Taupō District Council

KINLOCH SEVEN OAKS STAGE 1 DEVELOPER QUERY - WATER SUPPLY MODELLING ASSESSMENT

Project NO -3-39692.01

30 JANUARY 2024

CONFIDENTIAL

wsp

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30 January 2024

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1 PROJECT BACKGROUND

A new development is currently in progress to the west of Kinloch, Taupō. This development is to be constructed in 14 stages and will be accessed from Okaia Drive and Kahikatea Drive and connected to the central Kinloch Water Supply. An overview of the Seven Oaks Development is shown below in Figure 1-1.

WSP has been engaged by Taupō District Council (TDC) to perform modelling and hydraulic analysis for the Kinloch Water Supply network. The investigation has been divided into three stages: Stage 1 (discussed in this report) involves assessing the network against the required Level of Service (LoS) and resolving the High Zone Pinch Point; Stage 2 involves hydraulic analysis of Seven Oaks Development with permitted and proposed development; and Stage 3 undertakes the entire Seven Oaks Development for the assessment.

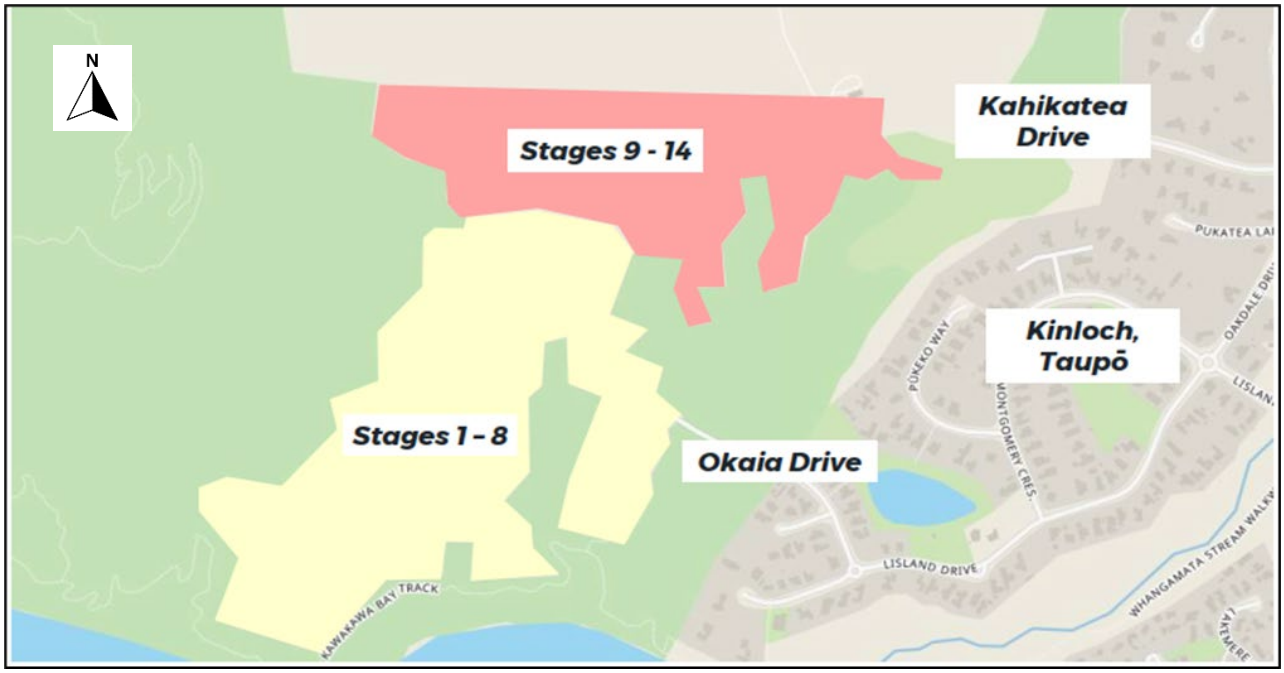


Figure 1-1: Overview of the Seven Oaks Development

1.1 SCOPE

The scope for Stage 1 of this Seven Oaks water supply assessment is to investigate the LoS of the network and to test a solution to resolve the High Zone Pinch Point on the Kinloch network. The overview of the High Zone is shown in Figure 1-2.

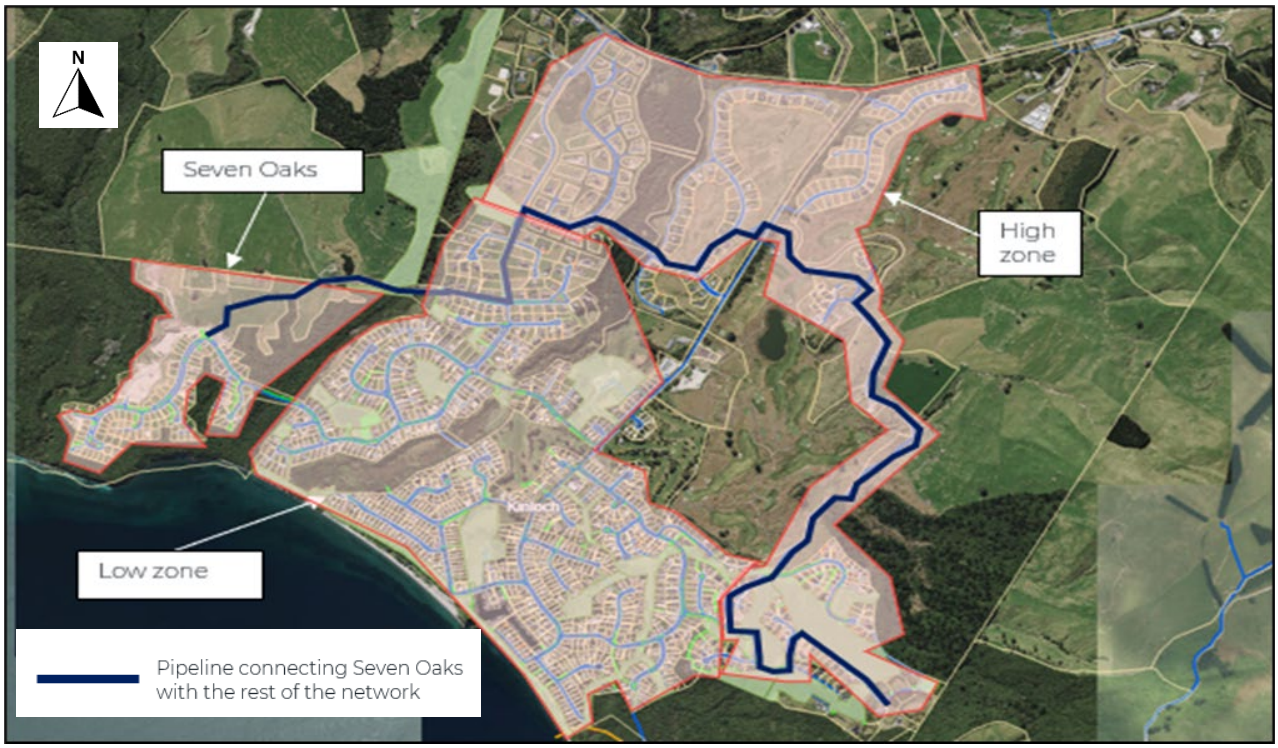


Figure 1-2: Overview of the Kinloch Network and Zones

There are two proposed options to resolve the high-pressure issues in the area of concern.

Option 1

To determine if the Low Zone pipe indicated in Figure 1-3 could be transferred to the High Zone in order to deal with the hydraulic pinch point in the High Zone. Note this is shown as 'sitting' within the High Zone, due to a second pipe in the vicinity which is in the High Zone.

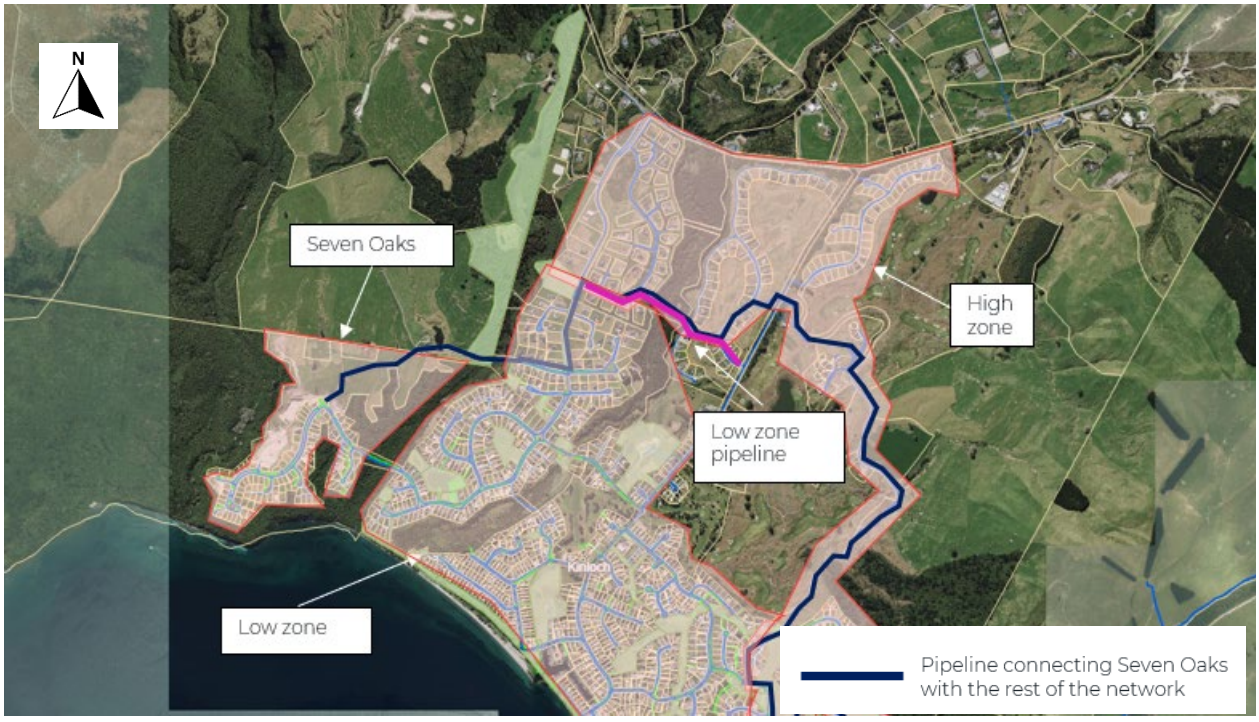


Figure 1-3: Overview of the Proposed Option 1

Option 2

If Option 1 is not a viable option due to undetermined effects on the Low Zone, modelling a secondary pipeline in the High Zone to resolve the pinch point e.g., a 125mm PE.

This report covers modelling Option 1 using two scenarios i.e .the base model and the transferred Low Zone pipe to the High Zone, which is further described in Section 5, to resolve the pinch point. If Option 1 causes issues in the Low Zone, then Option 2 can be actioned i.e. is a provisional Scenario 3. Option 2 results are not presented in this report.

2 ACCEPTANCE CRITERIA

The hydraulic analysis was conducted in accordance with the TDC Code of Practice (CoP). During the analysis, the acceptance criteria shown in Table 2-1 were considered:

Table 2-1 Acceptance Criteria for the LoS

Level of Services	Acceptance Criteria
Minimum Pressure	300 kPa (30 m) pressure at every connection point as per TDC CoP
Unit Headloss	Unit Headloss (m/km) of the proposed pipe and the existing supply pipe as per NZS 4404:2010 • 5 m/km for DN ≤ 150 diameter. • 3 m/km for DN ≥ 200 diameter.
Fire flow	New Zealand Fire Service CoP; SNZ PAS 509:2008 and subsequent amendments, to the satisfaction of the New Zealand Fire Service. Due to limitations in the hydraulic modelling (WS Pro) software, exceptional flow method has been used to assess the fire flow performance of the Seven Oaks network. In this methodology, an exceptional flow of 25 L/s has been allocated at each hydrant for 30 minutes at 60% peak day demand. The hydrants are tested one at a time for required fire flow (25 L/s) and minimum residual pressure (10 m).

3 METHODOLOGY

The methodology used for this assessment is presented below. This is used to assess Option 1 under two scenarios, the latter described in Section 5.

- Use the Kinloch model with the currently established Seven Oaks development demand as the base.
- Execute the preliminary changes as suggested by the client as follows (i.e. model Scenario 1):
  - The closed valve adjacent to the fairways is moved to the South of the entrance to the Poplars subdivision (yellow arrow), as shown in Figure 3-1.
  - The valve on the corner of Oakdale and Ribbonwood is closed (red circle), as shown in Figure 3-1.
  - Add a new connection between the two 180 mm pipes on Oakdale (red line/arrow), as shown in Figure 3-1.

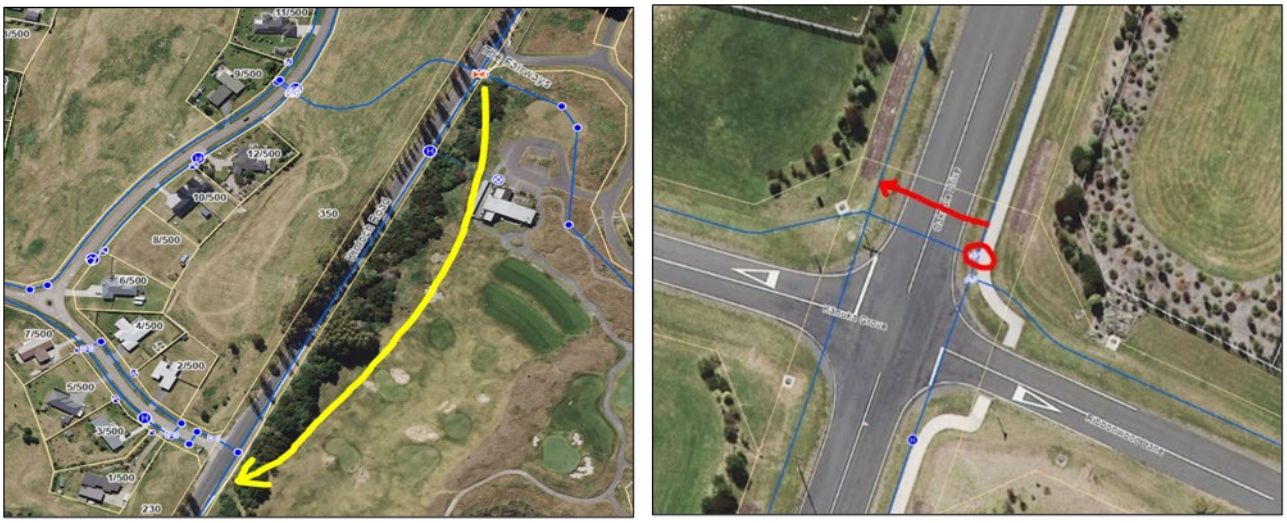


Figure 3-1 Shifting of closed valve & Addition of new connection on Oakdale

- Transfer Low Zone Pipeline into the High Zone to deal with the hydraulic pinch point in the High Zone (i.e. model Scenario 2).
- Run the models and confirm if the proposed development meets TDC's LoS requirements.
  - Carry out a fire flow analysis to see if the selected hydrants meet the minimum fire flow and residual pressure criteria set out in SNZ PAS 4509:2008.
- Provide a short technical report of analysis model results (i.e. this report).

4 MODEL ASSUMPTIONS

1 WSP will be using the Kinloch model with the currently established Seven Oaks development demand.

2 The model analysis utilized a unique database named 7 Oaks Development, which is comprised of the following:

   a) **Network:** Seven Oaks Stage 1

   b) **Control:** Seven Oaks Stage 1 – Control

   c) **Run Group:** 7 Oaks Development Developer Query

3. As confirmed by the client, the following changes were made in the model prior to starting the investigation (refer to the Figure 3-1 in Section 3):

   a) The closed valve adjacent to the fairways is moved to South of the entrance to the Poplars subdivision.

   b) The valve on the corner of Oakdale and Ribbonwood is closed (red circle).

   c) And a new connection between the 2 of 180mm pipes on Oakdale is made (red line/arrow).

5 MODELLING SCENARIOS

Table 5-1 summarises the modelled scenarios, which have been discussed and confirmed with TDC. A base model scenario, i.e. Scenario 1, incorporates the changes requested by the client prior to running both scenarios, to be able to assess Option 1 in reducing the pinch point.

Table 5-1 WS Modelling Scenarios

Scenario	Description	Model
1	Base Model Scenario	Kinloch Model
2	Option 1 – Transfer the existing Low Zone pipe to High Zone.	Kinloch Model
Provisional Scenario (if required)		
3	Option 2 - Model a secondary pipeline in the High Zone to resolve any hydraulic restrictions.	Kinloch Model

6 RESULTS

6.1 PRESSURE

This section discusses the minimum pressure of the Kinloch network (High Zone, Low Zone, and Seven Oaks), in Scenario 1 (i.e. the base model) and Scenario 2 (Option 1). Figure 6-1 describes the results in terms of Minimum Pressure (m) for the Base model.

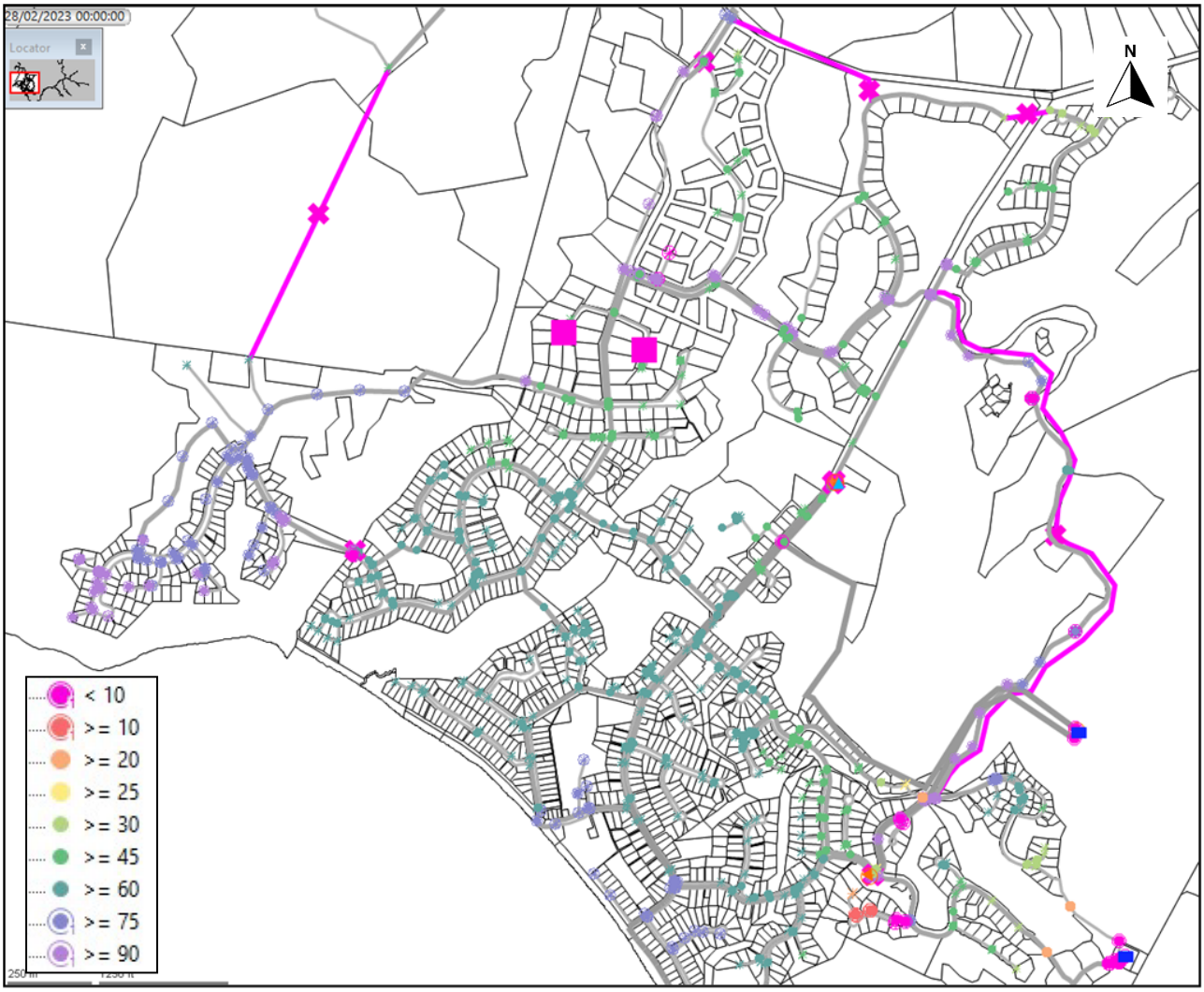


Figure 6-1 LoS Results for Scenario 1

The minimum pressure in the Seven Oaks Development region under Scenario 1 ranges from 74-104 m, while under Scenario 2, it ranges from 78-110 m, showing a very minimalistic increase. The values for minimum pressure under both the Scenarios is found to be more than 30 m which satisfies the criteria as specified by TDC.

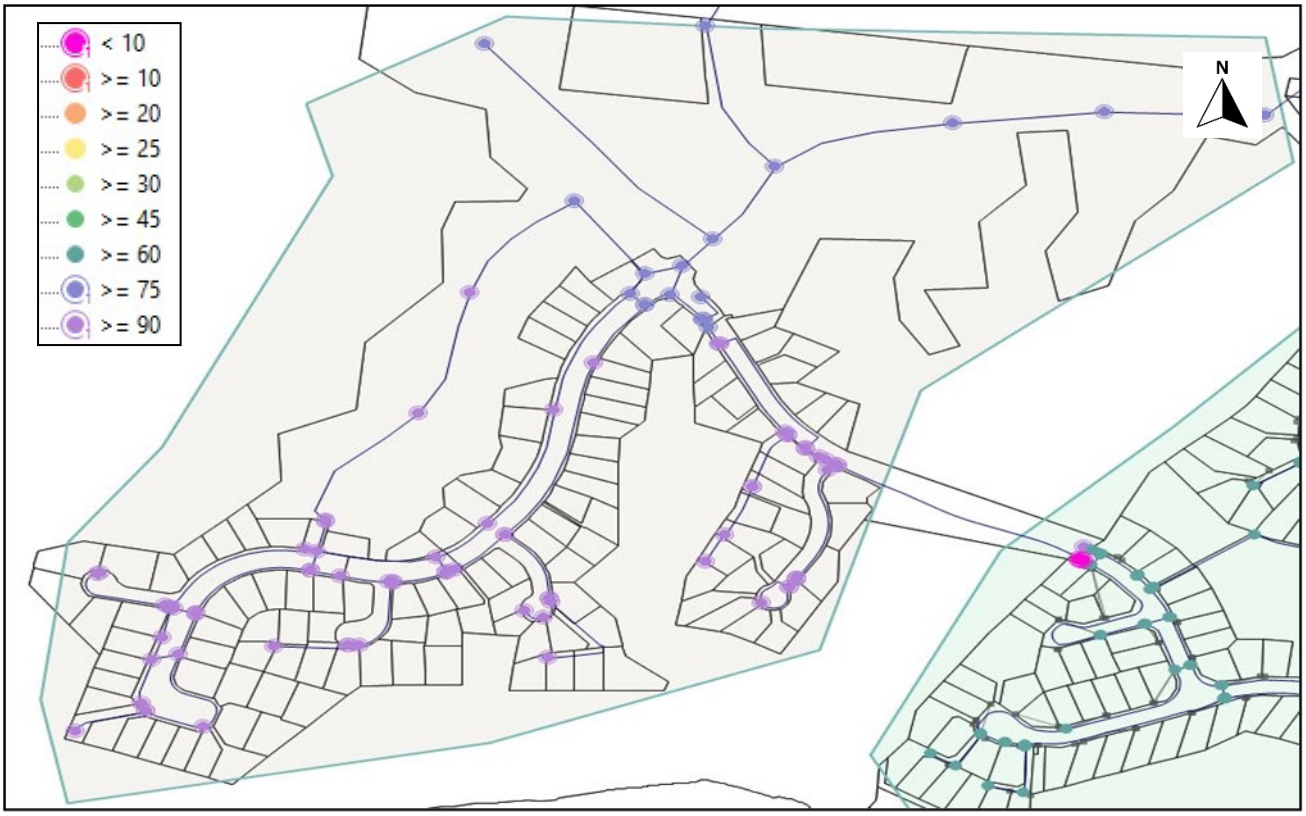


Figure 6-2 Minimum Pressure-Seven Oaks Development, Scenario 2

Similarly, for the High Zone, the minimum pressure is seen to exhibit a maximum value of 120 m while a few nodes near to the Locheagles Reservoir and downstream to the pressure reducing valves (PRVs), tend to show values less than 30 m. However, most of the network within the High Zone has more than 30 m for minimum pressure, thereby satisfying the limits set by TDC. Further, for the pinch point area within High Zone, it is found that pressure increases from 48 m to 108 m, when the Low Zone pipeline is transferred to the High Zone.

Figure 6-3 Minimum Pressure-High Zone, Scenario 2

In the Low Zone, the maximum value for minimum pressure is found to be 115 m under Scenario 2 while a few nodes which are downstream to PRV witness pressure less than 30 m. However, most of the network within Low Zone can establish a value of 30 m for minimum pressure which aligns with the requirements of TDC.

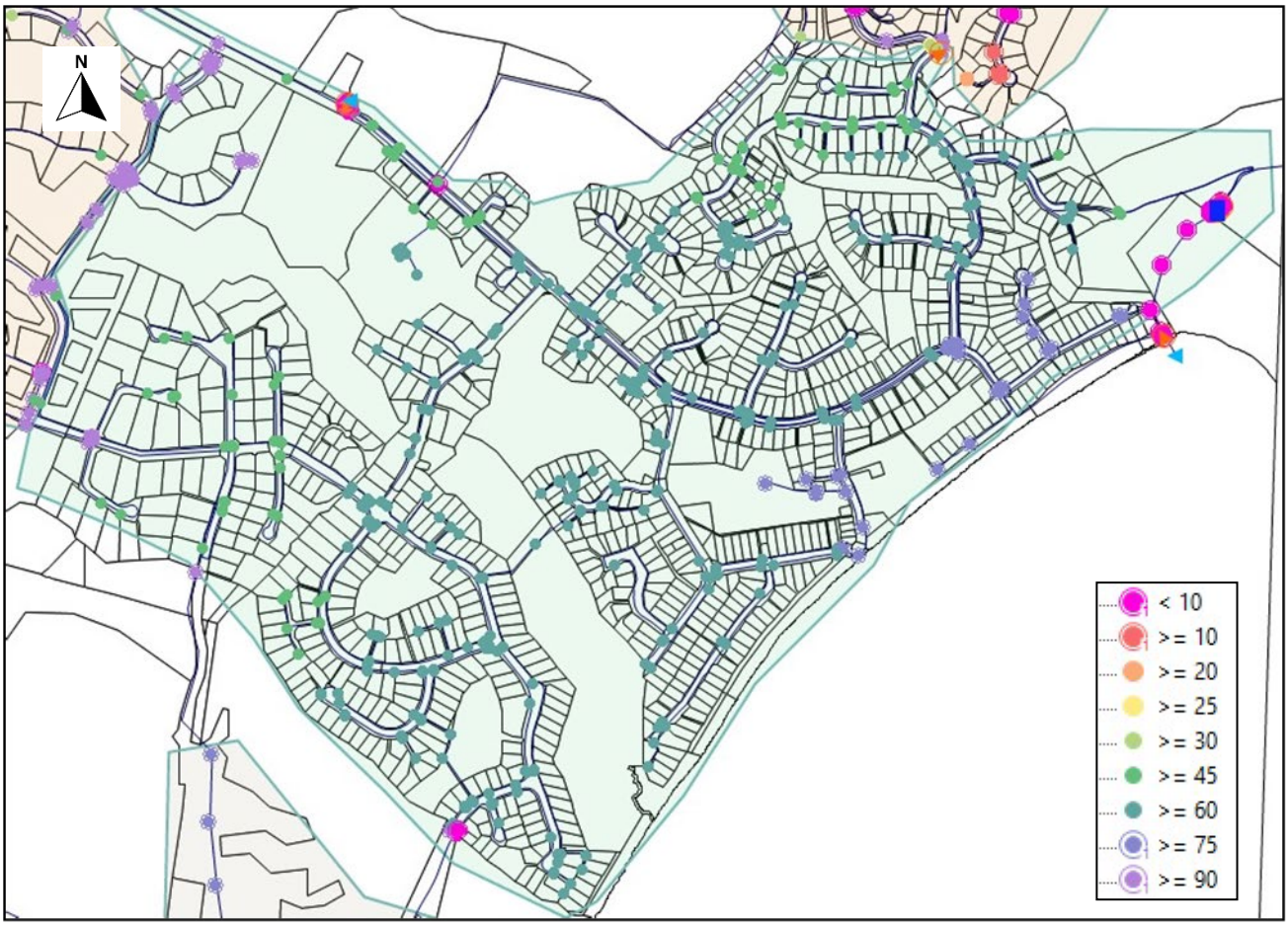


Figure 6-4 Minimum Pressure-Low Zone, Scenario 2

6.2 HEADLOSS

This section discusses the maximum unit headloss of the Kinloch network (High Zone, Low Zone, and Seven Oaks), in Scenario 1 (Base) and Scenario 2 (Stage 1).

Figure 6-5 describes the results in terms of Maximum Unit Headloss (m/km) for the Scenario 1 (Base model).

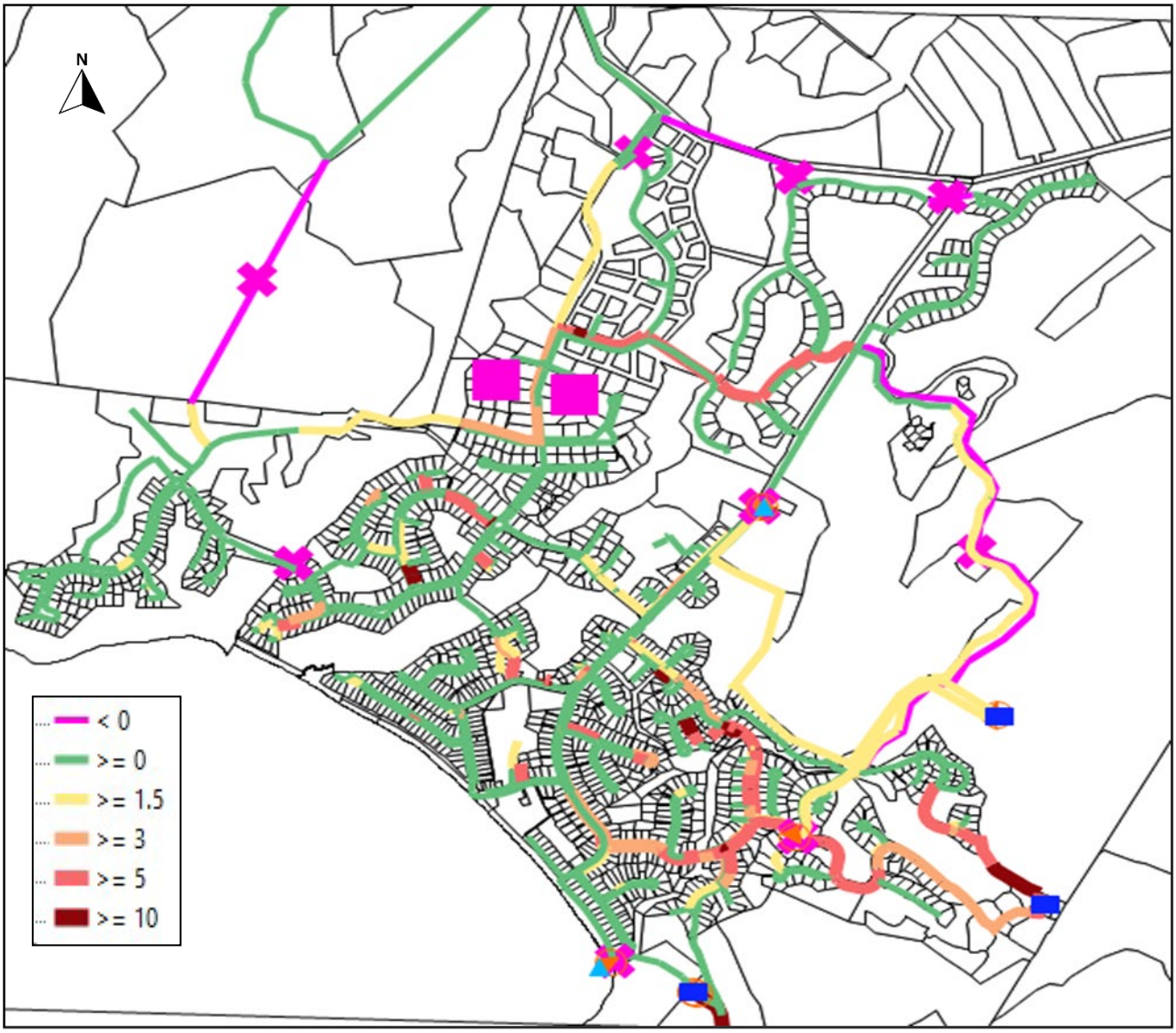


Figure 6-5 LoS Results for Scenario 1

On observing Figure 6-5 & Figure 6-6, it is seen that the Seven Oaks area experiences very minimal variation in terms of maximum unit headloss too, similar to the minimum pressure criteria. The maximum unit headloss observed in the region under Scenario 2 is found to be 2.95 m/km which lies well within the stipulated headloss criteria as specified by TDC.

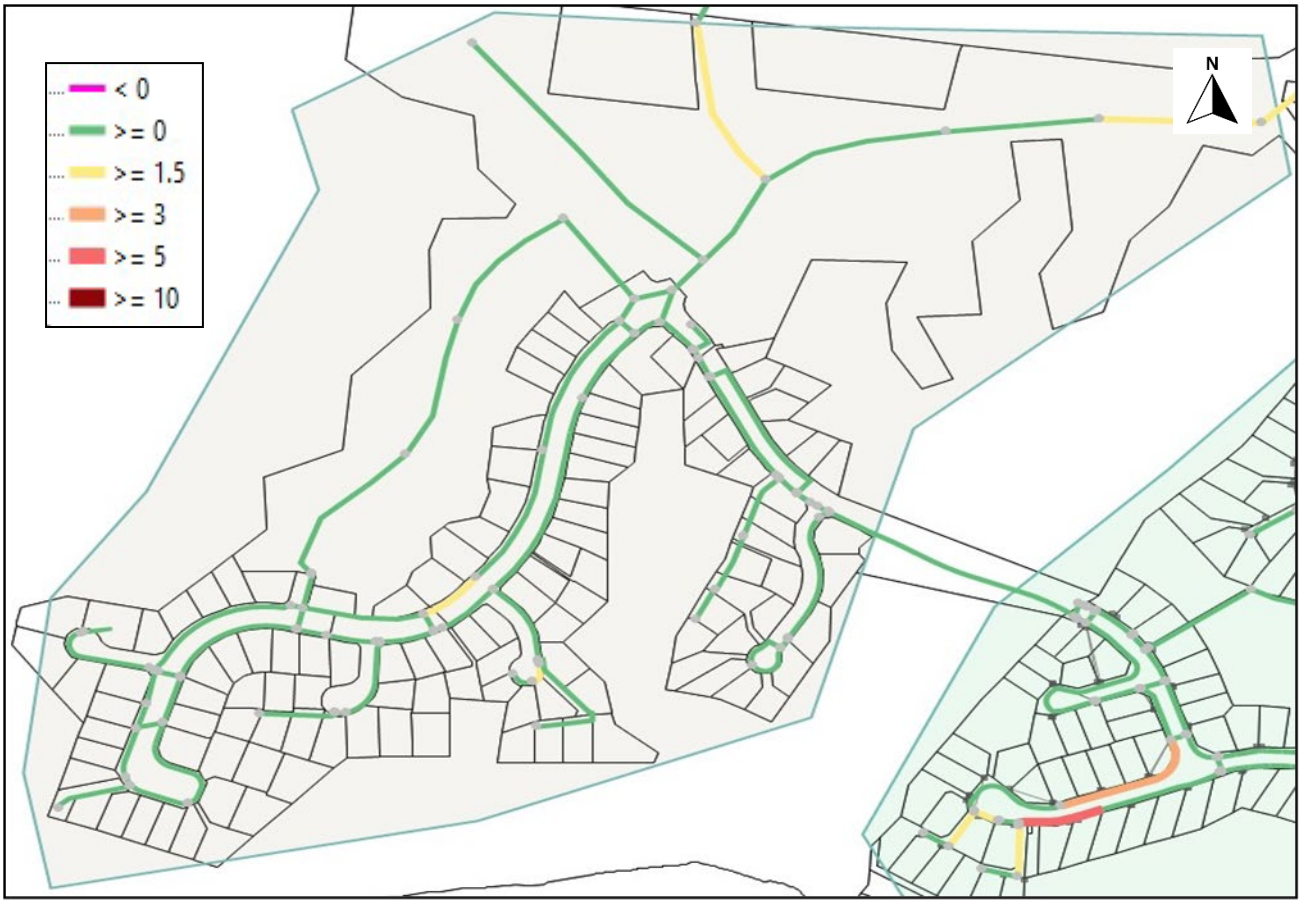


Figure 6-6 Maximum Unit Headloss-Seven Oaks Development, Scenario 2

Within the network for High Zone under Scenario 2, on comparison with Scenario 1, it was observed that in the pinch point region there is a general maximum headloss of the encircled pipe section shown in Figure 6-7.

Overall, the maximum headloss of the pipes within High Zone is within the headloss criteria as specified by TDC.

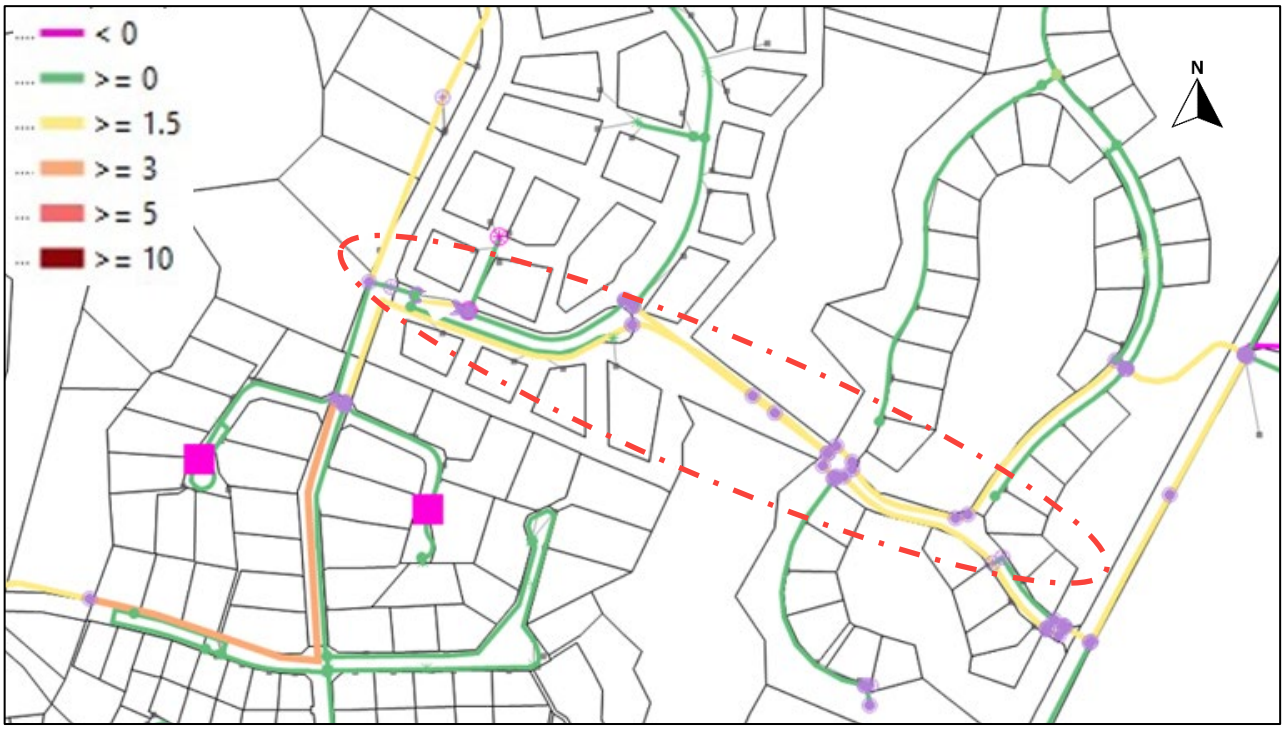


Figure 6-7 Maximum Unit Headloss-High Zone, Scenario 2

Similarly for the Low Zone, it was found that there are two sections where there is a noticeable variation in the maximum unit Headloss criteria exists, and same can be established using Figure 6-1 & Figure 6-5.

In Section 1, depicted in Figure 6-8, the encircled pipes with Internal Diameter 51 mm (as per the model), earlier showed the value of maximum unit headloss to be 2.69 m/km value and upon shifting the Low Zone pipeline to High Zone, this value rises to 3.90 m/km. However, this value remains below the guidelines issued by Taupō District Council's Code of Practices.

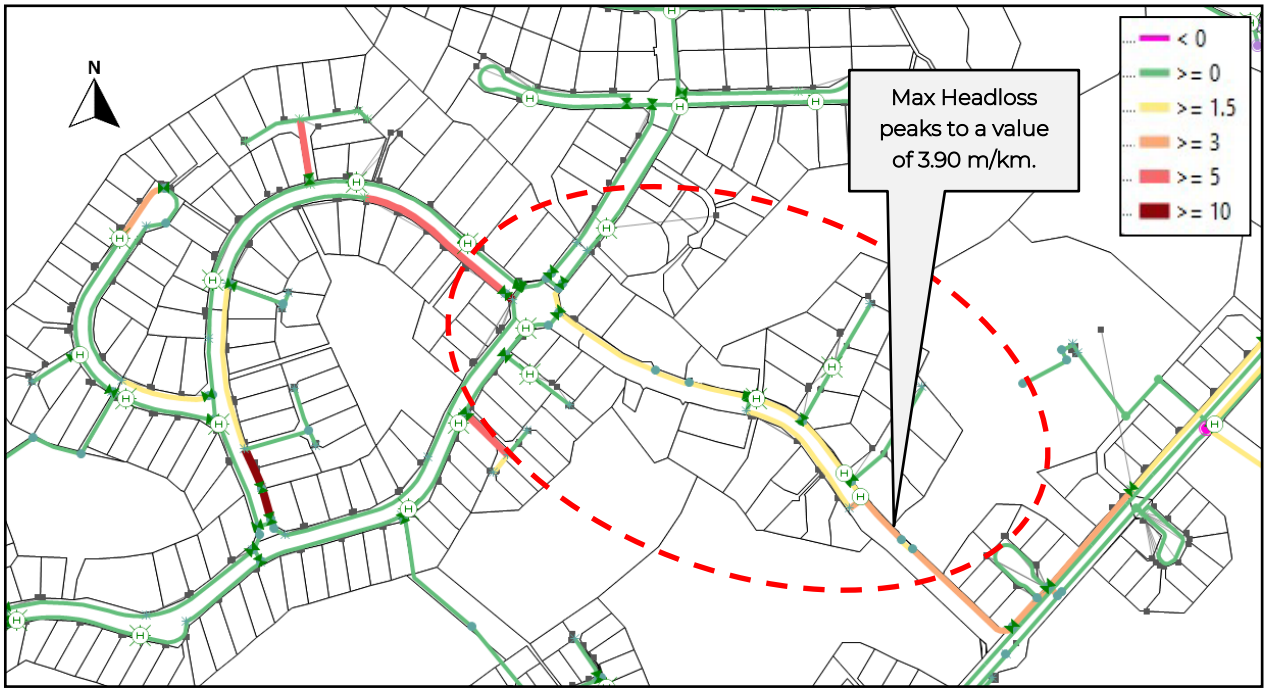


Figure 6-8 Maximum Unit Headloss-Low Zone (Section 1), Scenario 2

On observing Figure 6-1 & Figure 6-5, a variation in maximum unit headloss is found. In Section 2, the encircled pipes have an internal diameter of 100.7 mm as marked in Figure 6-9, which show an increase in maximum unit headloss from 5m/km to 7.8 m/km. This increase in maximum unit headloss is related to the shifting of Low Zone pipeline to High Zone. This increased value of 7.8 m/km on a single stretch of pipe does not meet the criteria laid down by the Taupō District Council's Code of Practices.

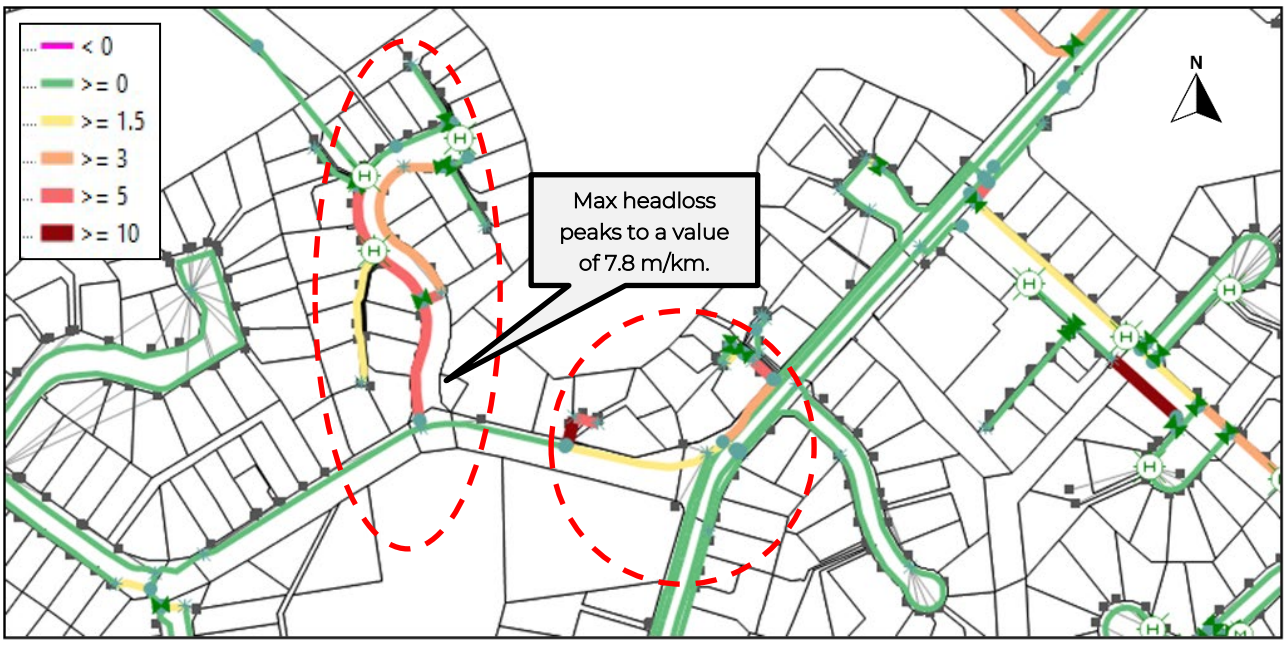


Figure 6-9 Maximum Unit Headloss-Low Zone (Section 2), Scenario 2

6.3 FIRE FLOW

All hydrants within the proposed development of Seven Oaks were tested for fire flow under FW2 specified criteria using the Exceptional Flow Methodology, after rezoning the low zone pipeline to high zone. Figure 6-10 shows the hydrants within Seven Oaks Development used for the fire flow assessment.

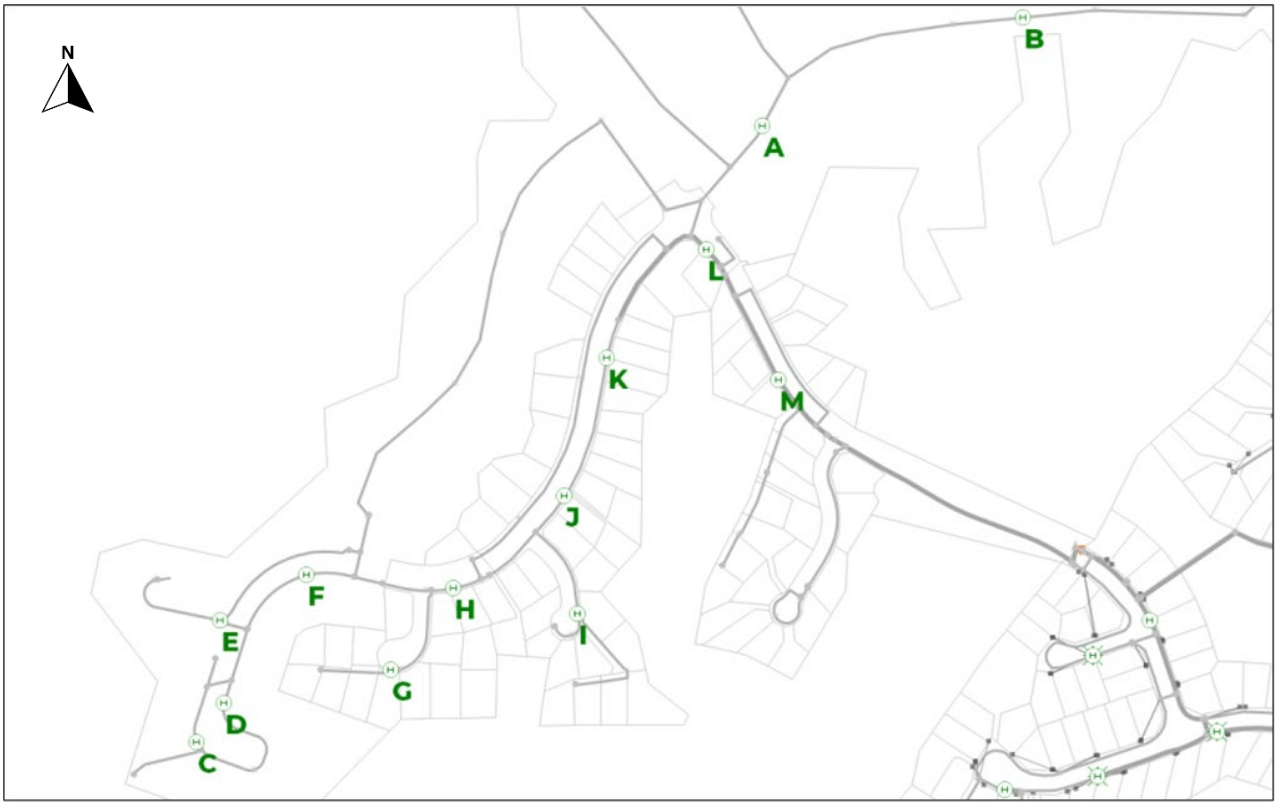


Figure 6-10 Hydrants tested for fire flow

To verify the network's ability to meet fire flow requirements, an exceptional flow of 25 L/s for 30 minutes at the 60% peak day demand was simulated at all the hydrants shown in Figure 6-10. This assumption is based on the condition that if these hydrants maintain the minimum residual pressure criteria under this exceptional scenario, they become compliant for the rest of the time as well.

The simulation results show the network meets the fire flow requirements. Table 6-1 shows the minimum residual pressure for the exceptional demand of fire flow 25 L/s for a 30 min duration for all the 13 Hydrants of Seven Oaks Development.

Table 6-1 Simulation Results for Fire Flow Analysis in Scenario 2

Hydrant	Hydrant ID	Minimum Fire Flow Achieved (L/s)	Residual Pressure (m)
A	SO_01	25	55.20
B	SO_02	25	52.77
C	SO_03	25	48.76
D	SO_04	25	55.58
E	SO_05	25	60.18
F	SO_06	25	59.80
G	SO_07	25	50.89
H	SO_08	25	57.10
I	SO_09	25	49.88
J	SO_10	25	54.79
K	SO_11	25	54.27
L	SO_12	25	56.48
M	SO_13	25	55.47

Appendix A shows the minimum residual pressure of each hydrant at the fire flow duration.

We have also tested 4 critical hydrants in Low Zone (Figure 6-11), to confirm that there were no impacts of rezoning the pipeline.

Figure 6-11 Hydrants tested for fire flow

Table 6-2 shows the fire flow results of the critical hydrants in low zone.

Hydrant	Asset ID	Minimum Fire Flow Achieved (L/s)	Residual Pressure (m)	
			Scenario 1	Scenario 2
A	20180608144640	25	53.97	49.02
B	OLD_WCHY0876	25	0	0
C	W41005	25	41.88	41.85
D	W41015	25	46.74	46.78

As shown in the table, there is no significant variation in the fire flow results between the base model (Scenario 1) and Scenario 2. Hydrant B (OLD_WCHY0876) fails to achieve FW2 criteria in both scenario while all other three critical hydrants pass for FW2 fire flow requirements. This means rezoning the low zone pipe section to high zone has no significant impact on the fire flow performance of the low zone.

7 CONCLUSIONS

The hydraulic performance of all the three regions (Seven Oaks, High Zone and Low Zone) were evaluated to assess if the network meets the LoS requirements under two scenarios: Scenario 1 which is the base model run; and Scenario 2 where the Low Zone pipeline is transferred to the High Zone.

The findings from the assessment are summarised below:

— The analysis revealed that the entire region within the network meets the LoS requirements for pressure and Headloss as per TDC CoPs. The minimum pressure of the Kinloch network (Low Zone, High Zone, and Seven Oaks) is generally above 30 m, and the maximum Headloss in the network also stays within the stipulated limits, baring a few sections which have been highlighted in the results section.

— The exceptional flow methodology has been used to assess the hydrants within Seven Oaks area. Using this method, all the hydrants tested achieve a residual pressure greater than 10 m at the required fire flow of 25 L/s. This signifies that the network meets the FW2 fire flow requirements.

— The transfer of Low Zone pipeline to High Zone does not address the high-pressure issues for the area of concern. Option 2 was not carried out in this assessment but could be investigated to try to address this. Additionally, the installation of PRVs to resolve the high pressures in the area may be another solution. A separate hydraulic assessment may be required to confirm the exact locations of the PRVs to optimise the resulting pressures.

8 LIMITATIONS

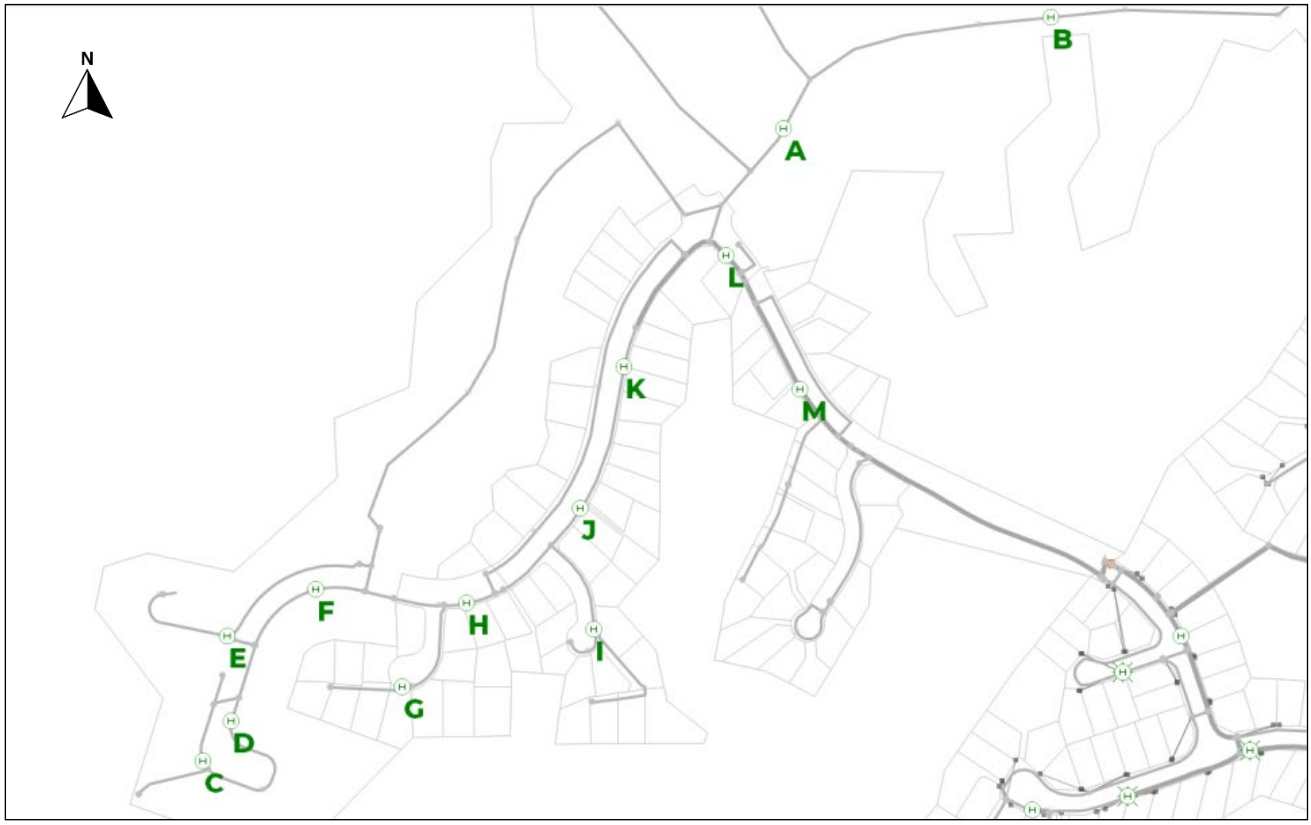
This report ('Report') has been prepared by WSP New Zealand Limited ('WSP') exclusively for Taupō District Council ('Client') in relation to investigate the Kinloch Seven Oaks Region for resolving the High Zone Pinch Point and checking the LOS for the region, and in accordance with the Offer of Service – Kinloch Seven Oaks Region - High Zone Pinch Point dated 6th November 2023. The findings in this Report are based on and are subject to the assumptions specified offer of services dated 6th November 2023. WSP accepts no liability whatsoever for any use or reliance on this Report, in whole or in part, for any purpose other than the Purpose or for any use or reliance on this Report by any third party.

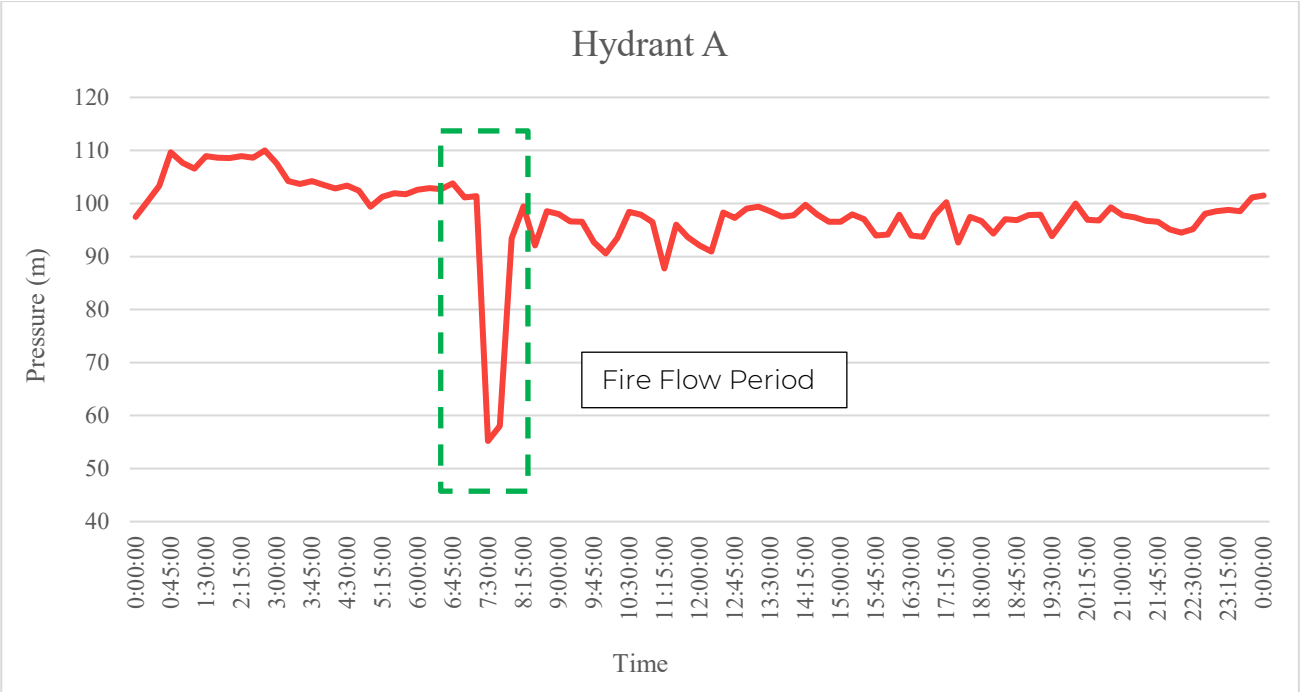
In preparing this Report, WSP has relied upon data, surveys, analyses, designs, plans and other information ('Client Data') provided by or on behalf of the Client. Except as otherwise stated in this Report, WSP has not verified the accuracy or completeness of the Client Data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in this Report are based in whole or part on the Client Data, those conclusions are contingent upon the accuracy and completeness of the Client Data. WSP will not be liable for any incorrect conclusions or findings in the Report should any Client Data be incorrect or have been concealed, withheld, misrepresented, or otherwise not fully disclosed to WSP.

APPENDIX A

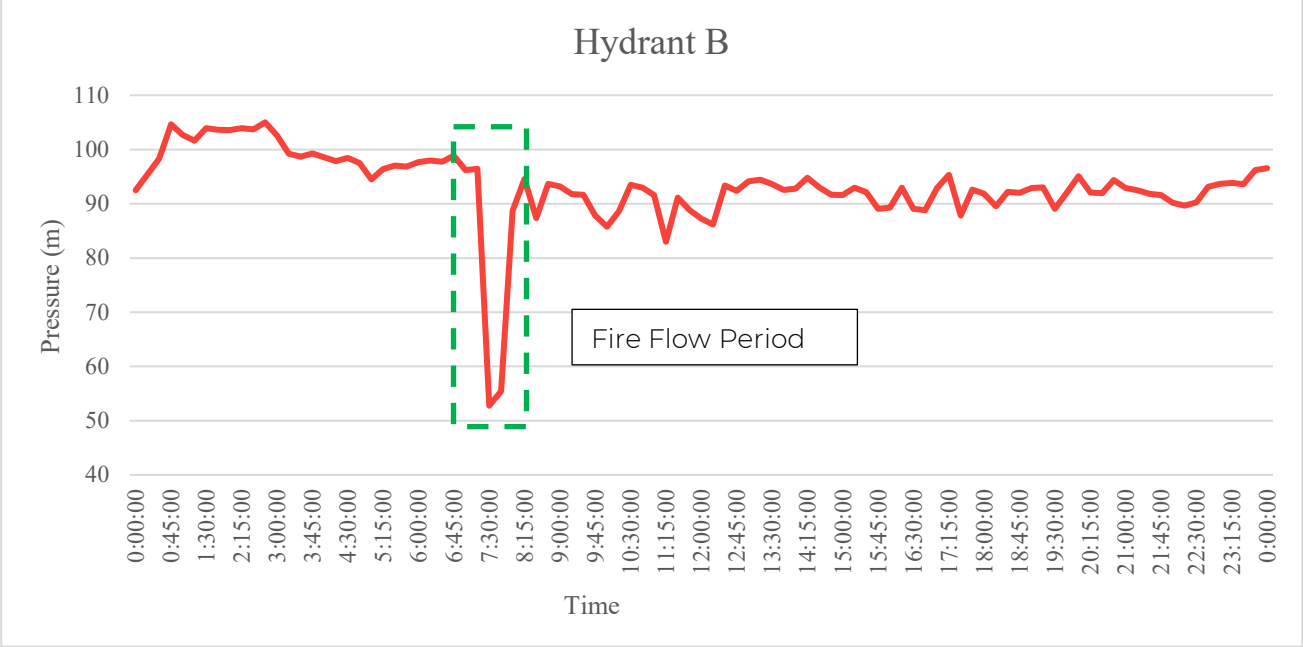
FIRE FLOW RESULTS

Overview

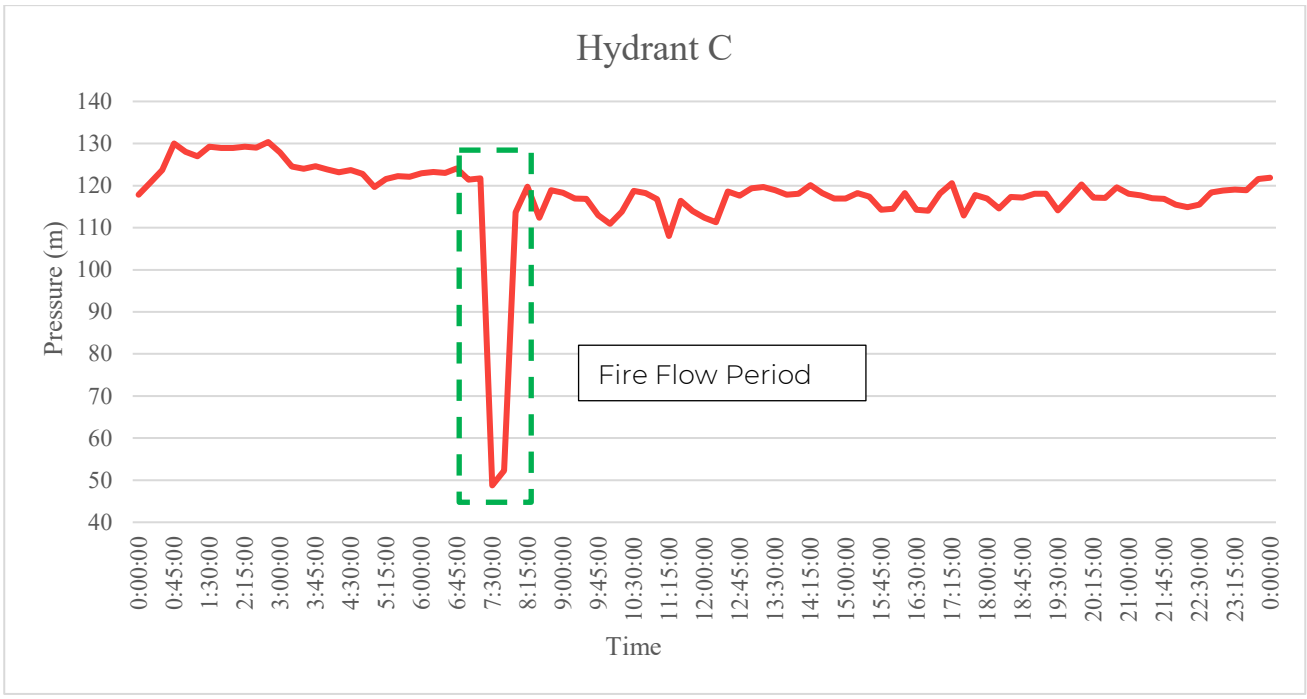




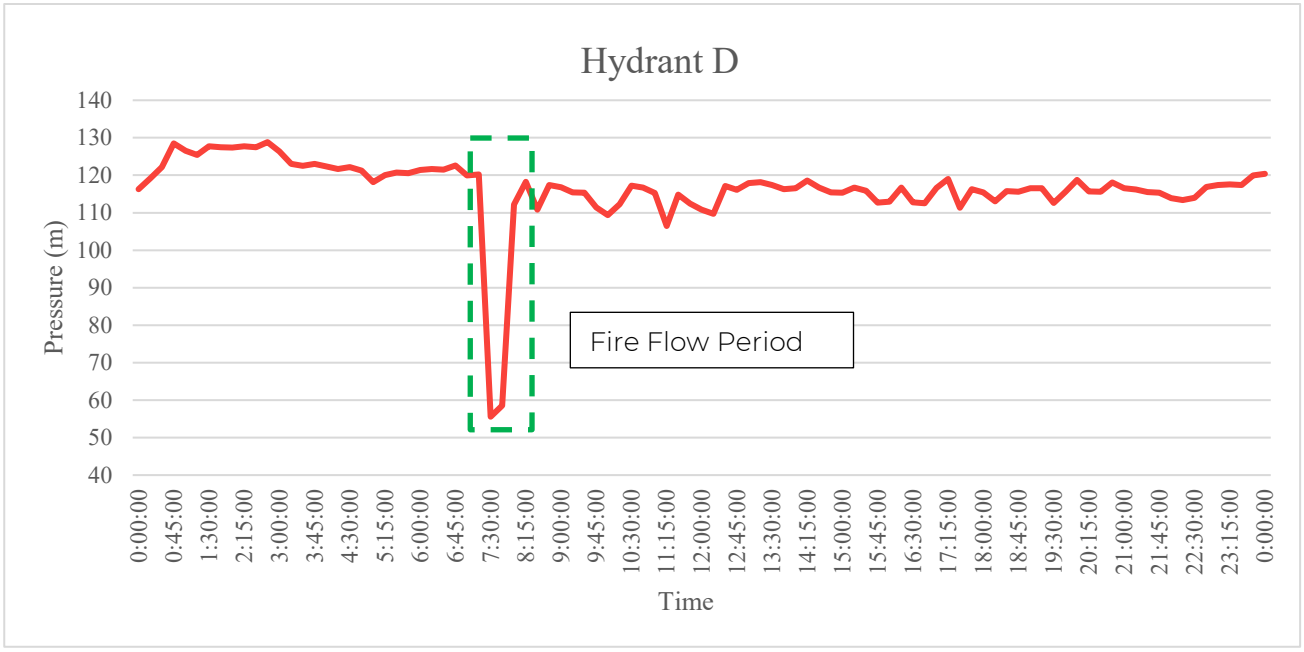
Residual Pressure at Hydrant A



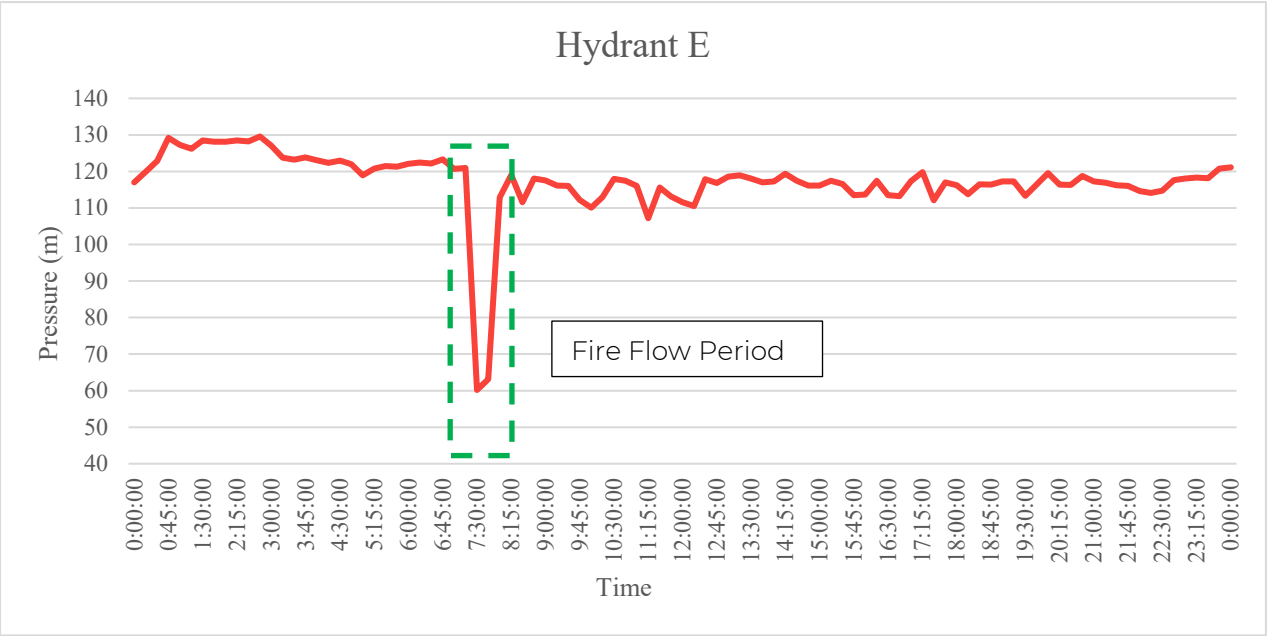
Residual Pressure at Hydrant B



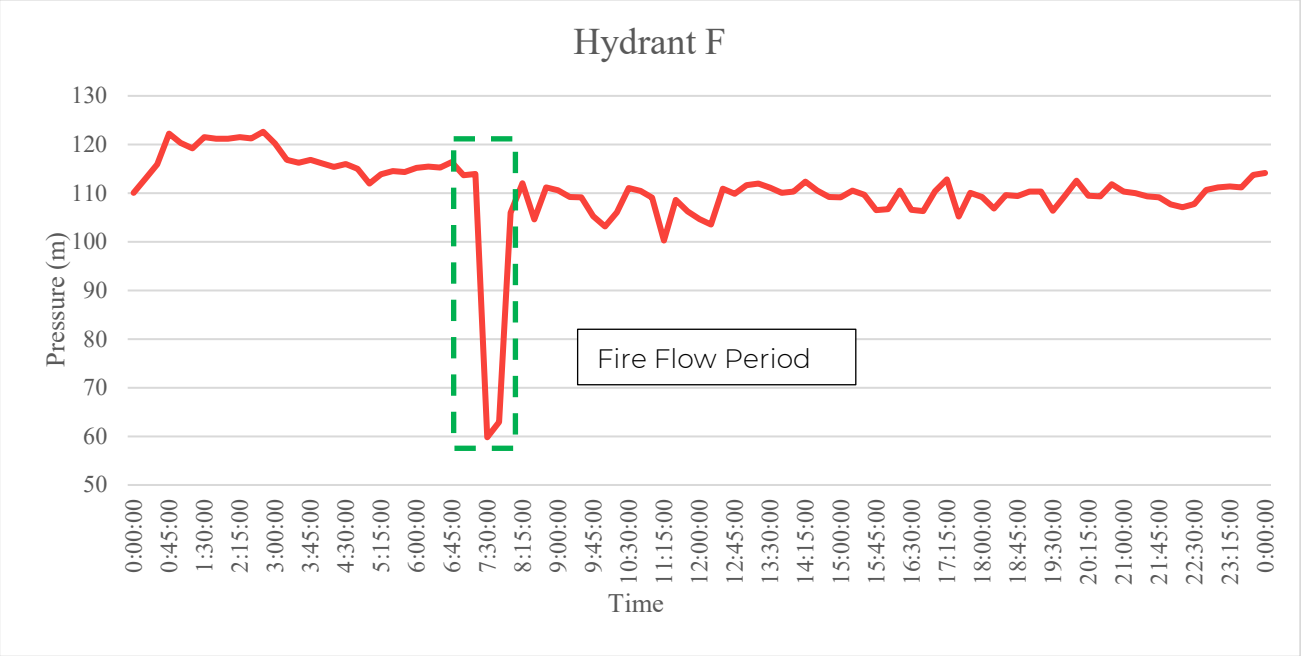
Residual Pressure at Hydrant C



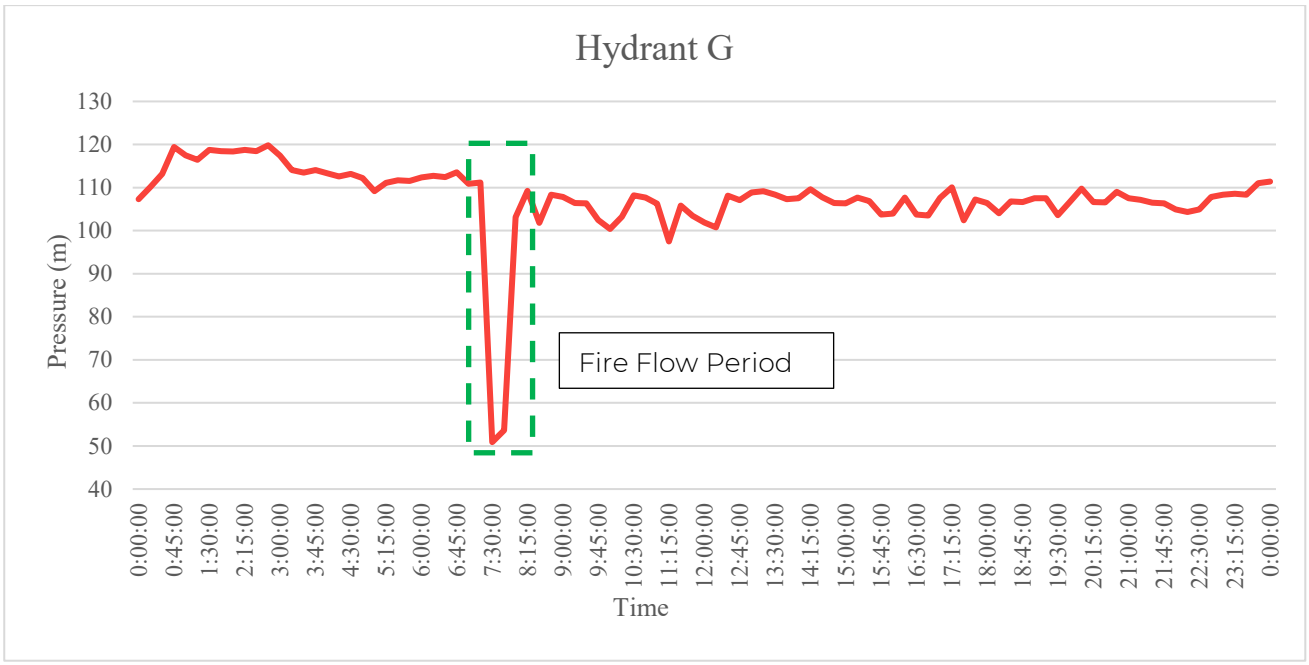
Residual Pressure at Hydrant D



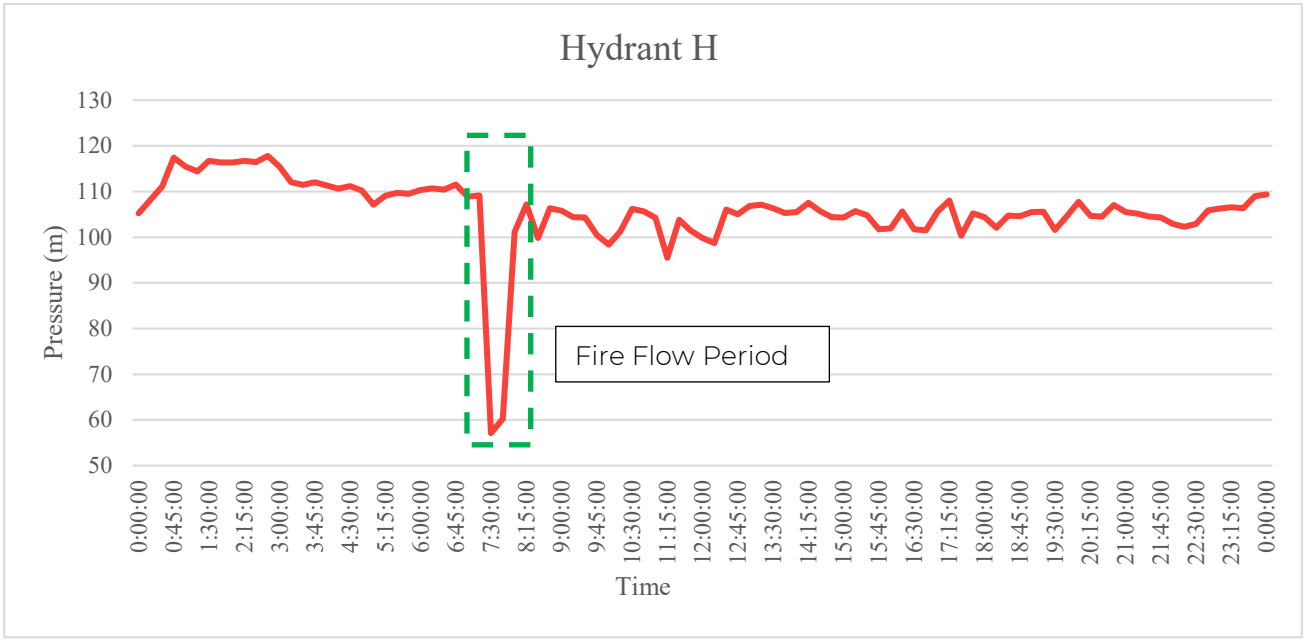
Residual Pressure at Hydrant E



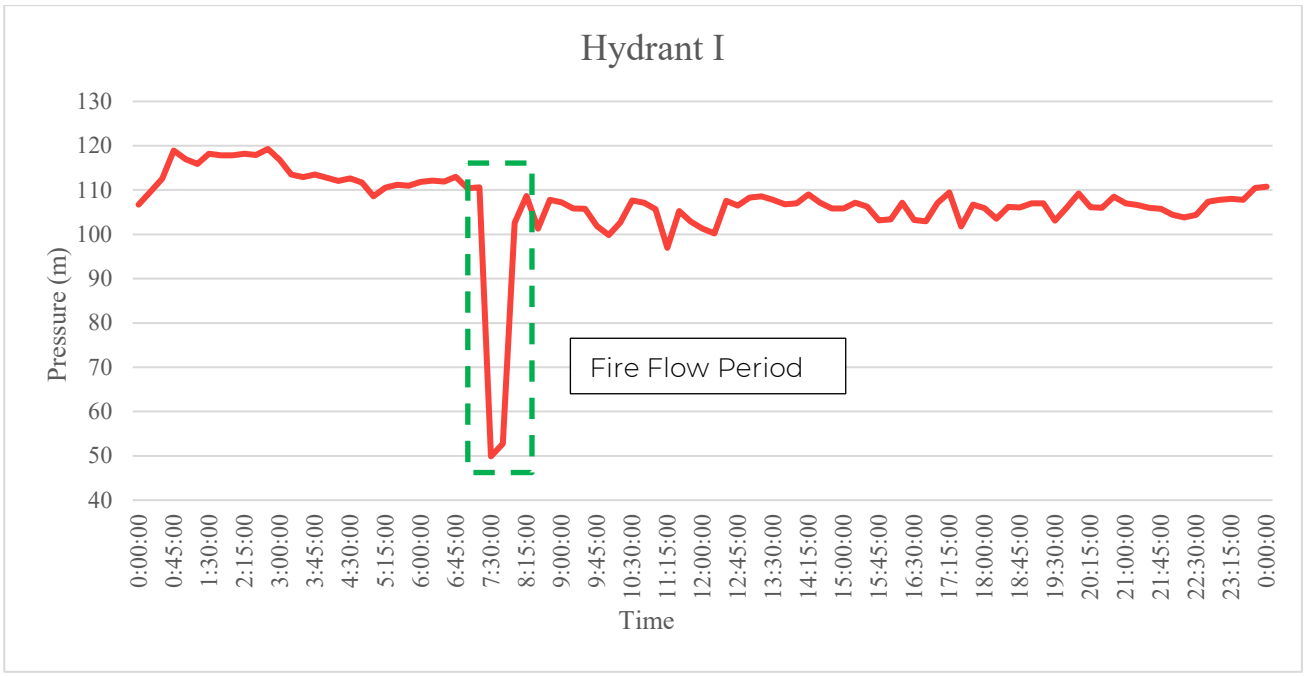
Residual Pressure at Hydrant F



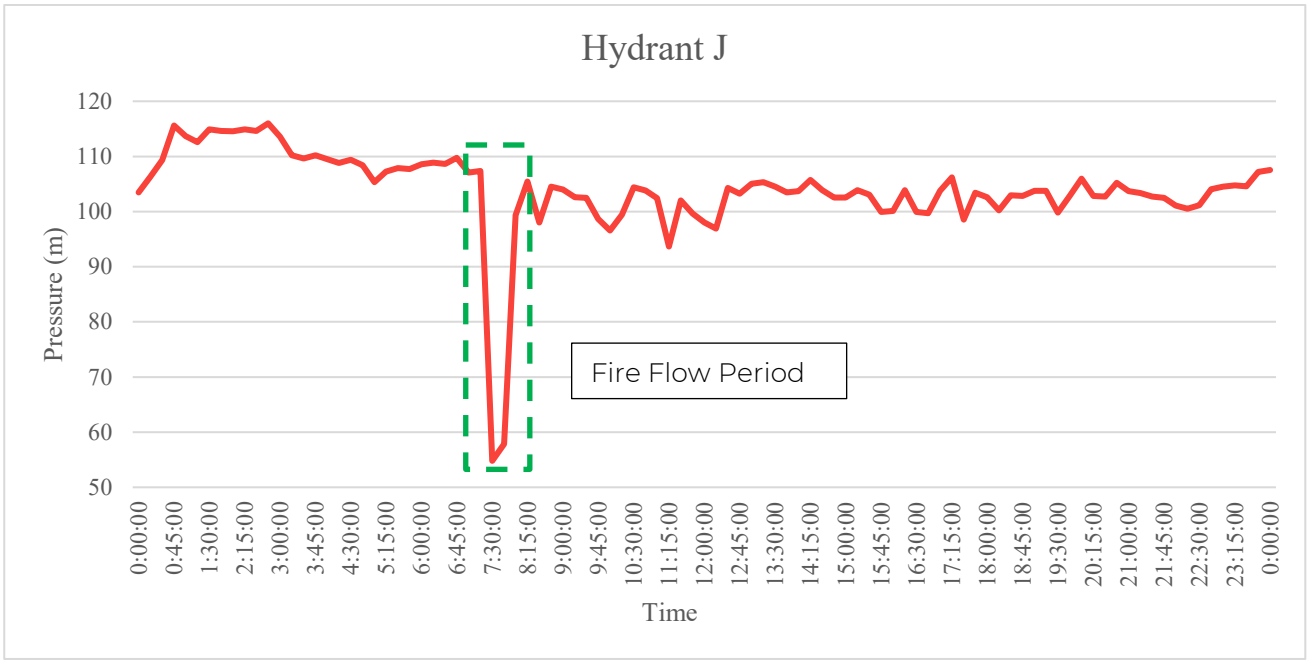
Residual Pressure at Hydrant G



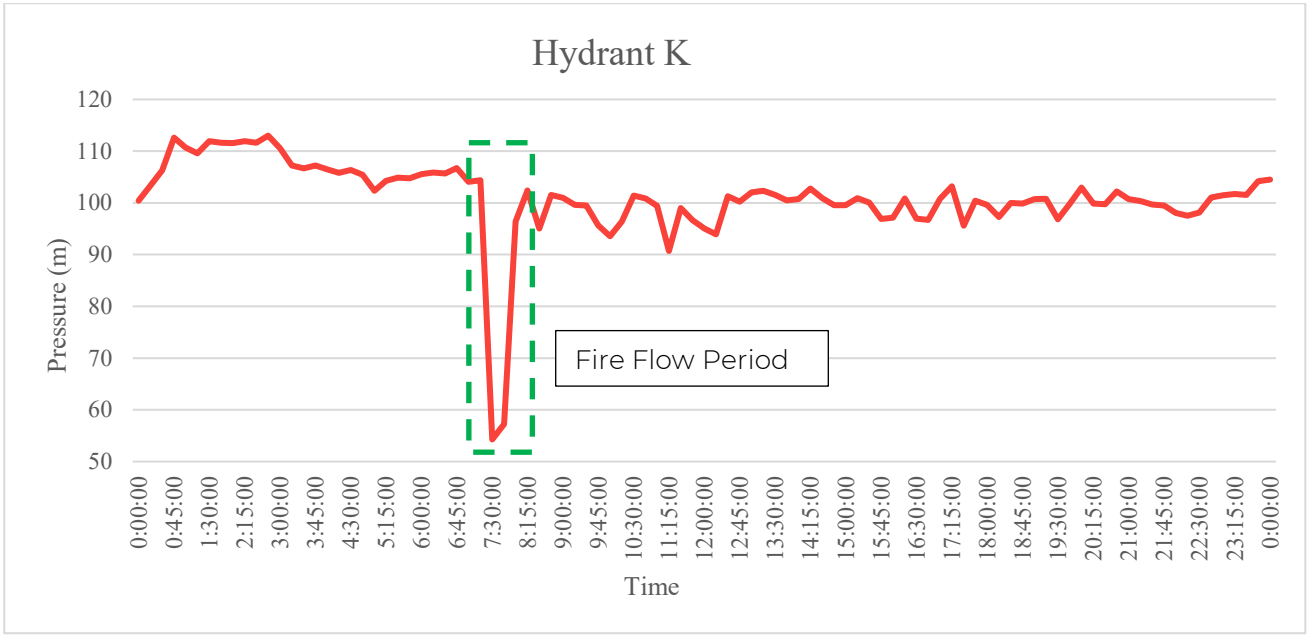
Residual Pressure at Hydrant H



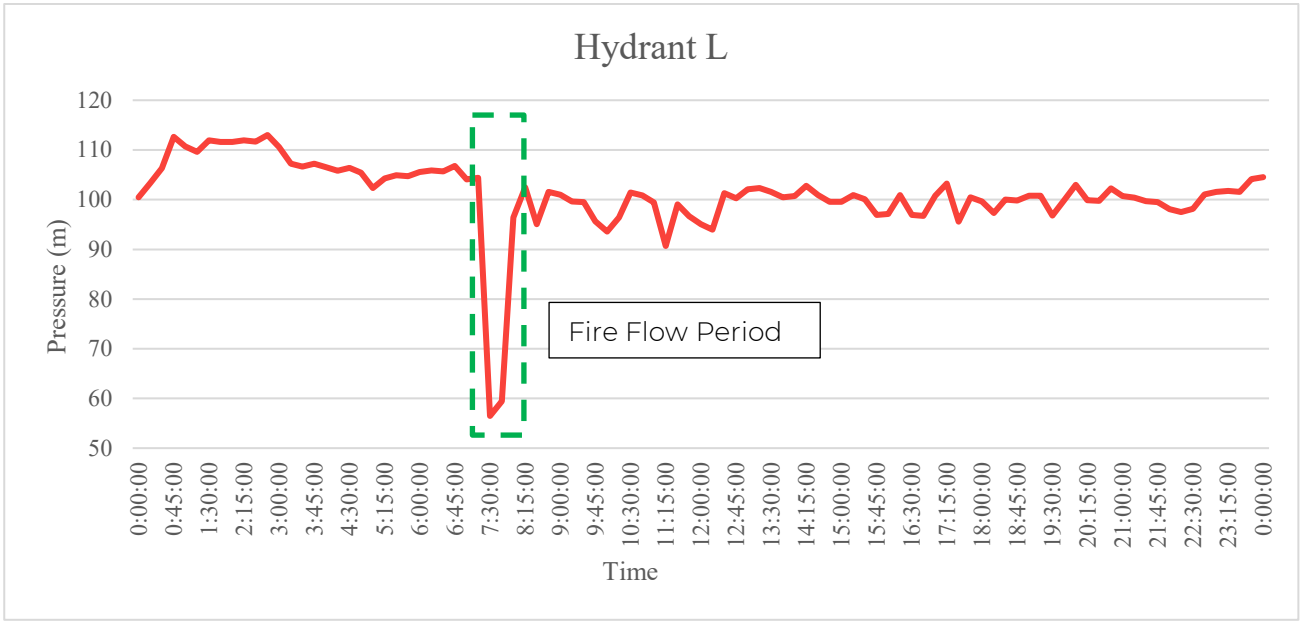
Residual Pressure at Hydrant I



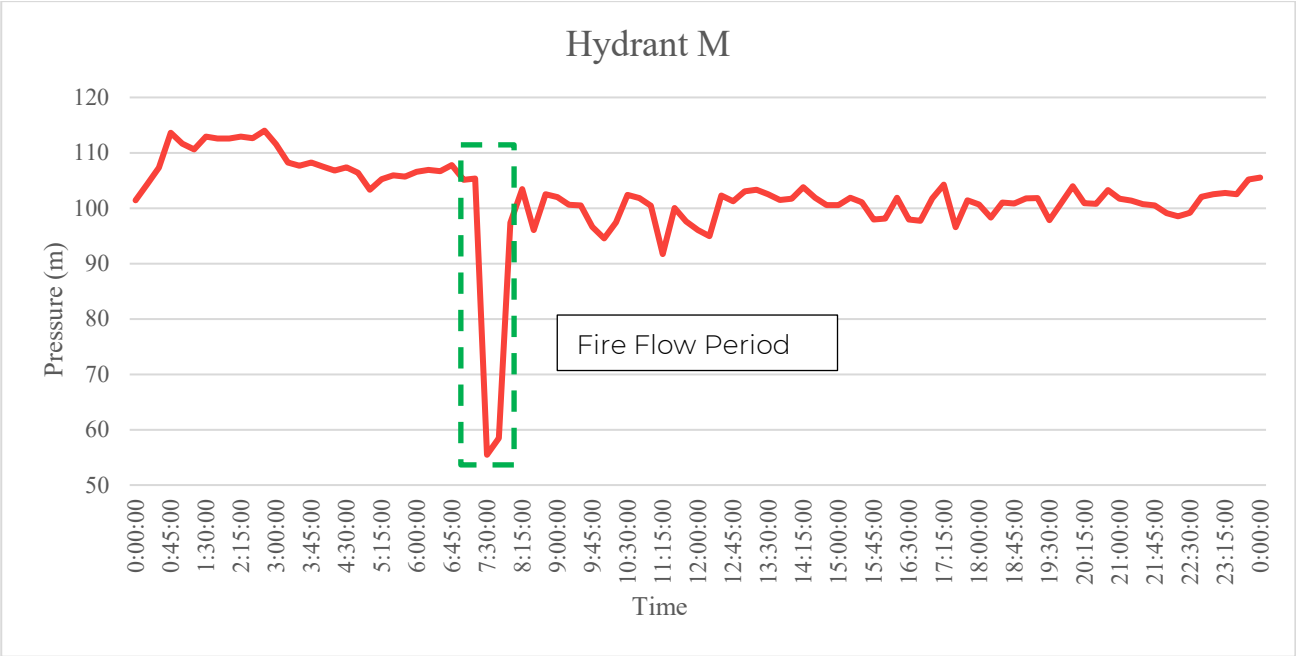
Residual Pressure at Hydrant J



Residual Pressure at Hydrant K



Residual Pressure at Hydrant L



Residual Pressure at Hydrant M