUN_2856	0.2730	5.0000	41.6961	3.5959
DMM_JUN_2858	1.0078	2.0000	41.7947	3.8996
DMM_JUN_3000	1.4850	6.0000	41.8970	3.5176
DMM_3879	0.0059	6.0000	41.8968	3.5176
DMM_JUN_2860	1.8776	3.0000	42.1286	3.8343
DMM_JUN_2854	0.5968	6.0000	42.3593	3.5629
DMM_JUN_2996	0.0456	6.0000	42.3872	3.5657
DMM_JUN_2994	0.0235	6.0000	42.3873	3.5657
DMM_JUN_2852	0.2021	4.0000	42.8325	3.8053
DMM_JUN_3374	0.2107	3.0000	43.0655	3.9261
DMM_JUN_3372	0.7069	3.0000	43.1290	3.9323
DMM_JUN_2626	0.4985	3.0000	43.1866	3.9380
DMM_JUN_2638	0.4363	6.0000	43.1267	3.6381
DMM_JUN_3008	0.0485	5.0000	43.1188	3.7353
DMM_JUN_2690	0.6120	7.0000	43.0547	3.5331
DMM_JUN_3010	0.0774	2.0000	43.0537	4.0229
DMM_JUN_3012	0.3648	6.0000	43.0160	3.6273
DMM_JUN_2636	0.3916	4.0000	42.9379	3.8156
DMM_JUN_3014	0.0563	7.0000	41.2351	3.3548
DMM_JUN_3016	0.2307	5.0000	42.9220	3.7161
DMM_JUN_3024	0.4148	7.0000	42.9126	3.5192
DMM_JUN_3026	0.1571	6.0000	42.8841	3.6144
DMM_JUN_2692	0.8396	6.0000	42.8820	3.6142
DMM_JUN_3020	0.3399	6.0000	42.7774	3.6039
DMM_JUN_2740	0.1641	11.0000	42.5592	3.0926
DMM_JUN_3018	0.0204	4.0000	40.4687	3.5736
DMM_7590	0.0824	10.0000	42.5489	3.1895
DMM_JUN_3022	0.1604	4.0000	42.7695	3.7991
DMM_JUN_3028	0.2898	4.0000	42.8384	3.8059

ID	Demand (L/s)	Elevation (m)	Head (m)	Pressure (bar)
DMM_JUN_2634	0.2652	4.0000	42.8359	3.8056
DMM_JUN_3032	0.0190	4.0000	42.8145	3.8035
DMM_JUN_3030	0.0625	6.0000	42.2175	3.5490
DMM_JUN_3038	0.2288	2.0000	42.8086	3.9989
DMM_JUN_2632	0.2481	2.0000	42.8069	3.9988
DMM_JUN_3040	0.0160	2.0000	42.7822	3.9963
DMM_JUN_3034	0.1113	2.0000	42.7960	3.9977
DMM_JUN_2640	0.5737	2.0000	42.8016	3.9982
DMM_JUN_2654	0.4126	3.0000	42.7991	3.9000
DMM_JUN_2630	0.2215	3.0000	42.7559	3.8958
DMM_JUN_3042	0.3246	2.0000	42.7513	3.9933
DMM_JUN_276	0.1432	5.0000	42.6617	3.6905
DMM_JUN_3044	0.2193	4.0000	42.7439	3.7966
DMM_JUN_3046	0.0614	4.0000	42.7986	3.8020
DMM_JUN_3048	0.0869	4.0000	42.4604	3.7688
DMM_JUN_2730	0.2281	4.0000	42.7943	3.8015
J-14	0.5763	4.3951	42.7942	3.7628
DMM_JUN_2656	0.0000	11.0000	44.9097	3.3229
DMM_JUN_2732	0.0873	5.0000	44.9097	3.9108
DMM_JUN_3052	0.0250	4.0000	44.9097	4.0088
DMM_JUN_3054	0.0469	4.0000	42.3591	3.7589
DMM_JUN_2734	0.1024	3.0000	44.9097	4.1068
DMM_JUN_3058	0.0151	2.0000	44.9097	4.2048
DMM_JUN_3378	0.0326	7.0000	44.9097	3.7149
DMM_JUN_3376	0.0152	7.0000	44.1204	3.6375
DMM_JUN_3062	0.0071	3.0000	44.9097	4.1068
DMM_JUN_2736	1.7654	1.0000	44.9107	4.3029
DMM_JUN_3064	0.1097	7.0000	44.9141	3.7153
DMM_JUN_3066	0.0043	7.0000	44.9055	3.7144
DMM_JUN_3070	0.0164	7.0000	44.9049	3.7144
DMM_JUN_3068	0.0190	7.0000	44.9039	3.7143
DMM_JUN_2738	0.4094	18.0000	44.9230	2.6382
DMM_2915	0.0043	12.0000	44.9195	3.2258
DMM_JUN_2976	0.5247	6.0000	44.9350	3.8153
DMM_JUN_2980	0.6324	6.0000	44.9387	3.8157

ID	Demand (L/s)	Elevation (m)	Head (m)	Pressure (bar)
DMM_JUN_2962	0.0000	6.0000	195.0820	18.5285
DMM_JUN_2978	2.5945	6.0000	44.9195	3.8138
J52	0.0000	0.0000	17.2629	1.6916
J54	0.0000	0.0000	17.2611	1.6914
DMM_JUN_2960	0.0000	3.0000	195.0967	18.8240
DMM_JUN_3284	1.2171	10.0000	44.7288	3.4031
DMM_JUN_3282	0.2364	10.0000	44.7320	3.4035
DMM_JUN_2390	0.0268	10.0000	44.7312	3.4034
DMM_JUN_2392	0.0241	15.0000	44.7305	2.9134
DMM_3406	0.0043	15.0000	44.7303	2.9133
DMM_JUN_3348	0.0597	15.0000	44.7303	2.9133
DMM_JUN_3350	0.4452	15.0000	44.7214	2.9125
DMM_JUN_2394	0.0719	15.0000	44.7045	2.9108
DMM_JUN_2814	0.1696	11.0000	44.7267	3.3049
DMM_JUN_3288	0.3654	12.0000	44.7161	3.2059
DMM_JUN_3286	0.2375	12.0000	44.7096	3.2053
DMM_JUN_2816	0.3325	12.0000	44.7140	3.2057
DMM_JUN_3290	0.3374	13.0000	44.7083	3.1072
DMM_JUN_3292	0.2864	13.0000	44.7094	3.1073
J30	0.0000	13.0000	44.0571	3.0434
DMM_JUN_3300	0.2066	10.0000	44.7061	3.4009
DMM_JUN_3298	0.1588	10.0000	44.7047	3.4008
J28	0.0000	10.0000	43.8100	3.3131
DMM_JUN_2818	0.6159	14.0000	44.7058	3.0089
DMM_JUN_2812	0.3409	14.0000	44.7050	3.0089
DMM_JUN_3296	1.7522	14.0000	44.7042	3.0088
DMM_JUN_3294	0.7787	14.0000	44.7013	3.0085
DMM_JUN_3354	0.2799	12.0000	42.5697	2.9956
DMM_JUN_3360	0.0030	11.0000	42.6218	3.0987
DMM_JUN_3358	0.1563	11.0000	42.6213	3.0986
DMM_JUN_3356	0.1507	11.0000	42.6234	3.0988
DMM_JUN_2806	1.0504	9.0000	42.6589	3.2983
DMM_2856	0.4120	12.0000	42.3916	2.9781
DMM_JUN_3380	0.2336	9.0000	42.6934	3.3017
DMM_JUN_3382	0.3355	9.0000	42.6864	3.3010

ID	Demand (L/s)	Elevation (m)	Head (m)	Pressure (bar)
DMM_JUN_3302	0.3353	3.0000	43.8902	4.0069
DMM_JUN_2294	0.0232	3.0000	43.8913	4.0070
DMM_JUN_2810	0.3590	12.0000	43.1629	3.0537
DMM_JUN_3352	0.1291	12.0000	43.1535	3.0528
DMM_846	0.2362	17.0000	45.9942	2.8412
DMM_JUN_3138	0.0523	11.0000	46.0466	3.4343
DMM_JUN_3384	0.0644	4.0000	46.0384	4.1194
DMM_JUN_3142	0.1988	6.0000	46.0896	3.9285
DMM_JUN_2744	0.2164	6.0000	46.0890	3.9284
DMM_JUN_3386	0.2190	6.0000	46.0282	3.9225
DMM_JUN_2746	0.2976	2.0000	46.1635	4.3277
DMM_JUN_3148	0.8870	8.0000	46.3514	3.7581
DMM_JUN_3146	0.0756	8.0000	46.2768	3.7508
DMM_JUN_2762	0.1394	5.0000	46.6191	4.0783
DMM_JUN_3388	0.1076	7.0000	46.5892	3.8794
DMM_2002	0.0565	3.0000	46.4428	4.2571
DMM_JUN_2764	0.0341	6.0000	46.7670	3.9948
DMM_JUN_3150	0.0273	2.0000	46.7195	4.3822
DMM_JUN_2766	0.4793	4.0000	46.8164	4.1957
DMM_JUN_2768	0.0509	5.0000	47.1409	4.1295
DMM_JUN_3152	0.0558	5.0000	47.1170	4.1271
DMM_JUN_2982	0.0534	5.0000	47.8345	4.1974
J58	0.0000	0.0000	16.4239	1.6094
DMM_JUN_2986	0.0512	5.0000	47.8461	4.1986
J56	0.0000	0.0000	16.4264	1.6097
DMM_JUN_2944	0.0000	7.0000	84.6447	7.6086
DMM_JUN_2942	0.0000	10.0000	85.6196	7.4101
DMM_JUN_2940	0.0000	12.0000	86.0628	7.2576
DMM_JUN_2938	0.0000	9.0000	86.2517	7.5701
DMM_JUN_2936	0.0000	16.0000	86.5945	6.9177
DMM_JUN_2934	0.0000	12.0000	87.0282	7.3522
DMM_JUN_2932	0.0000	21.0000	87.8064	6.5465
DMM_JUN_2930	0.0000	29.0000	89.1945	5.8986
DMM_JUN_3280	0.0000	33.0000	89.3425	5.5211
DMM_JUN_2428	0.0000	32.0000	89.3049	5.6154

ID	Demand (L/s)	Elevation (m)	Head (m)	Pressure (bar)
DMM_19836	0.0000	38.0000	89.2759	5.0246
J60	0.0000	37.0000	45.7778	0.8602
J62	0.0000	0.0000	45.7833	4.4864
DMM_JUN_3276	0.0000	37.0000	45.7599	0.8584
DMM_JUN_3278	0.0375	38.0000	68.0165	2.9414
DMM_JUN_3174	0.0203	30.0000	45.6973	1.5382
DMM_1160	0.0138	31.0000	68.0011	3.6258
21665-B	0.0000	27.0000	68.0003	4.0177
DMM_JUN_2794	5.6043	27.0000	67.8086	3.9989
DMM_JUN_2796	0.0231	33.0000	67.8070	3.4108
DMM_JUN_3176	0.0050	31.0000	67.8065	3.6067
DMM_JUN_2678	0.0094	16.0000	67.7301	5.0691
DMM_JUN_3418	0.0040	15.0000	50.9515	3.5230
DMM_JUN_2680	0.0250	14.0000	67.6268	5.2550
DMM_6709	0.5874	19.0000	50.6556	3.1020
DMM_JUN_2790	0.6767	21.0000	67.6047	4.5669
DMM_JUN_3182	0.0363	21.0000	48.2157	2.6669
DMM_JUN_2788	0.1454	10.0000	41.6257	3.0991
J-23	0.0000	10.2337	67.5137	5.6130
DMM_6915	0.0154	15.0000	41.6151	2.6081
DMM_JUN_3186	0.1001	16.0000	41.5188	2.5006
DMM_JUN_2684	0.0563	10.0000	41.4345	3.0803
DMM_JUN_3188	0.0121	5.0000	41.4311	3.5700
DMM_JUN_2682	0.0961	5.0000	41.3968	3.5666
DMM_5853	0.1407	5.0000	41.3935	3.5663
DMM_JUN_3190	0.0747	7.0000	41.3452	3.3656
DMM_JUN_3192	0.0737	2.3782	41.3065	3.8147
DMM_JUN_3194	0.0170	5.5318	41.3003	3.5050
DMM_5301	0.1077	4.0000	41.2784	3.6530
DMM_JUN_2802	0.1548	3.0000	41.2809	3.7512
197	0.0092	5.3500	41.2545	3.5184
10789	0.0442	5.1300	41.2541	3.5399
5447	0.0074	2.0000	41.2467	3.8459
10800	0.0043	2.0000	41.2467	3.8459
10795	0.0000	1.7300	41.2544	3.8731

ID	Demand (L/s)	Elevation (m)	Head (m)	Pressure (bar)
196	0.0000	1.7000	41.2544	3.8760
DMM_JUN_3184	0.0875	9.0000	41.4829	3.1831
DMM_3337	0.0941	7.0000	46.9966	3.9194
DMM_JUN_3320	0.0635	7.0000	46.9874	3.9185
DMM_JUN_2984	0.1823	5.0000	47.8403	4.1980
DMM_JUN_2776	0.9853	11.0000	47.6181	3.5883
DMM_JUN_2778	0.4409	17.0000	47.4887	2.9876
DMM_JUN_3158	0.3149	17.0000	47.4690	2.9857
DMM_JUN_2884	1.3250	17.0000	47.4808	2.9869
DMM_JUN_2780	0.0204	8.0000	47.2174	3.8430
DMM_JUN_3160	0.1725	8.0000	47.2058	3.8419
DMM_1813	0.2215	5.0000	47.1648	4.1318
DMM_17921	0.0830	9.0000	39.7291	3.0112
DMM_JUN_2782	0.1246	5.0000	47.1261	4.1280
DMM_JUN_3162	0.0027	2.0000	47.0817	4.4176
DMM_JUN_3416	0.0751	7.0000	47.1034	3.9298
DMM_JUN_3414	0.0857	7.0000	46.9720	3.9169
DMM_JUN_3164	0.0345	7.0000	47.1010	3.9296
DMM_12447	0.1252	8.0000	37.0701	2.8486
DMM_JUN_3312	0.2295	4.0000	47.0967	4.2231
DMM_JUN_2600	0.0000	4.0000	47.0964	4.2231
DMM_3191	0.3241	7.0000	46.6945	3.8897
DMM_1781	0.5706	8.0000	46.5831	3.7808
DMM_JUN_3316	0.0082	5.0000	47.0904	4.1245
DMM_JUN_3318	0.0552	5.0000	47.0894	4.1244
DMM_JUN_3314	0.0672	4.0000	47.0900	4.2225
DMM_JUN_3156	0.3694	17.0000	47.1251	2.9520
DMM_JUN_3154	0.2991	17.0000	46.9532	2.9352
DMM_JUN_3178	0.0206	37.0000	67.8000	3.0182
DMM_6695	0.0180	38.0000	67.7999	2.9202
DMM_JUN_2926	0.0000	38.0000	89.5274	5.0493
DMM_JUN_2928	0.0000	35.0000	89.7092	5.3611
DMM_JUN_2924	0.0000	35.0000	89.8719	5.3770
DMM_JUN_2922	0.0000	42.0000	91.0286	4.8044
DMM_JUN_2918	0.0000	40.0000	96.4467	5.5313

ID	Demand (L/s)	Elevation (m)	Head (m)	Pressure (bar)
DMM_JUN_2920	0.0000	80.0000	100.9683	2.0547
DMM_14474	0.0207	89.0000	115.4519	2.5921
DMM_JUN_2846	1.1782	89.0000	115.4520	2.5921
DMM_6953	0.0383	42.0000	68.0096	2.5487
DMM_JUN_3260	270.1328	80.0000	100.9104	2.0491
DMM_JUN_2844	0.0200	89.0000	115.5018	2.5970
DMM_5840	0.0000	89.0000	115.5017	2.5970
DMM_5339	0.1408	91.0000	115.4713	2.3980
DMM_JUN_2840	0.4230	95.0000	115.4716	2.0061
DMM_5340	0.1346	74.0000	115.2865	4.0458
DMM_JUN_2838	0.7172	71.0000	115.2865	4.3397
DMM_JUN_2842	0.0540	53.0000	83.1302	2.9525
DMM_5812	0.0233	51.0000	76.8086	2.5290
J-49	0.1417	53.0000	83.6039	2.9989

Table 14: Table for pipes within Dammam 2 and 5 within scenario 2

ID	From Node	To Node	Length (m)	Diameter (mm)	Roughness (mm)	Flow (L/s)	Velocity (m/s)	Headloss (m)	HL/1000 (m/k-m)	Status
P-30	FCV-3	DHAHYIA_TANK	158.1679	2,000.0000	0.3000	18,004.6801	5.7311	0.8422	5.3250	Open
P-29	DHAHIYASTRATEGICTANK	FCV-3	420.1012	2,000.0000	0.3000	18,004.6801	5.7311	2.2370	5.3250	Open
DHAHIYA_OUTLET	DHAHYIA_TANK	DHAHYIA_PUMP	90.4825	1,400.0000	0.3000	886.0026	0.5756	0.0165	0.1824	Open
P11	DHAHYIA_TANK	IAHIYASTRATEGICOPTION2P	105.0086	1,600.0000	0.3000	3,700.0106	1.8402	0.1585	1.5098	Open
P15	DHAHYIA_TANK	IAHIYASTRATEGICOPTION2P	104.0323	1,600.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Closed
P17	HIYASTRATEGICOPTION2	J-68	109.0136	1,600.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Closed
P13	HIYASTRATEGICOPTION2	DMM_JUN_2900	108.7711	1,600.0000	0.3000	3,700.0106	1.8402	0.1642	1.5097	Open
DMM_PIP_3041	DMM_VAL_8180	DMM_JUN_2974	88.9742	1,400.0000	0.3000	886.0026	0.5756	0.0162	0.1824	Open
DMM_PIP_3039	DHAHYIA_PUMP	DMM_VAL_8180	86.3150	1,400.0000	0.3000	886.0026	0.5756	0.0157	0.1824	Open
DMM_PIP_2095	DMM_JUN_2974	DMM_VAL_8188	328.9556	1,000.0000	0.3000	474.2593	0.6038	0.0990	0.3008	Open
DMM_PIP_2143	DMM_JUN_2974	DMM_VAL_8190	312.4777	1,000.0000	0.3000	411.7433	0.5242	0.0715	0.2288	Open
DMM_PIP_3059	DMM_VAL_8190	DMM_JUN_2972	193.3053	1,000.0000	0.3000	411.7433	0.5242	0.0442	0.2289	Open
DMM_PIP_3057	DMM_VAL_8188	DMM_JUN_2970	165.8876	1,000.0000	0.3000	474.2593	0.6038	0.0499	0.3008	Open
P19	J-68	DMM_JUN_2900	11.0483	1,600.0000	0.3000	-1,139.9952	0.5670	0.0017	0.1515	Open
DMM_PIP_3109A	DMAV34	DMM_JUN_3002	151.4414	400.0000	0.3000	15.4827	0.1232	0.0069	0.0455	Open
DMM_PIP_3109	DMM_JUN_3006	DMAV34	23.4707	400.0000	0.3000	15.4827	0.1232	0.0011	0.0456	Open
DMM_PIP_3107	DMM_JUN_3006	DMAV35	17.5910	400.0000	0.3000	32.3834	0.2577	0.0032	0.1811	Open
DMM_PIP_2761	DMM_JUN_2856	DMM_JUN_3006	35.6976	400.0000	0.3000	47.9012	0.3812	0.0136	0.3815	Open
DMM_PIP_3107A	DMAV35	DMM_JUN_3004	46.7041	400.0000	0.3000	32.3834	0.2577	0.0085	0.1811	Open
DMM_PIP_2747	DMM_JUN_2858	DMM_JUN_2856	255.6478	400.0000	0.3000	48.1742	0.3834	0.0986	0.3857	Open
DMM_PIP_3099	DMM_JUN_3000	DMM_JUN_2858	255.0532	400.0000	0.3000	49.1820	0.3914	0.1023	0.4013	Open
DMM_PIP_3101	DMM_JUN_3000	DMAV33	2.5392	400.0000	0.3000	13.8220	0.1100	0.0001	0.0366	Open
DMM_PIP_2749	DMM_JUN_2860	DMM_JUN_3000	342.7624	400.0000	0.3000	64.4889	0.5132	0.2315	0.6754	Open
DMM_PIP_3101A	DMAV33	DMM_3879	5.0712	400.0000	0.3000	13.8220	0.1100	0.0002	0.0376	Open
DMM_8544	DMM_3563	DMM_3879	0.6716	197.3000	0.3000	-13.8160	0.4519	0.0009	1.2743	Open
DMM_PIP_2745	DMM_JUN_2854	DMM_JUN_2860	323.1590	400.0000	0.3000	66.3665	0.5281	0.2307	0.7139	Open
DMM_PIP_3093	DMM_JUN_2996	DMM_JUN_2854	38.4895	400.0000	0.3000	66.9633	0.5329	0.0280	0.7263	Open
DMM_PIP_3095	DMM_JUN_2996	DMAV32	5.2456	400.0000	0.3000	-4.4383	0.0353	0.0000	0.0044	Open
DMM_PIP_2743	DMM_JUN_2852	DMM_JUN_2996	698.8017	400.0000	0.3000	62.5706	0.4979	0.4453	0.6373	Open
DMM_PIP_3095A	DMAV32	DMM_JUN_2994	18.5296	400.0000	0.3000	-4.4383	0.0353	0.0001	0.0048	Open
DMM_PIP_3675	DMM_JUN_3372	DMM_JUN_2852	462.3809	400.0000	0.3000	62.7727	0.4995	0.2965	0.6412	Open
DMM_PIP_3089	DMM_JUN_3372	DMAV30	55.0482	400.0000	0.3000	35.4143	0.2818	0.0118	0.2145	Open
DMM_PIP_3089A	DMAV30	DMM_JUN_3374	241.1596	400.0000	0.3000	35.4143	0.2818	0.0517	0.2146	Open
DMM_PIP_2137	DMM_JUN_2626	DMM_JUN_3372	37.2392	400.0000	0.3000	98.8938	0.7870	0.0576	1.5465	Open
DMM_PIP_3113	DMM_JUN_2638	DMAV42	22.7195	400.0000	0.3000	21.6481	0.1723	0.0019	0.0850	Open

ID	From Node	To Node	Length (m)	Diameter (mm)	Roughness (mm)	Flow (L/s)	Velocity (m/s)	Headloss (m)	HL/1000 (m/k-m)	Status
DMM_PIP_2109	DMM_JUN_2638	DMM_JUN_2690	593.2417	1,000.0000	0.3000	296.1703	0.3771	0.0720	0.1214	Open
DMM_PIP_2097	DMM_JUN_2626	DMM_JUN_2638	429.6359	1,000.0000	0.3000	318.2547	0.4052	0.0599	0.1393	Open
DMM_PIP_3113A	DMAV42	DMM_JUN_3008	70.4685	400.0000	0.3000	21.6481	0.1723	0.0060	0.0849	Open
DMM_PIP_3117	DMM_JUN_2690	DMAV37	125.8354	400.0000	0.3000	2.5669	0.0204	0.0002	0.0018	Open
DMM_PIP_2277	DMM_JUN_2690	DMM_JUN_3012	326.2218	1,000.0000	0.3000	292.9914	0.3730	0.0388	0.1189	Open
DMM_PIP_3117A	DMAV37	DMM_JUN_3010	430.3304	400.0000	0.3000	2.5669	0.0204	0.0008	0.0018	Open
DMM_PIP_3123	DMM_JUN_3012	DMAV43	25.0933	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Open
DMM_PIP_3119	DMM_JUN_3012	DMM_JUN_2636	658.4426	1,000.0000	0.3000	292.6266	0.3726	0.0781	0.1186	Open
DMM_PIP_3127	DMM_JUN_2636	DMAV38	69.2475	400.0000	0.3000	22.5228	0.1792	0.0063	0.0915	Open
DMM_PIP_2107	DMM_JUN_2636	DMM_JUN_3024	249.0059	1,000.0000	0.3000	269.7122	0.3434	0.0253	0.1015	Open
DMM_PIP_3127A	DMAV38	DMM_JUN_3016	103.8293	400.0000	0.3000	22.5228	0.1792	0.0095	0.0914	Open
DMM_PIP_3123A	DMAV43	DMM_JUN_3014	70.4380	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Open
DMM_PIP_3139	DMM_JUN_3024	DMAV44	31.2033	400.0000	0.3000	40.5215	0.3225	0.0087	0.2772	Open
DMM_PIP_3139A	DMAV44	DMM_JUN_3026	71.4614	400.0000	0.3000	40.5215	0.3225	0.0198	0.2772	Open
DMM_PIP_3135	DMM_JUN_3024	DMM_JUN_2692	412.3026	1,000.0000	0.3000	228.7760	0.2913	0.0306	0.0741	Open
DMM_PIP_2427	DMM_JUN_2692	DMAV45	52.7775	400.0000	0.3000	52.2161	0.4155	0.0238	0.4500	Open
DMM_PIP_2287	DMM_JUN_2692	DMM_JUN_3028	972.3816	1,000.0000	0.3000	175.7203	0.2237	0.0437	0.0449	Open
DMM_PIP_2427A	DMAV45	DMM_JUN_3020	179.8362	400.0000	0.3000	52.2161	0.4155	0.0809	0.4500	Open
DMM_PIP_3131	DMM_JUN_3020	DMM_JUN_2740	1,541.3807	400.0000	0.3000	28.4223	0.2262	0.2182	0.1415	Open
DMM_PIP_2289	DMM_JUN_3020	DMM_JUN_3022	79.8294	400.0000	0.3000	23.4538	0.1866	0.0079	0.0987	Open
DMM_PIP_2431	DMM_JUN_2740	DMM_JUN_3018	109.8553	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Closed
DMM_PIP_2429	DMM_JUN_2740	DMM_7590	73.1603	400.0000	0.3000	28.2582	0.2249	0.0102	0.1400	Open
DMM_PIP_3145	DMM_JUN_3028	DMAV46	25.3978	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Open
DMM_PIP_3141	DMM_JUN_3028	DMM_JUN_2634	55.3791	1,000.0000	0.3000	175.4305	0.2234	0.0025	0.0448	Open
DMM_PIP_3145A	DMAV46	DMM_JUN_3030	81.4981	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Open
DMM_PIP_2129	DMM_JUN_2634	DMAV39	48.3822	400.0000	0.3000	27.0679	0.2154	0.0062	0.1291	Open
DMM_PIP_2105	DMM_JUN_2634	DMM_JUN_3038	838.2071	1,000.0000	0.3000	148.0975	0.1886	0.0273	0.0325	Open
DMM_PIP_2129A	DMAV39	DMM_JUN_3032	117.4084	400.0000	0.3000	27.0679	0.2154	0.0152	0.1291	Open
DMM_PIP_3151	DMM_JUN_3038	DMM_JUN_2632	68.6345	1,000.0000	0.3000	127.4503	0.1623	0.0017	0.0245	Open
DMM_PIP_2125	DMM_JUN_3038	DMAV40	50.4294	400.0000	0.3000	20.4183	0.1625	0.0038	0.0762	Open
DMM_PIP_2125A	DMAV40	DMM_JUN_3034	115.9837	400.0000	0.3000	20.4183	0.1625	0.0088	0.0761	Open
DMM_PIP_2127	DMM_JUN_2632	DMAV48	12.0192	400.0000	0.3000	49.6854	0.3954	0.0049	0.4094	Open
DMM_PIP_2103	DMM_JUN_2632	DMM_JUN_2640	551.5128	1,000.0000	0.3000	77.5168	0.0987	0.0054	0.0097	Open
DMM_PIP_2127A	DMAV48	DMM_JUN_3040	48.4536	400.0000	0.3000	49.6854	0.3954	0.0198	0.4092	Open
DMM_PIP_2121	DMM_JUN_2640	DMM_JUN_2654	255.3563	1,000.0000	0.3000	76.9431	0.0980	0.0025	0.0096	Open

ID	From Node	To Node	Length (m)	Diameter (mm)	Roughness (mm)	Flow (L/s)	Velocity (m/s)	Headloss (m)	HL/1000 (m/k-m)	Status
DMM_PIP_2183	DMM_JUN_2654	DMM_JUN_3046	257.0146	1,000.0000	0.3000	32.8270	0.0418	0.0005	0.0020	Open
DMM_PIP_2181	DMM_JUN_2654	DMAV41	40.2069	400.0000	0.3000	43.7035	0.3478	0.0129	0.3201	Open
DMM_PIP_2181A	DMAV41	DMM_JUN_2630	94.8501	400.0000	0.3000	43.7035	0.3478	0.0304	0.3202	Open
DMM_PIP_2101	DMM_JUN_2630	DMM_JUN_3042	61.5293	400.0000	0.3000	20.1099	0.1600	0.0046	0.0740	Open
P761	DMM_JUN_2630	DMAV294	194.9822	300.0000	0.1000	23.3721	0.3306	0.0715	0.3666	Open
DMM_PIP_3159	DMM_JUN_3042	DMM_JUN_3044	104.0888	400.0000	0.3000	19.7853	0.1574	0.0075	0.0718	Open
P763	DMAV294	DMM_JUN_276	61.9644	300.0000	0.1000	23.3721	0.3306	0.0227	0.3666	Open
DMM_PIP_3165	DMM_JUN_3046	DMAV49	18.3973	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Open
DMM_PIP_3161	DMM_JUN_3046	DMM_JUN_2730	2,128.0051	1,000.0000	0.3000	32.7655	0.0417	0.0043	0.0020	Open
DMM_PIP_3165A	DMAV49	DMM_JUN_3048	53.9475	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Open
DMM_PIP_3169	DMM_JUN_2730	DMM_JUN_3050	52.1965	400.0000	0.3000	22.1976	0.1766	0.0046	0.0890	Open
DMM_PIP_2397(1)	DMM_JUN_2730	J-14	249.3805	1,000.0000	0.3000	10.3399	0.0132	0.0001	0.0003	Open
DMM_PIP_2245	DMM_VAL_8152	DMM_JUN_2656	170.1767	1,000.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Open
DMM_PIP_2397(2)	J-14	DMM_VAL_8152	381.3947	1,000.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Closed
DMM_PIP_2185	DMM_JUN_2656	DMM_JUN_2732	209.3597	1,000.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Open
DMM_PIP_2407	DMM_JUN_2732	DMM_JUN_3052	288.7430	1,000.0000	0.3000	-0.0873	0.0001	0.0000	0.0000	Open
DMM_PIP_3171	DMM_JUN_3052	DMM_JUN_2734	660.2352	1,000.0000	0.3000	-0.1123	0.0001	0.0000	0.0000	Open
DMM_PIP_2409	DMM_JUN_3052	DMAV292	15.8176	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Open
P757	DMAV292	DMM_JUN_3054	12.9162	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Open
DMM_PIP_2411	DMM_JUN_2734	DMM_JUN_3058	335.9824	1,000.0000	0.3000	-0.2147	0.0003	0.0000	0.0000	Open
DMM_PIP_3177	DMM_JUN_3058	DMM_JUN_3378	483.5338	1,000.0000	0.3000	-0.2298	0.0003	0.0000	0.0000	Open
DMM_PIP_3681	DMM_JUN_3378	DMM_JUN_3062	700.9806	1,000.0000	0.3000	-0.2624	0.0003	0.0000	0.0000	Open
DMM_PIP_3179	DMM_JUN_3378	DMAV293	6.8567	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Open
P759	DMAV293	DMM_JUN_3376	18.9144	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Open
DMM_PIP_3185	DMM_JUN_3062	DMAV51	13.7876	400.0000	0.3000	52.1696	0.4152	0.0062	0.4490	Open
DMM_PIP_3185A	DMAV51	DMM_JUN_3060	25.2030	400.0000	0.3000	52.1696	0.4152	0.0113	0.4492	Open
DMM_PIP_3183	DMM_JUN_3062	DMM_JUN_2736	204.8566	1,000.0000	0.3000	-52.4391	0.0668	0.0010	0.0047	Open
DMM_PIP_2417	DMM_JUN_2736	DMM_JUN_3064	679.5434	1,000.0000	0.3000	-54.2044	0.0690	0.0034	0.0050	Open
DMM_PIP_3193	DMM_JUN_3064	DMM_JUN_3066	27.3053	400.0000	0.3000	43.3664	0.3451	0.0086	0.3154	Open
DMM_PIP_3187	DMM_JUN_3064	DMM_JUN_2738	593.0266	1,000.0000	0.3000	-97.6805	0.1244	0.0089	0.0149	Open
DMM_PIP_3197	DMM_JUN_3066	DMM_JUN_3070	11.8099	400.0000	0.3000	16.2573	0.1294	0.0006	0.0500	Open
DMM_PIP_3195	DMM_JUN_3066	DMM_JUN_3068	11.9030	400.0000	0.3000	27.1047	0.2157	0.0015	0.1293	Open
DMM_PIP_3199	DMM_JUN_2738	DMAV53	14.2963	400.0000	0.3000	19.1973	0.1528	0.0010	0.0680	Open
DMM_JUN_2738A	DMAV53	DMM_2915	37.0639	400.0000	0.3000	19.1973	0.1528	0.0025	0.0679	Open
DMM_PIP_3053	DMM_VAL_8184	DMM_JUN_2976	42.8756	1,000.0000	0.3000	117.8119	0.1500	0.0009	0.0212	Open

ID	From Node	To Node	Length (m)	Diameter (mm)	Roughness (mm)	Flow (L/s)	Velocity (m/s)	Headloss (m)	HL/1000 (m/k-m)	Status
DMM_PIP_2421	DMM_JUN_2738	DMM_JUN_2976	572.1145	1,000.0000	0.3000	-117.2872	0.1493	0.0120	0.0210	Open
DMM_PIP_3043	DMM_JUN_2980	DMM_VAL_8184	132.4107	1,000.0000	0.3000	117.8119	0.1500	0.0028	0.0212	Open
TANK71OUTLET	DMM_VAL_8182	DMM_JUN_2980	24.8994	1,400.0000	0.3000	1,009.2369	0.6556	0.0059	0.2350	Open
DMM_PIP_3049	TANK_71_PS	DMM_VAL_8182	13.6756	1,400.0000	0.3000	1,009.2369	0.6556	0.0032	0.2347	Open
DMM_PIP_2201	DMM_JUN_2980	DMM_VAL_8186	31.3356	1,200.0000	0.3000	890.7926	0.7876	0.0127	0.4042	Open
P813	J54	TANK_71_PS	15.5040	1,400.0000	0.3000	1,009.2369	0.6556	0.0036	0.2348	Open
DMM_PIP_3055	DMM_VAL_8186	DMM_JUN_2978	16.1688	1,200.0000	0.3000	890.7926	0.7876	0.0065	0.4044	Open
DMM_PIP_3529	DMM_JUN_2978	DMM_JUN_3282	590.1604	1,000.0000	0.3000	487.7268	0.6210	0.1874	0.3176	Open
DMM_PIP_3537	DMM_VAL_8246	DMM_JUN_3284	11.5117	1,000.0000	0.3000	282.0519	0.3591	0.0013	0.1107	Open
DMM_PIP_3535	DMM_JUN_3282	DMM_VAL_8246	18.0664	1,000.0000	0.3000	282.0519	0.3591	0.0020	0.1104	Open
DMM_PIP_3533	DMM_JUN_3284	DMM_JUN_2394	36.0959	700.0000	0.3000	280.8348	0.7297	0.0242	0.6709	Open
DMM_PIP_3531	DMM_JUN_3282	DMM_JUN_2390	13.3610	1,000.0000	0.3000	205.4385	0.2616	0.0008	0.0602	Open
DMM_PIP_1137	DMM_JUN_2390	DMM_JUN_2392	31.7794	1,200.0000	0.3000	205.4116	0.1816	0.0008	0.0243	Open
DMM_PIP_1143	DMM_JUN_2392	DMM_3406	6.5543	1,200.0000	0.3000	205.3875	0.1816	0.0002	0.0241	Open
DMM_PIP_2617	DMM_3406	DMM_JUN_3348	0.7164	1,000.0000	0.3000	180.7807	0.2302	0.0000	0.0519	Open
DMM_PIP_3631	DMM_JUN_3348	DMM_VAL_8248	19.9899	400.0000	0.3000	34.6065	0.2754	0.0041	0.2052	Open
DMM_PIP_3627	DMM_JUN_3348	DMM_JUN_2814	113.1321	1,000.0000	0.3000	146.1144	0.1860	0.0036	0.0317	Open
DMM_PIP_3633	DMM_VAL_8248	DMM_JUN_3350	23.1385	400.0000	0.3000	34.6065	0.2754	0.0048	0.2054	Open
DMM_PIP_2621	DMM_JUN_2814	DMM_JUN_3288	333.1554	1,000.0000	0.3000	145.9449	0.1858	0.0105	0.0316	Open
DMM_PIP_3541	DMM_JUN_3288	DMM_JUN_2816	149.5690	1,000.0000	0.3000	96.0074	0.1222	0.0022	0.0145	Open
DMM_PIP_2627	DMM_JUN_3288	DMM_JUN_3286	16.0531	400.0000	0.3000	49.5721	0.3945	0.0065	0.4073	Open
DMM_PIP_2623	DMM_JUN_2816	DMM_JUN_3292	321.1077	1,000.0000	0.3000	95.6749	0.1218	0.0046	0.0144	Open
DMM_PIP_2629	DMM_JUN_3292	DMAV67	4.3482	400.0000	0.3000	19.5591	0.1556	0.0003	0.0695	Open
DMM_PIP_2629A	DMAV67	DMM_JUN_3290	10.7088	400.0000	0.3000	19.5591	0.1556	0.0008	0.0704	Open
DMM_PIP_3545	DMM_JUN_3292	DMM_JUN_3300	415.2813	1,000.0000	0.3000	69.2343	0.0882	0.0033	0.0079	Open
P217	DMM_JUN_3292	DMAV63	421.9033	140.3000	0.1000	6.5951	0.4266	0.6350	1.5051	Open
P219	DMAV63	J30	11.4384	140.3000	0.1000	6.5951	0.4266	0.0172	1.5052	Open
P211	DMM_JUN_3300	DMAV62	1,252.6060	197.3000	0.1000	10.9057	0.3567	0.8859	0.7072	Open
P213	DMAV62	J28	14.4390	197.3000	0.1000	10.9057	0.3567	0.0102	0.7073	Open
DMM_PIP_3553	DMM_JUN_3300	DMM_JUN_2818	111.3169	1,000.0000	0.3000	35.2244	0.0448	0.0003	0.0023	Open
DMM_PIP_2631	DMM_JUN_3300	DMAV68	4.3771	400.0000	0.3000	22.8976	0.1822	0.0004	0.0946	Open
DMM_PIP_2631A	DMAV68	DMM_JUN_3298	10.4896	400.0000	0.3000	22.8976	0.1822	0.0010	0.0940	Open
DMM_PIP_2625	DMM_JUN_2818	DMAV61	339.4440	1,000.0000	0.3000	34.6085	0.0441	0.0008	0.0022	Open
DMM_PIP_2625A	DMAV61	DMM_JUN_2812	13.4230	1,000.0000	0.3000	34.6085	0.0441	0.0000	0.0021	Open
DMM_PIP_2637	DMM_JUN_2812	DMM_JUN_3294	73.7163	400.0000	0.3000	16.3863	0.1304	0.0037	0.0506	Open

ID	From Node	To Node	Length (m)	Diameter (mm)	Roughness (mm)	Flow (L/s)	Velocity (m/s)	Headloss (m)	HL/1000 (m/k-m)	Status
DMM_PIP_2635	DMM_JUN_2812	DMM_JUN_3296	13.7738	400.0000	0.3000	17.8813	0.1423	0.0008	0.0594	Open
DMM_PIP_3647	DMM_JUN_3360	DMM_JUN_3354	602.0642	400.0000	0.3000	21.8766	0.1741	0.0521	0.0866	Open
DMM_PIP_3645	DMM_JUN_3360	DMM_JUN_3358	8.7225	400.0000	0.3000	18.5523	0.1476	0.0006	0.0640	Open
DMM_PIP_3643A	DMAV86	DMM_JUN_3360	3.6893	400.0000	0.3000	40.4320	0.3217	0.0010	0.2761	Open
DMM_PIP_3643	DMM_JUN_3356	DMAV86	2.2199	400.0000	0.3000	40.4320	0.3217	0.0006	0.2766	Open
P265	DMM_JUN_2806	DMAV78	52.3986	140.3000	0.1000	8.8974	0.5755	0.1379	2.6321	Open
P267	DMAV78	DMM_2856	49.1738	140.3000	0.1000	8.8974	0.5755	0.1294	2.6322	Open
DMM_PIP_2601	DMM_JUN_3380	DMM_JUN_3382	13.9159	400.0000	0.3000	55.3628	0.4406	0.0070	0.5037	Open
DMM_PIP_2611	DMM_JUN_2294	DMM_JUN_3302	20.9171	400.0000	0.3000	17.0742	0.1359	0.0011	0.0545	Open
DMM_PIP_2609	DMM_JUN_2810	DMM_JUN_3352	10.6103	400.0000	0.3000	73.9312	0.5883	0.0093	0.8793	Open
DMM_PIP_3305	DMM_JUN_3138	DMM_846	1,898.6678	1,000.0000	0.3000	135.6391	0.1727	0.0524	0.0276	Open
DMM_PIP_2785	DMM_JUN_3138	DMAV182	51.7184	400.0000	0.3000	20.4764	0.1629	0.0040	0.0765	Open
DMM_PIP_2441	DMM_JUN_2744	DMM_JUN_3138	1,181.4428	1,000.0000	0.3000	156.1678	0.1988	0.0425	0.0359	Open
P523	DMAV182	DMM_JUN_3384	55.2520	400.0000	0.3000	20.4764	0.1629	0.0042	0.0766	Open
DMM_PIP_3309	DMM_JUN_3142	DMM_JUN_2746	749.4691	1,000.0000	0.3000	-265.6745	0.3383	0.0739	0.0986	Open
DMM_PIP_2443	DMM_JUN_3142	DMM_JUN_3386	32.7767	400.0000	0.3000	109.0916	0.8681	0.0614	1.8723	Open
DMM_PIP_2437	DMM_JUN_2744	DMM_JUN_3142	15.1349	1,000.0000	0.3000	-156.3841	0.1991	0.0005	0.0360	Open
DMM_PIP_2439	DMM_JUN_2746	DMM_JUN_3148	1,902.8049	1,000.0000	0.3000	-265.9722	0.3386	0.1880	0.0988	Open
DMM_PIP_3317	DMM_JUN_3148	DMM_JUN_3146	65.6665	400.0000	0.3000	84.3989	0.6716	0.0746	1.1366	Open
DMM_PIP_3315	DMM_JUN_3148	DMM_JUN_2762	1,588.9784	1,000.0000	0.3000	-351.2581	0.4472	0.2677	0.1684	Open
DMM_PIP_2501	DMM_JUN_2762	DMM_JUN_3388	122.5552	400.0000	0.3000	37.8885	0.3015	0.0299	0.2439	Open
DMM_PIP_2497	DMM_JUN_2762	DMM_JUN_2764	656.1777	1,000.0000	0.3000	-408.4895	0.5201	0.1479	0.2254	Open
P359	DMM_JUN_2762	DMAV113	22.7184	197.3000	0.1000	19.2035	0.6281	0.0462	2.0343	Open
P361	DMAV113	DMM_2002	63.9446	197.3000	0.1000	19.2035	0.6281	0.1301	2.0343	Open
DMM_PIP_2511	DMM_JUN_2764	DMM_JUN_3150	25.7386	400.0000	0.3000	108.2076	0.8611	0.0474	1.8429	Open
DMM_PIP_2499	DMM_JUN_2764	DMM_JUN_2766	139.0197	1,000.0000	0.3000	-516.7312	0.6579	0.0494	0.3553	Open
DMM_PIP_2505	DMM_JUN_2766	DMM_JUN_2768	911.8123	1,000.0000	0.3000	-517.2105	0.6585	0.3245	0.3559	Open
DMM_PIP_3323	DMM_JUN_2768	DMM_JUN_3152	14.3290	400.0000	0.3000	102.8697	0.8186	0.0239	1.6700	Open
DMM_PIP_2507	DMM_JUN_2768	DMM_JUN_2982	1,369.2132	1,000.0000	0.3000	-620.1311	0.7896	0.6936	0.5066	Open
DMM_PIP_3071	DMM_VAL_8194	DMM_JUN_2982	7.3654	1,000.0000	0.3000	620.1845	0.7896	0.0037	0.5071	Open
DMM_PIP_3061	DMM_JUN_2986	DMM_VAL_8194	15.5373	1,000.0000	0.3000	620.1845	0.7896	0.0079	0.5065	Open
CT_OUTLET	DMM_VAL_8192	DMM_JUN_2986	9.2608	1,600.0000	0.3000	1,809.1558	0.8998	0.0034	0.3706	Open
DMM_PIP_3067	CENTRAL_TANK_PS	DMM_VAL_8192	11.2199	1,600.0000	0.3000	1,809.1558	0.8998	0.0042	0.3702	Open
P821	J58	CENTRAL_TANK_PS	4.7147	1,600.0000	0.3000	1,809.1558	0.8998	0.0017	0.3707	Open
P-33	DMM_JUN_2946	FCV_CENTRAL_TANK	47.3153	1,600.0000	0.3000	1,999.9859	0.9947	0.0213	0.4506	Open

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P-34	FCV_CENTRAL_TANK	J56	12.3051	1,600.0000	0.3000	1,999.9859	0.9947	0.0055	0.4507	Open
DMM_PIP_2977	DMM_JUN_2944	DMM_JUN_2948	296.6949	1,600.0000	0.3000	1,999.9857	0.9947	0.1337	0.4507	Open
DMM_PIP_2975	DMM_JUN_2942	DMM_JUN_2944	2,163.0970	1,600.0000	0.3000	1,999.9857	0.9947	0.9749	0.4507	Open
DMM_PIP_2973	DMM_JUN_2942	DMM_JUN_2940	983.4080	1,600.0000	0.3000	-1,999.9857	0.9947	0.4432	0.4507	Open
DMM_PIP_2971	DMM_JUN_2938	DMM_JUN_2940	419.0785	1,600.0000	0.3000	1,999.9857	0.9947	0.1889	0.4507	Open
DMM_PIP_2969	DMM_JUN_2936	DMM_JUN_2938	760.6230	1,600.0000	0.3000	1,999.9857	0.9947	0.3428	0.4507	Open
DMM_PIP_2967	DMM_JUN_2934	DMM_JUN_2936	962.3452	1,600.0000	0.3000	1,999.9857	0.9947	0.4337	0.4507	Open
DMM_PIP_2965	DMM_JUN_2932	DMM_JUN_2934	1,726.5588	1,600.0000	0.3000	1,999.9857	0.9947	0.7781	0.4507	Open
DMM_PIP_2963	DMM_JUN_2930	DMM_JUN_2932	3,079.9867	1,600.0000	0.3000	1,999.9857	0.9947	1.3881	0.4507	Open
DMM_PIP_2961	DMM_JUN_3280	DMM_JUN_2930	328.4499	1,600.0000	0.3000	1,999.9857	0.9947	0.1480	0.4507	Open
DMM_PIP_3527	DMM_JUN_3280	DMM_JUN_2926	95.3555	1,600.0000	0.3000	-4,199.9700	2.0889	0.1849	1.9390	Open
DMM_PIP_1271	DMM_JUN_2428	DMM_JUN_3280	34.8838	1,400.0000	0.3000	-2,199.9845	1.4291	0.0376	1.0775	Open
DMM_PIP_1193	DMM_VAL_8024	DMM_JUN_2428	13.6552	1,400.0000	0.3000	-2,199.9845	1.4291	0.0147	1.0776	Open
DMM_5089	DMM_19836	DMM_VAL_8024	13.3400	1,400.0000	0.3000	-2,199.9845	1.4291	0.0144	1.0773	Open
P-35	DMM_19836	FCV_TANK55	6.9463	1,600.0000	0.3000	2,199.9845	1.0942	0.0038	0.5437	Open
P-36	FCV_TANK55	J62	7.8302	1,600.0000	0.3000	2,199.9845	1.0942	0.0043	0.5435	Open
DMM_PIP_3517	DMM_JUN_3276	MEW_TANK_55_PS	71.6074	1,400.0000	0.3000	1,060.8510	0.6891	0.0185	0.2587	Open
DMM_PIP_2659	MEW_TANK_55_PS	DMM_JUN_3278	21.5346	1,400.0000	0.3000	1,060.8510	0.6891	0.0056	0.2587	Open
DMM_PIP_3521	DMM_JUN_3278	DMM_1160	63.0371	1,400.0000	0.3000	1,028.4777	0.6681	0.0154	0.2436	Open
P23	DMM_JUN_3174	DMM_1160	4.4425	1,000.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Closed
DMM_PIP_2571(2)	DMM_JUN_2794	21665-B	1,558.0150	1,000.0000	0.3000	-298.2664	0.3798	0.1917	0.1230	Open
DMM_VAL_8038_U	DMM_1160	DMM_VAL_8038	3.0752	1,000.0000	0.3000	298.2664	0.3798	0.0004	0.1240	Open
DMM_VAL_8038_D	DMM_VAL_8038	21665-B	3.4913	1,000.0000	0.3000	298.2664	0.3798	0.0004	0.1226	Open
DMM_PIP_2249	DMM_JUN_2678	DMM_JUN_2794	674.3797	1,000.0000	0.3000	-289.8043	0.3690	0.0785	0.1164	Open
DMM_PIP_2573	DMM_JUN_2794	DMM_JUN_2796	746.3929	400.0000	0.3000	2.8579	0.0227	0.0016	0.0022	Open
DMM_PIP_2577(1)	DMM_JUN_2796	PRV-8	178.8718	400.0000	0.3000	2.8348	0.0226	0.0004	0.0022	Open
DMM_PIP_2577(2)	PRV-8	DMM_JUN_3176	40.6283	400.0000	0.3000	2.8348	0.0226	0.0001	0.0022	Open
DMM_PIP_2255(1)	DMM_JUN_2678	PRV-7	56.1034	400.0000	0.3000	43.1222	0.3432	0.0175	0.3121	Open
DMM_PIP_2255(2)	PRV-7	DMM_JUN_3418	18.6748	400.0000	0.3000	43.1222	0.3432	0.0058	0.3121	Open
DMM_PIP_2251	DMM_JUN_2680	DMM_JUN_2678	1,207.9848	1,000.0000	0.3000	-246.6727	0.3141	0.1033	0.0856	Open
DMM_PIP_2567	DMM_JUN_2790	DMM_JUN_2680	257.8840	1,000.0000	0.3000	-246.6476	0.3140	0.0221	0.0855	Open
DMM_PIP_2253	DMM_JUN_2680	DMM_6709	43.9786	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Closed
DMM_PIP_2569	DMM_JUN_2790	DMM_JUN_3182	28.9899	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Closed
DMM_PIP_3249(1)	DMM_JUN_2790	J-23	1,069.3960	1,000.0000	0.3000	245.9710	0.3132	0.0910	0.0851	Open
DMM_PIP_2597	DMM_JUN_2788	DMM_JUN_3186	1,416.0236	1,000.0000	0.3000	231.0263	0.2942	0.1069	0.0755	Open

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DMM_PIP_2565	DMM_JUN_2788	DMAV111	35.9430	400.0000	0.3000	14.7992	0.1178	0.0015	0.0419	Open
P-43	J-23	PRV-5	11.6063	1,000.0000	0.3000	245.9710	0.3132	0.0010	0.0850	Open
P-44	PRV-5	DMM_JUN_2788	11.6103	1,000.0000	0.3000	245.9710	0.3132	0.0010	0.0849	Open
DMM_PIP_2565A	DMAV111	DMM_6915	217.6934	400.0000	0.3000	14.7992	0.1178	0.0091	0.0419	Open
DMM_PIP_3359	DMM_JUN_3186	DMAV108	2,085.5044	400.0000	0.3000	8.8599	0.0705	0.0342	0.0164	Open
DMM_PIP_2259	DMM_JUN_2684	DMM_JUN_3186	1,204.0585	1,000.0000	0.3000	-222.0662	0.2827	0.0843	0.0700	Open
DMM_PIP_2263	DMM_JUN_2684	DMAV109	17.7265	400.0000	0.3000	15.7356	0.1252	0.0008	0.0467	Open
DMM_PIP_2257	DMM_JUN_2682	DMM_JUN_2684	619.1663	1,000.0000	0.3000	-206.2744	0.2626	0.0377	0.0609	Open
DMM_PIP_2263A	DMAV109	DMM_JUN_3188	53.9229	400.0000	0.3000	15.7356	0.1252	0.0025	0.0470	Open
DMM_PIP_2261	DMM_JUN_2682	DMAV110	13.2038	400.0000	0.3000	7.3629	0.0586	0.0002	0.0116	Open
DMM_PIP_2265	DMM_JUN_2682	DMM_JUN_3190	909.0325	1,000.0000	0.3000	198.8154	0.2531	0.0516	0.0567	Open
DMM_PIP_2261A	DMAV110	DMM_5853	267.3479	400.0000	0.3000	7.3629	0.0586	0.0031	0.0117	Open
DMM_12544	DMM_JUN_1186	DMM_5853	229.3976	197.3000	0.3000	-2.5850	0.0846	0.0128	0.0559	Open
DMM_PIP_2267	DMM_JUN_3192	DMAV107	26.6324	400.0000	0.3000	16.6841	0.1328	0.0014	0.0522	Open
DMM_PIP_2267A	DMAV107	DMM_JUN_3194	91.9454	400.0000	0.3000	16.6841	0.1328	0.0048	0.0523	Open
DMM_PIP_2591	DMM_JUN_2802	DMAV106	36.8191	400.0000	0.3000	9.2503	0.0736	0.0007	0.0177	Open
DMM_PIP_2591A	DMAV106	DMM_5301	105.8917	400.0000	0.3000	9.2503	0.0736	0.0019	0.0177	Open
25452	197	DMAV102	9.1541	400.0000	0.3000	7.7865	0.0620	0.0001	0.0132	Open
25452A	DMAV102	10789	20.7717	400.0000	0.3000	7.7865	0.0620	0.0003	0.0130	Open
25458	10800	5447	7.3498	400.0000	0.3000	1.5617	0.0124	0.0000	0.0006	Open
25450	196	DMAV103	2.4820	400.0000	0.3000	3.0668	0.0244	0.0000	0.0037	Open
25450A	DMAV103	10795	5.7802	400.0000	0.3000	3.0668	0.0244	0.0000	0.0024	Open
DMM_PIP_3359A	DMAV108	DMM_JUN_3184	102.6905	400.0000	0.3000	8.8599	0.0705	0.0017	0.0164	Open
DMM_PIP_2821	DMM_3337	DMAV179	4.7012	400.0000	0.3000	63.5251	0.5055	0.0031	0.6559	Open
P517	DMAV179	DMM_JUN_3320	9.3109	400.0000	0.3000	63.5251	0.5055	0.0061	0.6564	Open
DMM_PIP_3073	DMM_VAL_8196	DMM_JUN_2984	13.4179	1,000.0000	0.3000	440.1241	0.5604	0.0035	0.2603	Open
DMM_PIP_2203	DMM_JUN_2986	DMM_VAL_8196	8.9744	1,000.0000	0.3000	440.1241	0.5604	0.0023	0.2602	Open
DMM_PIP_3063	DMM_JUN_2984	DMM_JUN_2776	854.3405	1,000.0000	0.3000	439.9418	0.5602	0.2222	0.2601	Open
DMM_PIP_2535	DMM_JUN_2776	DMM_JUN_2778	499.8027	1,000.0000	0.3000	438.9566	0.5589	0.1294	0.2590	Open
DMM_PIP_2541	DMM_JUN_2778	DMM_JUN_3158	15.9318	400.0000	0.3000	88.0169	0.7004	0.0196	1.2331	Open
DMM_PIP_2537	DMM_JUN_2778	DMM_JUN_2884	46.5671	1,000.0000	0.3000	350.4987	0.4463	0.0078	0.1678	Open
DMM_PIP_2817	DMM_JUN_2884	DMM_JUN_2780	1,581.9928	1,000.0000	0.3000	349.1737	0.4446	0.2634	0.1665	Open
DMM_PIP_2545	DMM_JUN_2780	DMM_JUN_3160	17.7056	400.0000	0.3000	63.5105	0.5054	0.0116	0.6559	Open
DMM_PIP_2543	DMM_JUN_2780	DMM_JUN_2782	806.1272	1,000.0000	0.3000	285.6429	0.3637	0.0913	0.1132	Open
P409	DMAV133	DMM_17921	37.9889	197.3000	0.1000	0.0000	0.0000	0.0000	0.0000	Open

ID	From Node	To Node	Length (m)	Diameter (mm)	Roughness (mm)	Flow (L/s)	Velocity (m/s)	Headloss (m)	HL/1000 (m/k-m)	Status
P407	DMM_1813	DMAV133	30.8326	197.3000	0.1000	0.0000	0.0000	0.0000	0.0000	Open
DMM_PIP_2549	DMM_JUN_2782	DMM_JUN_3162	37.9330	400.0000	0.3000	85.7187	0.6821	0.0444	1.1714	Open
DMM_PIP_3717	DMM_JUN_3416	DMM_JUN_3164	313.5694	1,000.0000	0.3000	68.7724	0.0876	0.0024	0.0078	Open
DMM_PIP_3337	DMM_JUN_3416	DMM_JUN_3414	49.1183	400.0000	0.3000	130.9520	1.0421	0.1314	2.6749	Open
DMM_PIP_2547	DMM_JUN_2782	DMM_JUN_3416	396.3835	1,000.0000	0.3000	199.7996	0.2544	0.0227	0.0573	Open
P381	DMAV121	DMM_12447	17.4475	260.4000	0.1000	0.0000	0.0000	0.0000	0.0000	Open
P379	DMM_JUN_3164	DMAV121	19.2322	260.4000	0.1000	0.0000	0.0000	0.0000	0.0000	Open
DMM_PIP_3201	DMM_JUN_3164	DMM_JUN_3312	543.8372	1,000.0000	0.3000	68.7379	0.0875	0.0042	0.0078	Open
DMM_PIP_3587	DMM_JUN_3312	DMM_JUN_2600	9.3955	400.0000	0.3000	12.8918	0.1026	0.0003	0.0327	Open
DMM_PIP_3579	DMM_JUN_3312	DMM_JUN_3316	1,192.9900	1,000.0000	0.3000	55.6166	0.0708	0.0063	0.0053	Open
P415	DMM_3191	DMAV136	30.0804	276.6000	0.1000	36.9119	0.6143	0.0388	1.2883	Open
P419	DMAV136	DMM_1781	56.3494	276.6000	0.1000	36.9119	0.6143	0.0726	1.2883	Open
DMM_PIP_3343	DMM_JUN_3316	DMM_JUN_3318	3.4290	400.0000	0.3000	41.5833	0.3309	0.0010	0.2903	Open
DMM_PIP_3583	DMM_JUN_3316	DMM_JUN_3314	839.1509	1,000.0000	0.3000	14.0251	0.0179	0.0004	0.0004	Open
DMM_PIP_2819	DMM_JUN_3156	DMAV177	4.5805	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Open
P511	DMAV177	DMM_JUN_3154	5.1596	400.0000	0.3000	0.0000	0.0000	0.0000	0.0000	Open
DMM_PIP_2579	DMM_6695	DMM_JUN_3178	241.7037	400.0000	0.3000	-0.1660	0.0013	0.0000	0.0000	Open
DMM_PIP_2959	DMM_JUN_2928	DMM_JUN_2926	93.7455	1,600.0000	0.3000	4,199.9700	2.0889	0.1818	1.9388	Open
DMM_PIP_2957	DMM_JUN_2924	DMM_JUN_2928	83.9169	1,600.0000	0.3000	4,199.9700	2.0889	0.1627	1.9389	Open
DMM_PIP_2955	DMM_JUN_2922	DMM_JUN_2924	596.5691	1,600.0000	0.3000	4,199.9700	2.0889	1.1567	1.9389	Open
DMM_PIP_2953	DMM_JUN_2918	DMM_JUN_2922	2,794.4302	1,600.0000	0.3000	4,199.9700	2.0889	5.4181	1.9389	Open
DMM_PIP_2951	DMM_JUN_2920	DMM_JUN_2918	2,332.0760	1,600.0000	0.3000	4,199.9700	2.0889	4.5216	1.9389	Open
DMM_PIP_3013	JAMIAH_TANK	DMM_JUN_2920	12.3237	1,600.0000	0.3000	4,199.9700	2.0889	0.0239	1.9390	Open
DMM_PIP_2731	DMM_JUN_2846	DMM_14474	6.1337	400.0000	0.3000	2.4409	0.0194	0.0000	0.0015	Open
DMM_PIP_1393	DMM_6953	DMM_VAL_8124	20.7269	600.0000	0.3000	0.0128	0.0000	0.0000	0.0000	Open
JAMEAH_OUTLET	JAMIAH_TANK	DMM_JUN_3260	117.8040	1,000.0000	0.3000	729.0120	0.9282	0.0818	0.6946	Open
DMM_PIP_3469	DMM_JUN_3260	JAMIAH_PS	85.4643	600.0000	0.3000	201.8613	0.7139	0.0664	0.7766	Open
DMM_PIP_3465	DMM_JUN_3260	DMAV317	2,356.1574	1,000.0000	0.3000	257.0179	0.3272	0.2180	0.0925	Open
DMM_PIP_3471	JAMIAH_PS	DMM_JUN_2848	56.3945	600.0000	0.3000	201.8613	0.7139	0.0438	0.7765	Open
DMM_PIP_2727	DMM_JUN_2844	DMAV16	0.5643	400.0000	0.3000	17.5593	0.1397	0.0000	0.0659	Open
DMM_PIP_2727A	DMAV16	DMM_5840	0.5850	400.0000	0.3000	17.5593	0.1397	0.0000	0.0477	Open
DMM_PIP_2693	DMM_JUN_2840	DMM_5339	5.0960	400.0000	0.3000	16.8753	0.1343	0.0003	0.0529	Open
DMM_PIP_2689	DMM_JUN_2838	DMM_5340	9.6406	400.0000	0.3000	-0.7667	0.0061	0.0000	0.0000	Open
DMM_PIP_2707(1)	DMM_JUN_2842	PRV-20	33.6368	400.0000	0.3000	71.6433	0.5701	0.0278	0.8274	Open
DMM_PIP_2707(2)	PRV-20	DMM_5812	13.5305	400.0000	0.3000	71.6433	0.5701	0.0112	0.8277	Open

3.4.2 Pumps Operating Speeds

In ADD + FF scenario, pump operations and its operating speeds have been evaluated.

Figure 26 presents the pump operating speed and operation points. The pumps are performing as follows:

Dahyia pump is operating in the range of 0.52-0.65 of its operating speed to maintain the 4 bars pressure in the control junction (Table 5).

Tank 71 pump is operating in the range of 0.72-0.74 of its operating speed to maintain the 3.5 bar pressure in the control junction (Table 5).

Central Tank pump is operating in the range of 0.66-0.70 of its operating speed to maintain the 4 bars pressure in the control junction (Table 5).

MEW Tank 55 pump is operating in the range of 0.69-0.79 of its operating speed to maintain the 4 bars pressure in the control junction (Table 5).

Jamiah pump is operating in the range of 0.61-0.66 of its operating speed to maintain the 4 bars pressure in the control junction (Table 5).

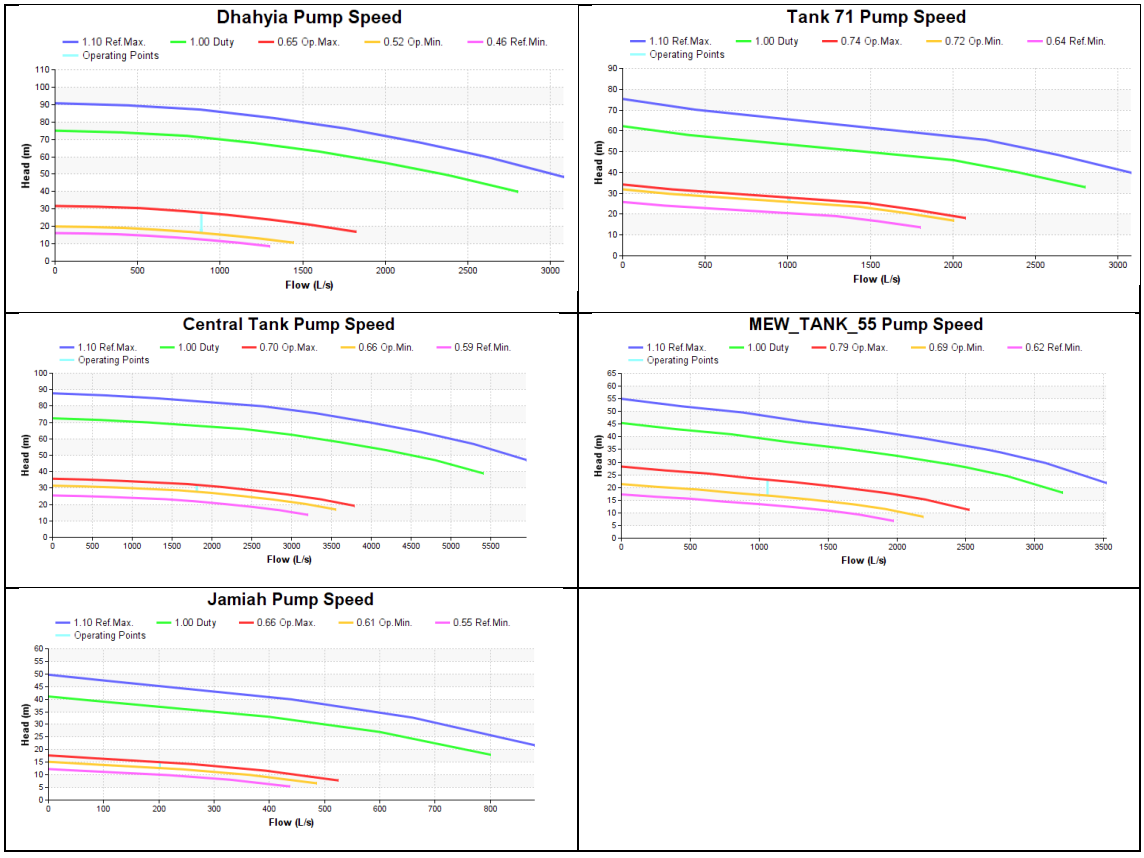

Figure 26- Pumps operating speeds and operation points

3.4.3 Tanks Levels

Within ADD+FF scenario, the tank levels have been evaluated. It is assumed that the initial level of the tanks is around half their heights. Figure 27 presents the level of the five tanks in the scope of Dammam 2 and Dammam 5 projects.

It is evident that the tanks have large capacities to supply Dammam water system in this ADD+FF scenario.

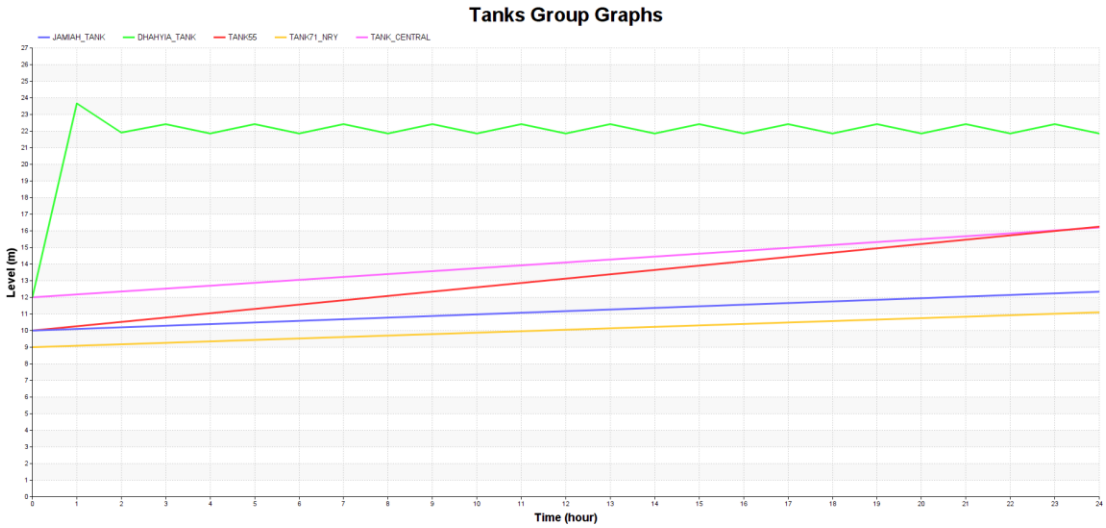

Figure 27- Tanks Levels (ADD+FF)

3.5 Aramco Emergency Scenario

In the RFP the Aramco emergency scenario is mentioned, such that if the Jamiah pump fails, the Aramco emergency pump in Tank 55 should be able to supply water to the south part of the system near Jamiah.

The following modifications have been made to the model:

- The outlet of the pump has been connected with the pipe 700 mm
- The throttle control valve (DMM_VAL_8122) has been open
- The pipe 700 mm between Pumps in Tank 55 and Aramco emergency pump has been closed
- The VSD properties of the Aramco emergency pump have been added as follows
    - Control Junction ID (J6)
    - Control Pressure 4 bar
    - Minimum and Maximum speed settings of 0.6 and 1.2

Following mentioned above modification, this emergency scenario has been tested, and the results are presented below.

Figure 28 presents the pressure of the system during minimum hourly demand and Figure 29 presents the pressure during peak hourly demand. As can be seen, the emergency pump can supply water with enough pressure in case of an

emergency. Most of the system has a pressure of less than 4 bar, with a few points slightly above 4 bar acceptable during an emergency.

Figure 28- Pressure during minimum hourly demand (emergency Aramco)

Figure 29- Pressure during minimum hourly demand (emergency Aramco)

4 CONCLUSIONS AND OBSERVATIONS

As mentioned above, to match the RFP, the following modifications have been made to the received model:

2) Storage types and levels have been modified and adjusted according to the RFP
3) The duty points of the pump stations are updated according to the provided pump curves.
4) The Variable Speed Drive (VSD) characteristics of the pumps are defined
5) Several Pressure Reducing Valves are removed from the model within Dammam 2 and Dammam 5 projects

Hydraulic simulation has been performed for both original and modified models within two main scenarios and one emergency scenario considering the 2050 proposed water system option in the master plan.

The results showed that by modifying the model especially simulating the VSD properties of the pumps, the system performs better in terms of pressure and Energy efficiency, and several of the Pressure Reducing Valves (PRVs) can be removed from the hydraulic model.

Moreover, both original and modified models showed that the overall water system has low velocities of less than 0.3 m/s. However, by modifying the model, the velocity in the system slightly increases.

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