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TECHNICAL MEMORANDUM

DATE	October 26, 2018
TO	**Freddy Baron, York Region**
CC	Luis Carvalho, York Region
SUBJECT	Stouffville Storage Class EA **Water Model Validation**
FROM	Kevin Brown, P.Eng
PROJECT NUMBER	17100

1 Background

As part of the Stouffville Water System Upgrades Class Environmental Assessment (Class EA), TMIG has undertaken a review of the background information relating to the community's water supply. The purpose of this technical memorandum is to document the validation process performed on the Region's Water Model to confirm the applicability of the model to the present assignment.

2 Model Review

Through the review of supply, storage, system demands, and distribution components of the Region's Water Model following items were identified as required updates to make the model acceptable for further analysis.

- There were differences in the model demands when compared with Region's Master Plan demand and these demands should be adjusted to match the Master Plan modified.
- The model is set up for an extended period simulation, therefore has a control data set to represent the operation conditions of the pump in field. From review of control dataset, it is observed that the operation of all well pumps is not actually controlled, but they operate constantly. As the modelled pump type and pump controls do not match the current operational procedures, the pump controls in model should be updated with operational conditions. Overall, all the model pump controls should be updated with Region's current operation procedures.
- Roughness coefficients of the pipes in model are generally within acceptable range, however there are few 100 to 200 mm pipes with C = 70. This might be based on calibration of model to field pressures, but these appear to have minimal impact on the system pressures.

3 Model Validation

- **Update to Model Demands**

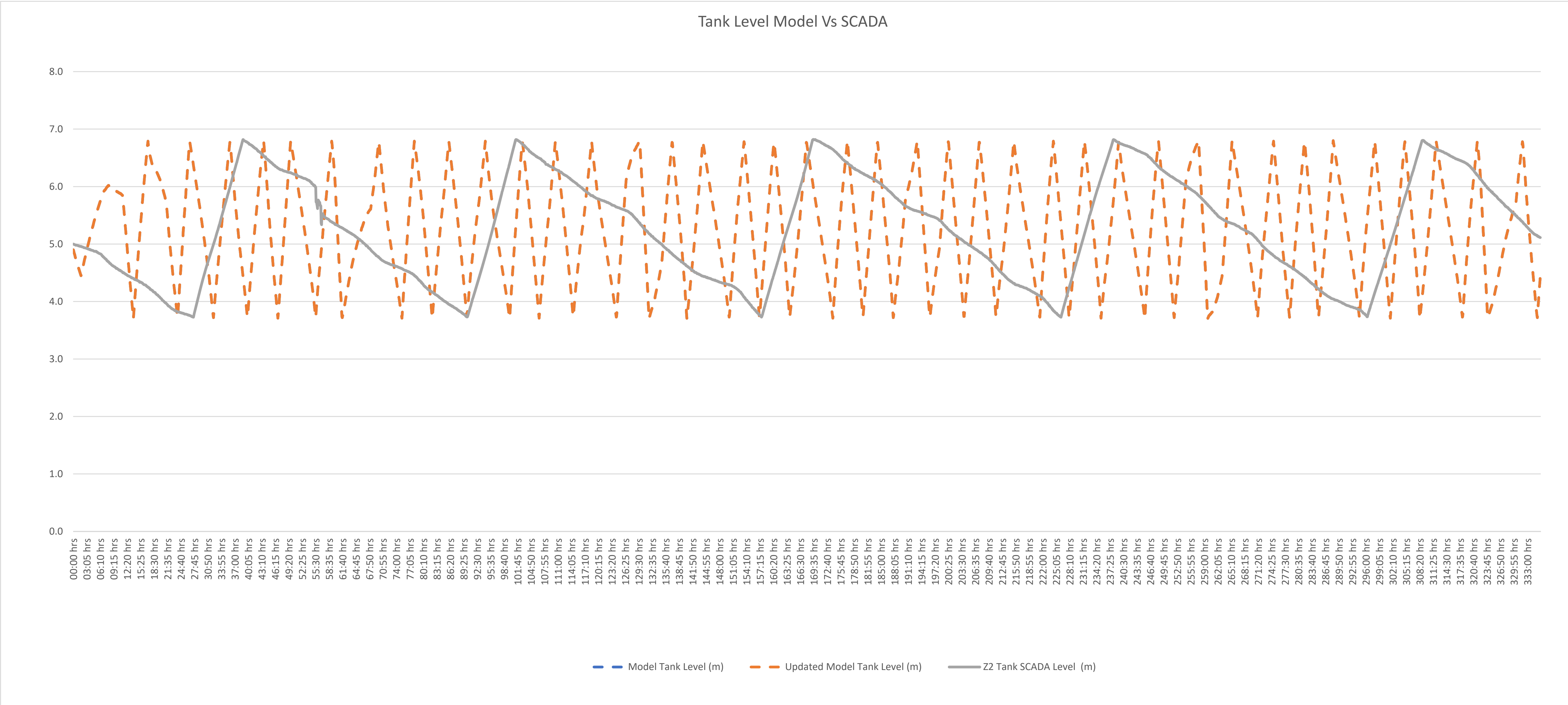
Adjustment factors for the model demands were calculated by dividing Master Plan zonal demand with Model zonal demand. Those Adjustment factors were multiplied to model demand for each scenario by block editing the demands.

- **Update to Model Pump Control Data based on Tank level and Time**

Model control data for the pumps based on tank level and time of the day was updated based on the control data provided by region to validate the model. The model was simulated for 48 hours period under average day demand scenario and the results are then compared with five-minute SCADA data provided.

- **Update to Model Pump Curves and Control Data to Match SCADA Data**

The comparison between the SCADA Data and updated Model Output showed some differences in the flow rates, the discharge pressure and frequency of the pump operations. The Tank level triggers for model and SCADA matched at 3.7 m at lower end and 6.9 m at higher end. The pump curves for McCowan PS and Wells 1, 2 and 3 were updated based on the given curves and modified a little to match the SCADA Data. This updated model was simulated for 48 hours period under average day demand scenario and the results are then compared with five-minute SCADA data provided. The Attachment 1 shows the graphs comparing SCADA data and the updated Model output. This updated model output is within the acceptable range variation. After the above the validation process performed on the Region's Water Model to this model can be used for the assignment of storage analysis.

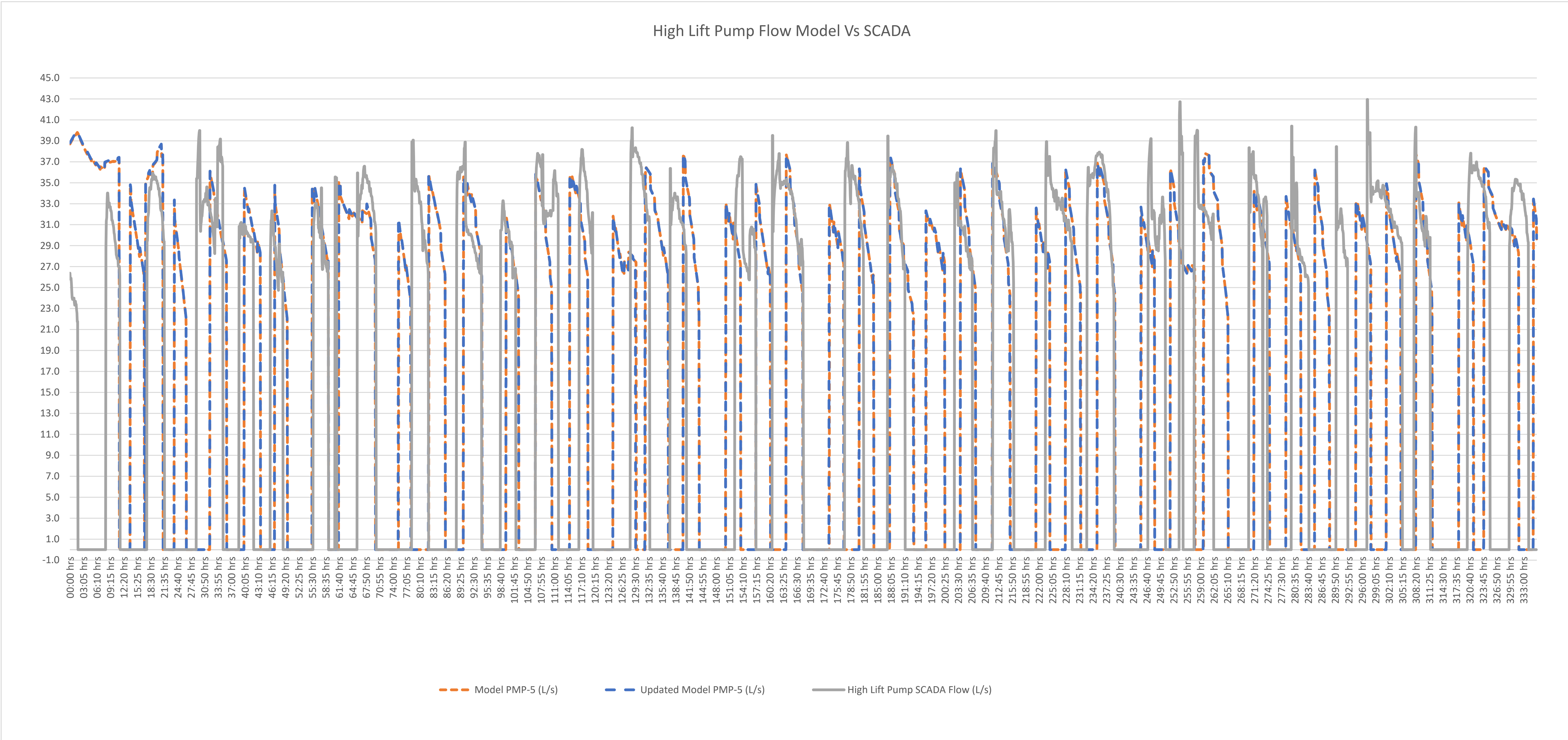


Inference from Initial Model output

- The high (6.9 m) and low (3.7 m) tank level match with SCADA.
- The Cycle of tank discharge and filling in model is more frequent than SCASA. This cannot be exactly simulated as there are operational overrides to pump controls and demand in model might be different that the SCADA demand for that given day.

Model Setting update

- No change to model was done to the control data set based on tank level.

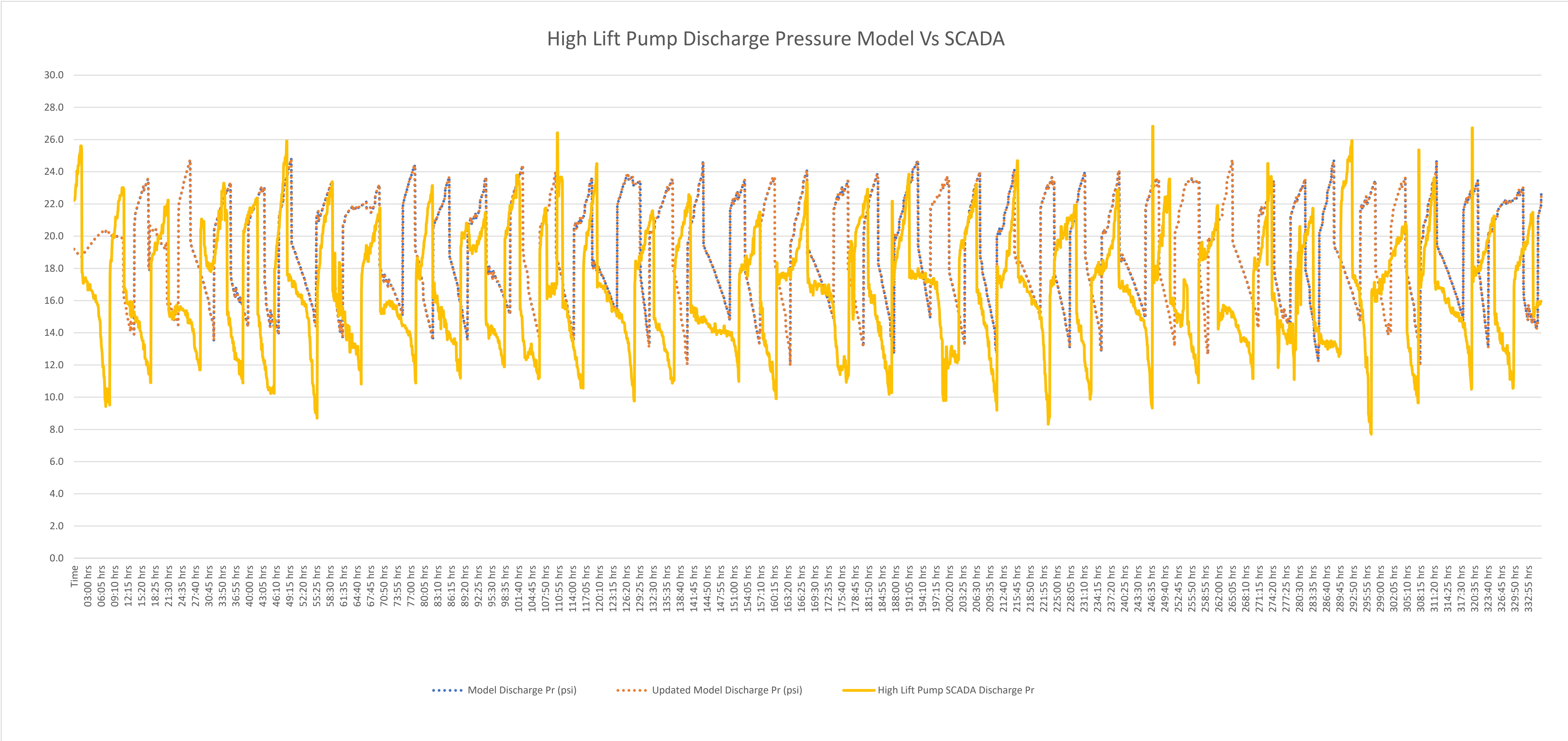


Inference from Initial Model output

- The average peak flow from the highlift PS in model is 35 l/s and that of SCADA is 36 L/s. This variation is within an acceptable limit.
- The Cycle of pump discharge on and off in model is similar to the SCADA.

Model Setting update

- No change to model was done to the high lift PS control data set.

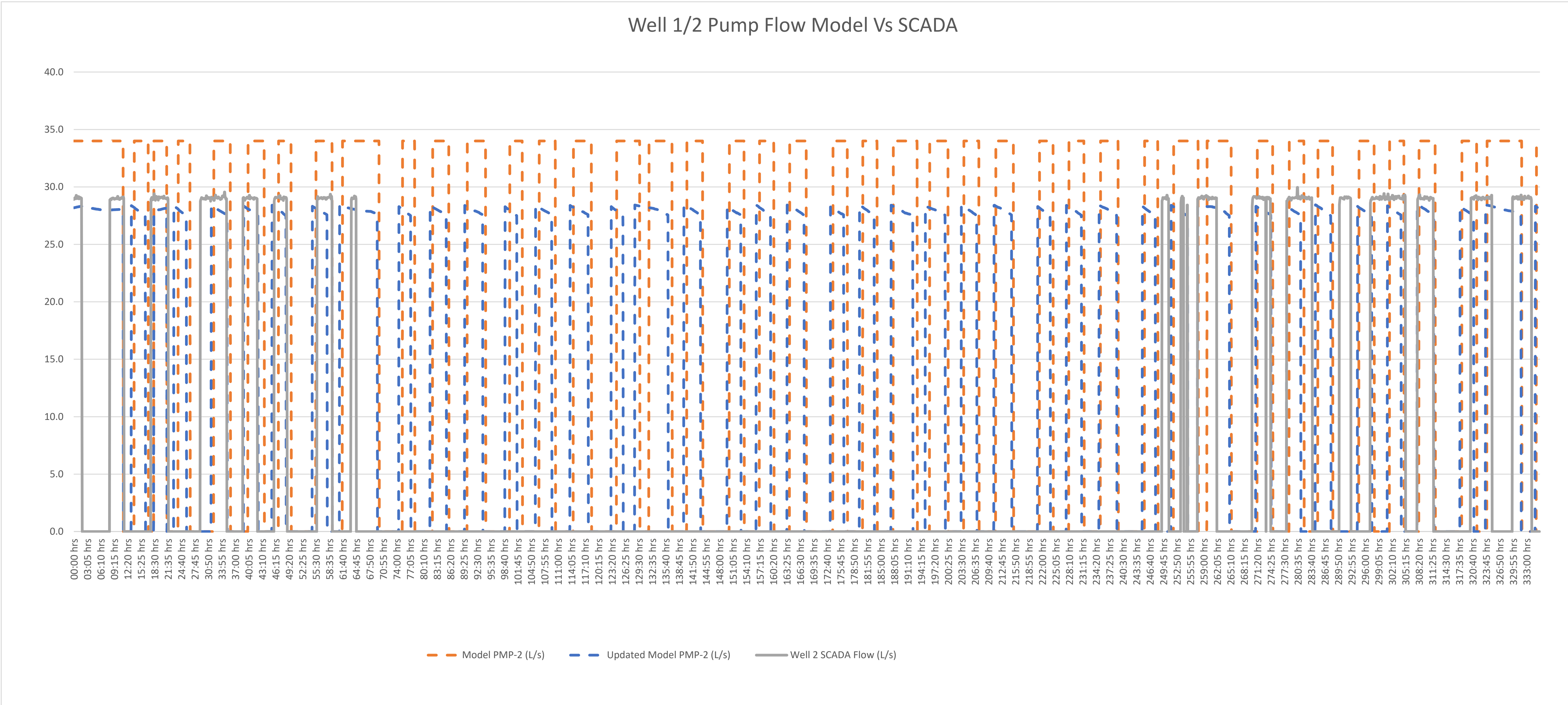


Inference from Initial Model output

- The average peak discharge pressure from the highlift PS in model is 22 psi and that of SCADA is 23 psi.
- The average shut off pressure in model is 13 psi and that of SCADA is 15 psi.
- These variations are within an acceptable limit.

Model Setting update

- No change to model was done to the high lift PS control data set.

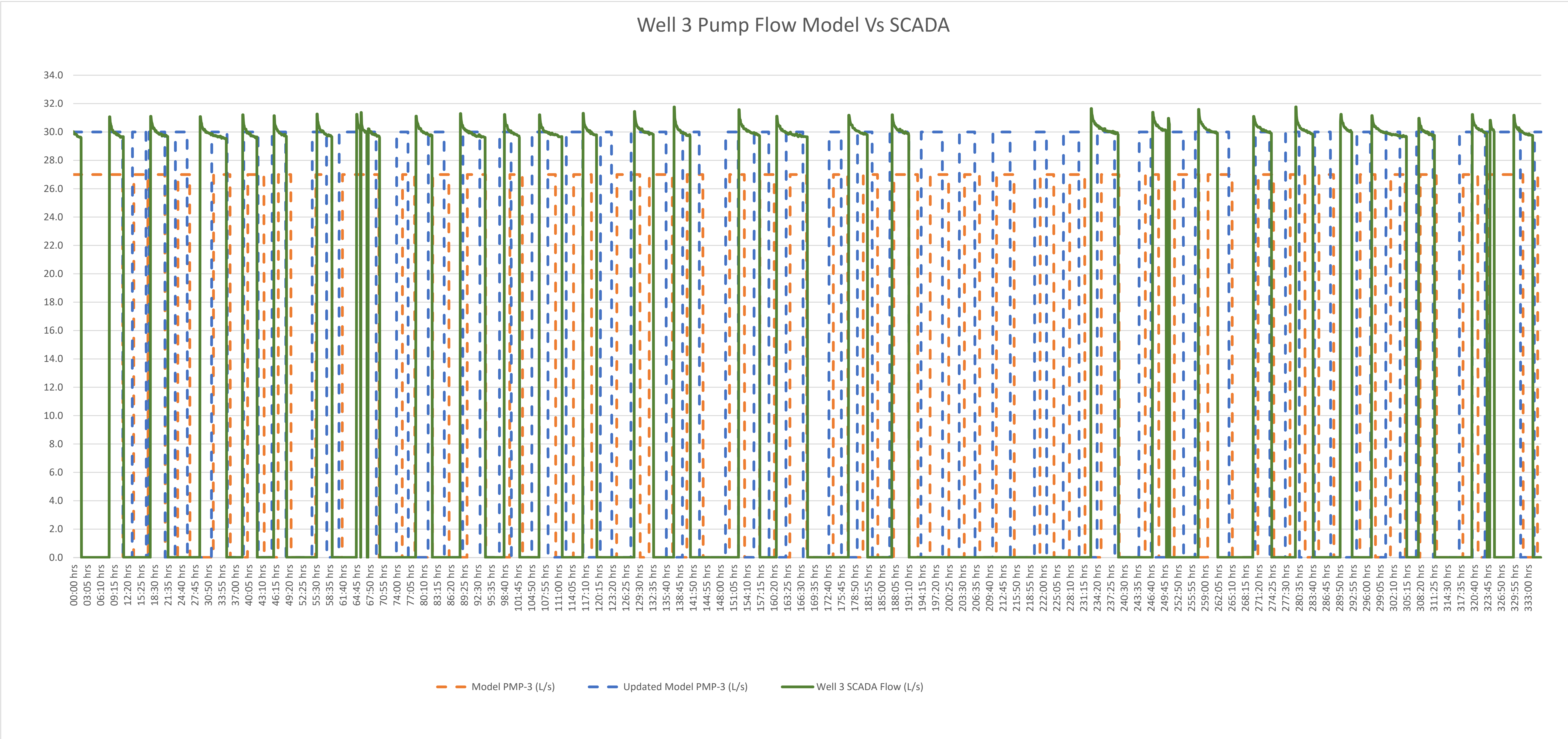


Inference from Initial Model output

- The average peak flow from the Well 1/2 PS in model is 34 l/s and that of SCADA is 28 L/s. This variation is high and the model setting needs to be verified.
- The Cycle of pump discharge on and off in model is more frequent than that of SCADA. There seems to be operational override to controls in SCADA, which cannot be simulated in model.

Model Setting update

-The well 3 pump curve was modified to change the discharge rate with discharge pressure to match the SCADA
- The maximum flow value for the Flow control valve in discharge line from PS is changed to reflect that of SCADA data.

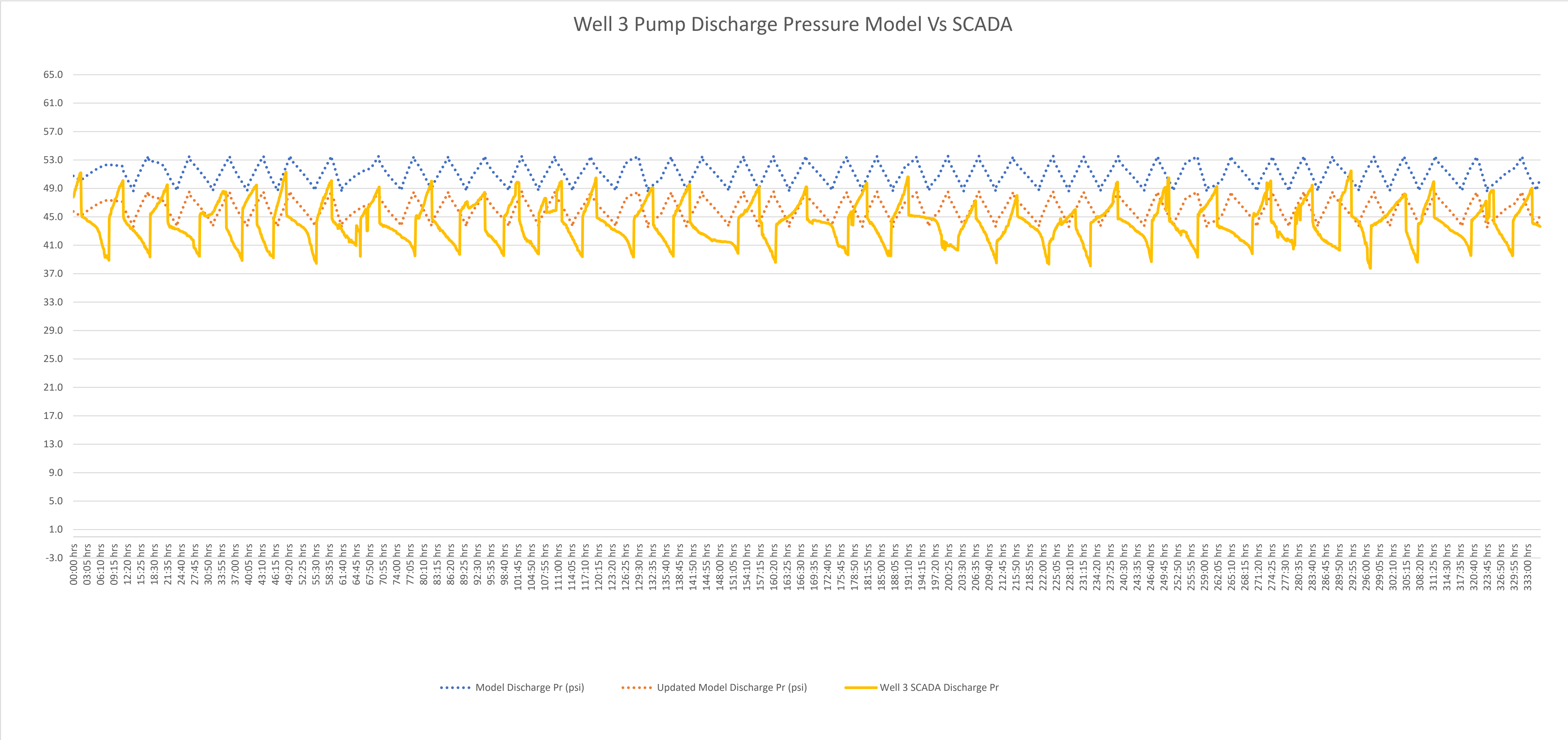


Inference from Initial Model output

- The average peak flow from the Well 3 PS in model is 27 l/s and that of SCADA is 30 L/s. This variation is high and the model setting needs to be verified.
- The Cycle of pump discharge on and off in model is similar to the SCADA.

Model Setting update

-The well 3 pump curve was modified to change the discharge rate with discharge pressure to match the SCADA
- The maximum flow value for the Flow control valve in discharge line from PS is changed to reflect that of SCADA data.

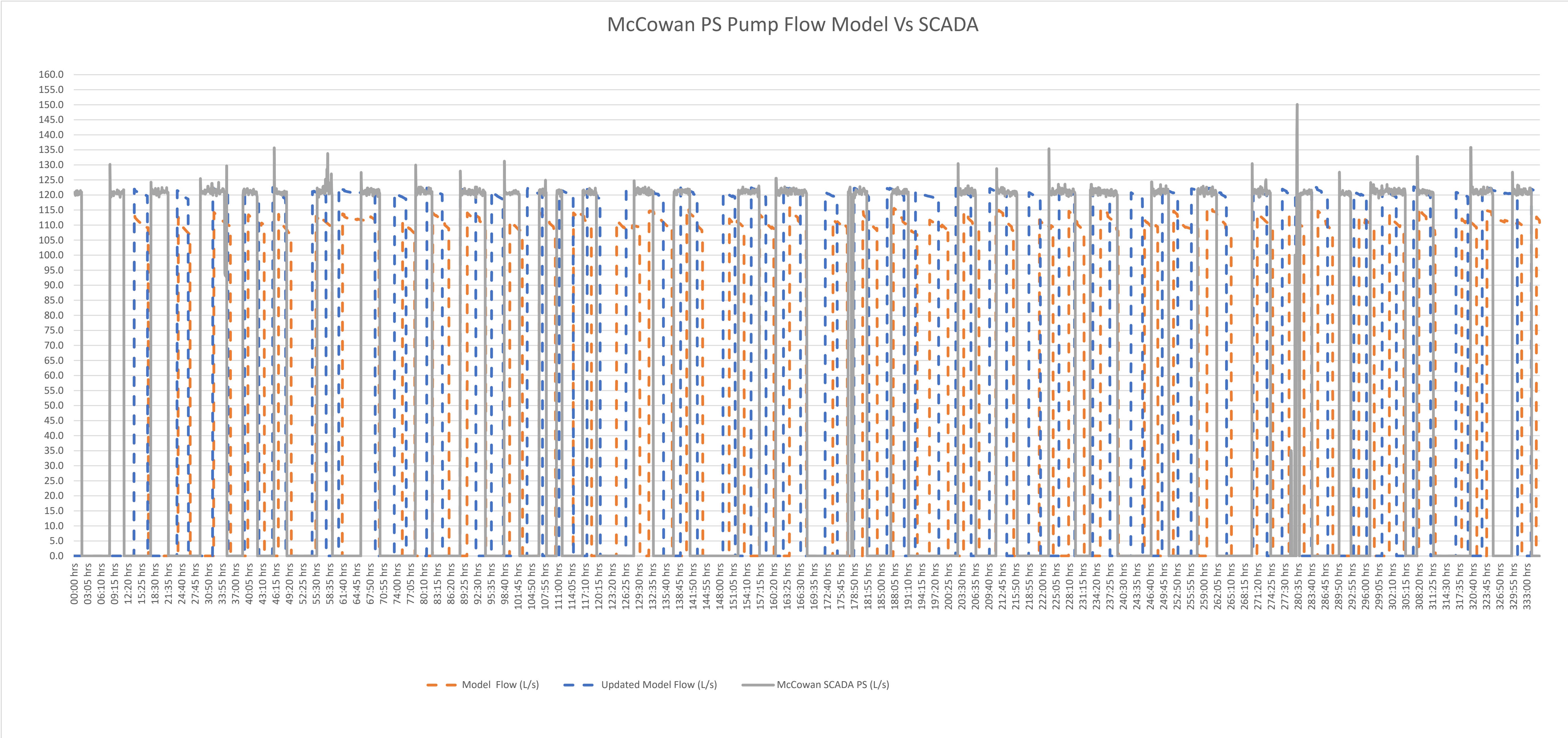


Inference from Initial Model output

- The average peak discharge pressure from the Well 3 PS in model is 53 psi and that of SCADA is 49 psi.
- The average shut off pressure in model is 49 psi and that of SCADA is 40 psi.
- These variations are high and the model setting needs to be verified.

Model Setting update

-The well 3 pump curve was modified to change the discharge rate with discharge pressure to match the SCADA within acceptable range.

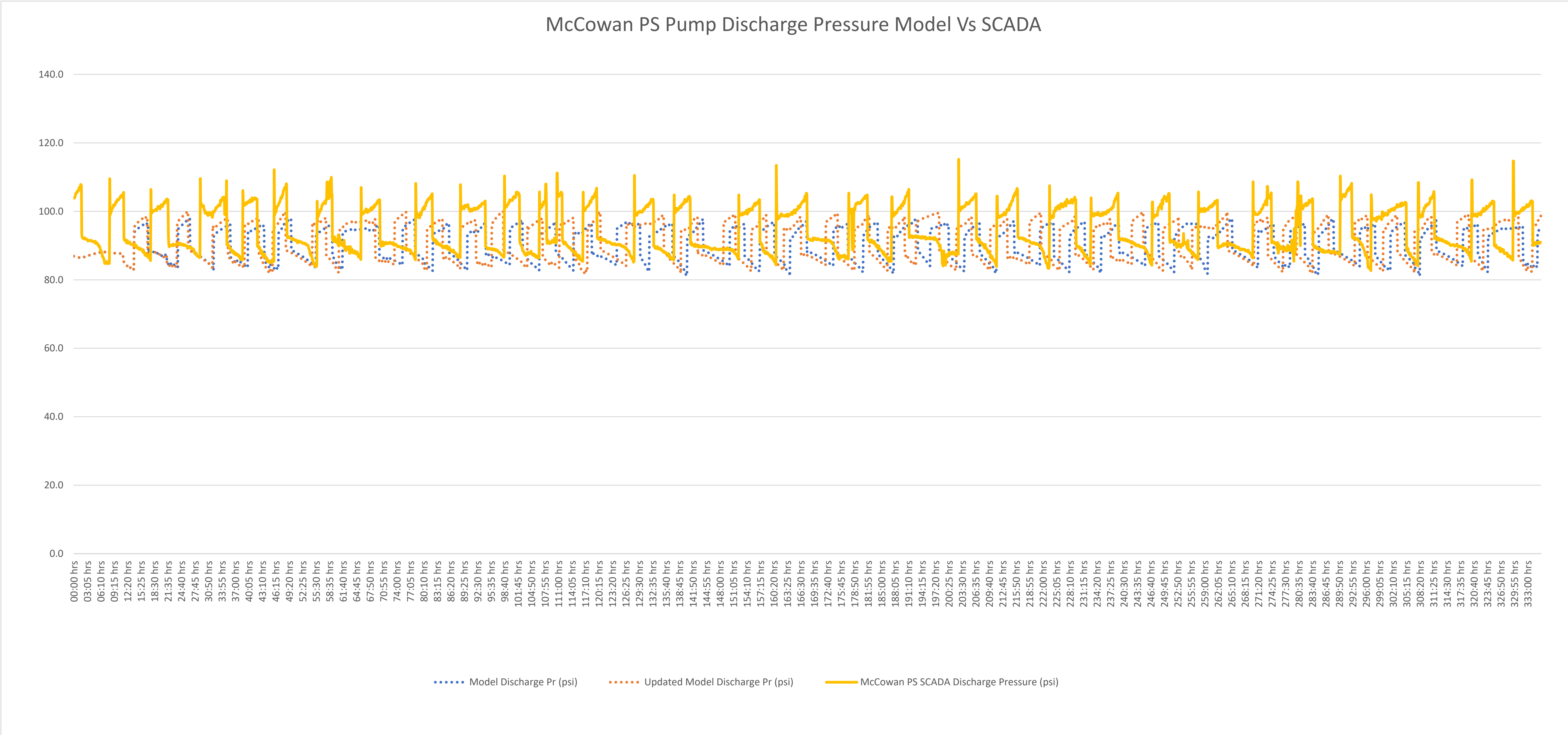


Inference from Initial Model output

- The average peak flow from the McCowan PS in model is 112 l/s and that of SCADA is 120 L/s. This variation is high and the model setting needs to be verified.
- The Cycle of pump discharge on and off in model is similar to the SCADA.

Model Setting update

-The McCowan PS pump curves were modified to change the discharge rate with discharge pressure to match the SCADA.



Inference from Initial Model output

- The average peak discharge pressure from the McCowan PS in model is 104 psi and that of SCADA is 94 psi.
- The average shut off pressure in model is 81 psi and that of SCADA is 88 psi.
- These variations are high and the model setting needs to be verified.

Model Setting update

-The McCowan PS pump curves were modified to change the discharge rate with discharge pressure to match the SCADA within acceptable range.

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MEMORANDUM

DATE	March 10, 2020
TO	**York Region,** Luis Carvalho, Freddy Baron
CC	
SUBJECT	Stouffville Water Storage Class EA **Macro-Calibration of Water Model and Storage Location Impact Analysis**
FROM	**TMIG**; Cassandra Leal, P.Eng
PROJECT NUMBER	17100

1 Background

TMIG was retained by York Region to complete the Stouffville Water Storage Class Environmental Assessment (EA). As part of this EA, TMIG will comment on and analyse the new Zone 2 Storage Locations. The purpose of this technical memorandum is to describe the modifications completed to calibrate the InfoWater model, as well as analyse various new storage locations options, as required to supply the long-term needs of the community.

The current Stouffville water system is comprised of three pressure districts, Zone 1, 2 and 3. All water is supplied into the system through Zone 2, with Zone 1 supplied through a Booster Pumping Station and Zone 3 supplied through pressure reducing valves.

There are also five operational wells providing water to the Stouffville system: Well 1, 2, 3, and 5 & 6 (located in the High Lift Pumping Station (HLPS)). The community is also connected to the Region's Lake-based system through the McCowan Reservoir and booster pumping station (BPS).

2 Model Review and Verification

TMIG received SCADA data from York Region in 2017 for use in this project and received the Stouffville InfoWater model in 2017. TMIG calibrated the received model to mimic the SCADA data received.

SCADA data received for the dates May 1 – 15 2017. **Table 2-1:** summarizes the SCADA data received and other facility information received for the period of May 1 to May 15th, 2017.

TABLE 2-1: SCADA DATA PROVIDED FOR MAY 1 – 15TH

FACILITY	DATA PROVIDED			
	FLOW	UPSTREAM HGL (suction pressure)	DOWNSTREAM HGL (discharge pressure)	PUMP CURVES
Well 1	✓	✓	X	✓
Well 2	✓	✓	X	✓
Well 3	✓	X	✓	✓
HLPS (Wells 5 & 6)	✓	X	X	X
McCowan BPS	✓	✓	✓	✓
Zone 1 BPS	✓	✓	✓	
Zone 1 Elevated Tank	✓	N/A	✓	N/A
Zone 2 Elevated Tank	✓	N/A	✓	N/A

A new scenario was created in InfoWater named “Calibration2019, May 8-12 2017”.

2.1 Model Review Objectives

In order to validate the modelling results to ensure that the model was appropriately calibrated to undertake the analysis required to support the Class Environmental Assessment Study, the Region established the following goals:

- 90% of the pressures should be within 3 psi (20 kPa);
- Flow and Tank levels should be within 5-10% (about 0.5 m).

A full C factor calibration of the system (most of which is under the Town’s jurisdiction) is not required, as the focus is on the Regional facilities, and in ensuring that the Region can supply the water required to meet the Town’s demands at reasonable pressures to support the ultimate conveyance to the individual customers.

2.2 Water Supply and Storage Requirements

The Water Supply and Storage requirements are provided in **Table 2-2** through **Table 2-3**. These are documented in Technical Memorandum 1 (TM 1) from the Class EA Process, and represent the overall servicing objectives. Further details are provided in that Technical Memorandum.

The Zone 2+3 Storage requirements provided in **Table 2-4** reflect that the Fire Storage requirement for Zone 2 can be provided through Zone 1.

TABLE 2-2: DESIGN WATER SUPPLY REQUIREMENTS BY ZONE

Source[1]	2016	2021	2026	2031	2036	2041
Total Max Day Demands (m^3/day)	15,686	17,955	20,657	20,767	20,627	20,821
Zone 1 Residential Demand (m^3/day)	1,696	2,625	3,543	3,560	3,507	3,573
Zone 1 Employment Demand (m^3/day)	334	421	491	506	519	528
Zone 1 Total (m^3/day)	2,030	3,046	4,034	4,066	4,026	4,101
Zone 2 Residential Demand (m^3/day)	10,534	11,635	12,980	12,935	12,714	12,774
Zone 2 Employment Demand (m^3/day)	1,985	2,081	2,299	2,361	2,409	2,410
Zone 2 Total (m^3/day)	12,519	13,716	15,279	15,296	15,123	15,184
Zone 3 Residential Demand (m^3/day)	478	510	555	565	596	636
Zone 3 Employment Demand (m^3/day)	659	683	789	840	882	900
Zone 3 Total (m^3/day)	1,137	1,193	1,344	1,405	1,478	1,536

1. *Demands Extracted from York Region's 2016 Water and Wastewater Master Plan*

TABLE 2-3: ZONE 1 STORAGE REQUIREMENTS

	2016	2021	2026	2031	2036	2041
Population	39,342	48,412	57,476	60,351	62,093	64,671
MDD (m^3/day)	15,686	17,955	20,657	20,767	20,627	20,821
A: Fire Storage (ML)	3.570	3.570	3.570	3.570	3.570	3.570
B: Equalization Storage (25% of MDD, ML)	3.921	4.489	5.164	5.192	5.157	5.205
C: Emergency Storage (25% of A + B) (ML)	4.550	4.692	4.861	4.868	4.859	4.871
Required Storage Volume (ML)	5.097	5.414	5.723	5.733	5.721	5.744

TABLE 2-4: REQUIRED ZONE 2+3 STORAGE WITH SHARED FIRE STORAGE FROM ZONE 1

	2016	2021	2026	2031	2036	2041
Population	39,342	48,412	57,476	60,351	62,093	64,671
MDD (m^3/day)	15,686	17,955	20,657	20,767	20,627	20,821
A: Fire Storage (ML)	-	-	-	-	-	-
B: Equalization Storage (25% of MDD, ML)	3.921	4.489	5.164	5.192	5.157	5.205
C: Emergency Storage (25% of A + B) (ML)	4.550	4.692	4.861	4.868	4.859	4.871
Required Volume Storage (m^3)	4,267	4,659	5,194	5,219	5,186	5,225

2.3 Existing Conditions Demands Adjustment

In order to verify the model based on the SCADA data, the demands in the model required adjustment to reflect the specific conditions for the period over which the SCADA data was provided. The demands were adjusted by completing a mass balance based on the SCADA data, for each 5-minute time step:

The Zone 1 Demands were determined as follows:

- Determine the total **supply** to the Zone (SCADA data from the Zone 1 BPS);
- Subtract the volume **into** the Zone 1 Elevated Tank (or add the flow **out of** the Tank)

The Zone 2/3 Demands were determined using a comparable process:

- Determine the total **supply** to the Zone (SCADA data from the Wells and the Lake-Based Supply);

- Subtract the Zone 1 BPS demand
- Subtract the volume **into** the Zone 2 Elevated Tank (or add the flow **out of** the Tank)

There was no differentiation between Zone 2 and Zone 3, as the Region views these as a single Zone, despite the fact that there are Pressure-Reducing Valves on the Town's system.

The InfoWater model had four demands: existing (residential and employment) and growth (residential and employment). The "growth" demands were set to 0 in the model, and the existing demands (which were based on design demands, not actual) in the received model were multiplied by a factor such that the new model demand equalled the demand calculated from SCADA data provided. The factors were different based on the zone and were applied to junctions based on the zone description (which was already set in the received model).

Once the demands in the model were replicating the demands observed in the SCADA data, an hourly pattern was applied to each junction (one pattern for Zone 1, one pattern for Zones 2/3) to replicate demand usage throughout a 24-hr period. It was noticed that the water usage varies between weekdays and weekends, and as such, the scenario is set for a Monday – Friday simulation. The week of May 8 – 12, 2017 was selected as it was more consistent and would be easier to replicate using a model. The overall demand between the two weeks are very similar.

2.4 System Modifications

Once the demands were adjusted the model was run to assess how it performed relative to the actual operation.

The wells in the Region's model are included as 'reservoirs' to represent the source aquifer with corresponding pipe and pump, and pump curves to replicate the well operation. A pattern was created for each pump for the 5-day simulation based on SCADA data to control when the corresponding pump was running and producing flow, and when it was not producing flow ("schedule" operation, versus "tank control"). This scheduled the modelled pumps to operate as they did during the week over which the model was being verified. This pattern is the only control on the facilities, the other controls (typically, controlled by levels in elevated tanks) have been removed and disabled for the purpose of the model verification.

During the simulation, flow control valves assigned to the model at Well 1, 2, 3, and HLPS were restricting the flow and caused several warnings, and failed simulations. The modelled flow control valves were deactivated, as information received by the Operations team indicated that there were no actual flow control valves in service in the system.

The elevated tank details (maximum, minimum and diameter) were not modified, as these matched the information previously provided by the Region. The initial levels were set to those from the SCADA data at the time of the simulation.

Once the pumps were operating in accordance with the actual system operation, the pump discharges were typically observed to be higher than the SCADA data. There are four ways that this situation can be addressed within the model:

1) Modify the pump curve;
2) Add a fixed headloss to represent losses between the well and the discharge point to the system (system losses associated with the wells, pumps, piping, valves, etc);
3) Increase the C factors in the pipes, to increase the head on the discharge side of the pumps; or,
4) Lower the elevation of the reservoir, to increase the head differential across the pumps.

As the pump curves were set by the Region (and generally matched the information provided) these were not modified during this modelling exercise. Modifying the pump curves is the most difficult method of adjusting the output of the pumps, as it is not a linear process.

Adding a fixed headloss is a reasonable option, as the head provided by the pump itself is always lower than the "net head" through the overall pumping process. Without suction and discharge pressures, this is difficult to adjust.

Without consistent pressure data on the discharge side of the pumps here is no basis for modifying the C factors. Further, the discrepancies that were observed in the initial modelling (30-50 m) would have required unreasonably low C Factors in the modelled pipes.

Lowering the elevations of the 'reservoirs' which represent the aquifers is effectively equivalent to modifying the pump curves or adding a fixed head loss. While the true elevations of the groundwater levels are not accurately represented, there is no need for these to be accurately modelled. There may ultimately be a desire by the Region to get these to represent the actual aquifer levels (which do vary seasonally, and in response to rainfall and well operation), but doing so would also require a more detailed representation of the entire well facilities in the model. These steps are not warranted for the purposes of this modelling exercise in support of the Class EA study being completed.

The net result of the changes proposed below are that the pump discharges are accurately represented compared to SCADA data, and the discharge HGL elevations seem reasonable. When discharge HGL elevations are available, the Region could consider further refinements to the model at that time.

To resolve this, the corresponding fixed head reservoirs at McCowan, Well 1, 2, and 3 were modified until the pump output was similar to SCADA data output. As the reservoir at the HLPS represents a physical facility, the variable-head curve could not be modified. The design point curve at HLPS was modified instead to replicate the SCADA data output at that facility. **Appendix A** includes graphs showing SCADA data and Model outputs for the various facilities before and after the parameter adjustments.

The changes made to various modelling parameters resulted in a model which closely replicates the actual system operation. A summary of the modelling parameters modified is shown in **Table 2-5**.

TABLE 2-5: MODIFIED MODELLING PARAMETERS

Facility	Parameter	Original	Updated
McCowan Reservoir	Reservoir Level	257.60 m	262.03 m
McCowan Reservoir	Pump Curve	-	increased discharge by 5%
Well 1	Reservoir Level	213 m	183 m
Well 2	Reservoir Level	214 m	186 m
Well 3	Reservoir Level	286 m	231 m
Well 5/6 HLPS	Design	46.05 L/s	20 L/s

This adjusted model will now be used to assess the potential impacts to the system-wide HGL elevations for alternate (or new) tank/reservoir locations being reviewed as part of the Class EA process.

3 Scenarios

The purpose of this exercise is to review the water supply and storage needs for the community of Stouffville through 2041.

The current Zone 1 storage of 6,140 m^3 is adequate to 2041 and will not require any upgrades. This was established in TM 1 (dated December 22, 2017) of the Class EA process.

The current Zone 2 water storage is provided at the Zone 2 Elevated Tank and the Stouffville Reservoir, and from the lake-based system at the McCowan Reservoir. The current effective water storage is insufficient for 2041 needs. This has been established in TM 1 of the Class EA process. The Zone 2 Water Storage requirement by 2041 is 5,225 m^3.

To complete this storage analysis, a variety of scenarios were considered. The scenarios would include changes to water storage volume and/or locations, pump capacities and possible new or upgraded feedermains.

These scenarios utilized the 2041 population and demands.

3.1 Scenario A (1) – One Reservoir Cell at Stouffville Reservoir and Zone 2 Elevated Tank Maintained

In this Scenario, the effective storage volume in the west cell at the Stouffville Reservoir will be increased to 2,996 m^3, and the Zone 2 Elevated Tank will be maintained with a storage volume of 3,400 m^3. This would bring the total Zone 2 water storage to 6,396 m^3. This is a larger volume than what is required for 2041, with the excess water storage to be utilized beyond 2041.

This increase in reservoir storage will be achieved by upgrading the HLPS, which is located adjacent to the Stouffville Reservoir, to pump at 110 L/s, which is more than twice the current rate of 46 L/s.

As fire flows in this scenario would be provided from the Z1 Elevated Tank, an additional PRV will be required.

The existing PRV (at the Zone 1 BPS) is currently capable of transferring water from Zone 1 to Zone 2 at more than 190 L/s, which is greater than the fire flow demand for the storage calculation. A redundant location for a second PRV is required.

3.1.1 Hydraulics from the Reservoir to the Network

There is a 400mm watermain that connects the reservoir/HLPS to the distribution system. At a rate of 110 L/s, approximately 5 m of headloss will be generated. The existing 400mm watermain can handle the increased flow and pressure, and no additional piping infrastructure is required for this scenario.

3.1.2 Hydraulics from the Network to Reservoir

The lowest pressure at the distribution system connection point is 315m, with the Top Water Level (TWL) at the Stouffville Reservoir of 308m. The distribution system can fill the Stouffville Reservoir to the TWL (315m – 5m = 310m, greater than TWL). This would allow the distribution system to re-fill the Stouffville Reservoir at a rate slightly exceeding 110 L/s.

3.2 Scenario A (2) – Two Reservoir Cells at Stouffville Reservoir and Zone 2 Elevated Tank Maintained

In this Scenario, the effective storage volume at the Stouffville Reservoir will be increased to 5,132 m^3, solely by increasing the capacity of the HLPS. The Zone 2 Elevated Tank will be maintained with a storage volume of 3,400 m^3. This would bring the total Zone 2 water storage to 8,532 m^3. This is a larger volume than what is required for 2041, with the excess water storage to be utilized beyond 2041.

This increase in reservoir storage will be achieved by upgrading the HLPS to pump at 190 L/s, which is more than four times the current rate of 46 L/s.

The existing PRV (at the Zone 1 BPS) is currently capable of transferring water from Zone 1 to Zone 2 at more than 190 L/s, which is greater than the fire flow demand for the storage calculation. A redundant location for a second PRV is required.

3.2.1 Hydraulics from the Reservoir to the Network

There is a 400mm watermain that connects HLPS to the distribution system. At a rate of 190 L/s, approximately 13 m of headloss will be generated. The existing 400mm watermain can handle the increased flow and pressure, and no additional piping infrastructure is required for this scenario.

3.2.2 Hydraulics from the Network to Reservoir

The lowest pressure at the distribution system is 315m, with the Top Water Level (TWL) of 308m. This 7m headloss would only allow for a maximum flow rate of approximately 140 L/s into the tank from the distribution system.

Wells 5 and 6 have a combined production rate of 60 L/s, so the reservoir could therefore be re-filled at a rate of 200 L/s, which is greater than the proposed peak discharge rate (190 L/s). When the reservoir is re-filling, Wells 5 and 6 would effectively be isolated from the distribution system, meaning that maximum day demands would have to be supplied from Wells 1, 2, 3 and the Lake-based system.

3.3 Scenario B (1) – Build a New Storage Facility, Upgrade Stouffville Reservoir and Decommission the Zone 2 Elevated Tank

In this Scenario, the effective storage volume in the west cell at the Stouffville Reservoir will be increased to 2,996 m^3, and a new storage facility with 2,229 m^3 of available storage would be constructed. This scenario also includes decommissioning the Zone 2 Elevated Tank. This would bring the total Zone 2 water storage to 5,225 m^3.

This increase in reservoir storage would be achieved by upgrading the HLPS to pump at 110 L/s, which is more than twice the current rate of 46 L/s.

3.3.1 Hydraulics from the Reservoir to the Network

There is a 400 mm watermain that connects HLPS to the distribution system. At a rate of 110 L/s, approximately 5 m of headloss will be generated. The existing 400mm watermain can handle the increased flow and pressure, and no additional piping infrastructure is required for this scenario.

3.3.2 Hydraulics from the Network to Reservoir

The lowest pressure at the distribution system connection point is 315m, with the Top Water Level (TWL) at the Stouffville Reservoir of 308m. The distribution system can fill the Stouffville Reservoir to the TWL (315m – 5m = 310m, greater than TWL). This would allow the distribution system to re-fill the Stouffville Reservoir at a rate slightly exceeding of 110 L/s.

This scenario also requires a new location for the new storage facility to be determined. In the InfoWater model, the storage was relocated to three locations – north, central and south. Under any location, the resulting pressures throughout the system met the Regional Design Criteria and do not change significantly from existing conditions. Refer to the pressure maps in **Appendix B**. The overall operation of the system and the provision of appropriate pressures is therefore not dependent on the location of a new storage facility.

3.4 Scenario B (2) – New Storage Facility, Upgrade Stouffville Reservoir and Decommission Zone 2 Elevated Tank

In this Scenario, the effective storage volume at the Stouffville Reservoir will be increased to 5,132 m^3, a new storage facility will be required for 93 m^3 and the Zone 2 Elevated Tank will be decommissioned. This would bring the total Zone 2 water storage to 5,225 m^3.

This increase in reservoir storage will be achieved by upgrading the HLPS to pump at 190 L/s, which is more than four times the current rate of 46 L/s.

3.4.1 Hydraulics from the Reservoir to the Network

There is a 400mm watermain that connects HLPS to the distribution system. At a rate of 190 L/s, approximately 13 m of headloss will be generated. The existing 400mm watermain can handle the increased flow and pressure, and no additional piping infrastructure is required for this scenario.

3.4.2 Hydraulics from the Network to Reservoir

The lowest pressure at the distribution system is 315m, with the Top Water Level (TWL) of 308m. This 7m headloss would only allow for a maximum flow rate of approximately 140 L/s into the tank from the distribution system.

Wells 5 and 6 have a combined production rate of 60 L/s, so the reservoir could therefore be re-filled at a rate of 200 L/s, which is greater than the peak discharge rate. When the reservoir is re-filling, Wells 5 and 6 would effectively be isolated from the distribution system, meaning that maximum day demands would have to be supplied from Wells 1, 2, 3 and the Lake-based system.

This scenario also requires a new location for the new storage facility to be determined. In the InfoWater model, the storage was relocated to three locations – north, central and south. Under any location, the resulting pressures throughout the system met the Regional Design Criteria and do not change significantly from existing conditions. Refer to the pressure maps in **Appendix B**. The overall operation of the system and the provision of appropriate pressures is therefore not dependent on the location of a new storage facility.

3.5 Scenario C (1) – New Storage Facility, Maintain Zone 2 Elevated Tank, Decommission Stouffville Reservoir and HLPS

In this Scenario, the Stouffville Reservoir will be decommissioned, a new storage facility with a volume of 1,825 m^3 will be constructed and the Zone 2 Elevated Tank will be maintained with a storage volume of 3,400 m^3. This would bring the total Zone 2 water storage to 5,225 m^3.

Under this scenario, a new storage facility would be constructed on the site of the Stouffville Reservoir/HLPS, or anywhere else in the system.

In the InfoWater model, the storage was relocated to three locations – north, central and south. Under any location, the resulting pressures throughout the system met the Regional Design Criteria and do not change significantly from existing conditions. Refer to the pressure maps in **Appendix B**. The overall operation of the system and the provision of appropriate pressures is therefore not dependent on the location of a new storage facility.

3.6 Scenario C (2) – New Storage Facility, Decommission Zone 2 Elevated Tank, Decommission Stouffville Reservoir and HLPS

In this Scenario, the Stouffville Reservoir will be decommissioned, a new storage facility with a volume of 5,225 m^3 will be constructed and the Zone 2 Elevated Tank will be decommissioned. This would bring the total Zone 2 water storage to 5,225 m^3.

Under this scenario, a new storage facility is required. There is the possibility of utilizing the Zone 2 Elevated Tank / Well 3 and the Stouffville Reservoir/HLPS sites for the new storage facility.

In the InfoWater model, the storage was relocated to three locations – north, central and south. Under any location, the resulting pressures throughout the system met the Regional Design Criteria and do not change significantly from existing conditions. Refer to the pressure maps in **Appendix B**. The overall operation of the system and the provision of appropriate pressures is therefore not dependent on the location of a new storage facility.

3.7 Pressure Review

In order to assess the overall impacts to the system resulting from the scenarios considered, a review of the minimum pressures observed at several key locations throughout the modelled network are provided in **Table 3-1**. These pressures represent the minimum pressure experienced at that location, under maximum day demands, the varying demand profile, and wells cycling based on elevated tank levels.

TABLE 3-1: LOWEST MODELLED MAXIMUM DAY DEMAND AT VARIOUS LOCATIONS IN THE SYSTEM

Junction ID	Description	Existing	Scenario A1	Scenario A2	Scenario B1	Scenario B2
J-24	Connection from McCowan reservoir to the system	573 kPa (83 psi)	546 kPa (79 psi)	542 kPa (79 psi)	459 kPa (67 psi)	414 kPa (60 psi)
769	Zone 3	568 kPa (82 psi)	568 kPa (82 psi)	568 kPa (82 psi)	568 kPa (82 psi)	568 kPa (82 psi)

718	Southern point in Zone 2	639 kPa (93 psi)	629 kPa (91 psi)	626 kPa (91 psi)	489 kPa (71 psi)	483 kPa (70 psi)
J-40	Low point in Zone 2	687 kPa (100 psi)	680 kPa (99 psi)	677 kPa (98 psi)	529 kPa (77 psi)	483 kPa (70 psi)
298	Connection point from wells 1 and 2 to the system	619 kPa (90 psi)	624 kPa (91 psi)	619 kPa (90 psi)	622 kPa (90 psi)	782 kPa (70 psi)
82	Connection from Stouffville Reservoir to the system	394 kPa (57 psi)	366 kPa (53 psi)	362 kPa (53 psi)	288 kPa (42 psi)	278 kPa (40 psi)
316	High point in Zone 2	332 kPa (48 psi)	334 kPa (49 psi)	330 kPa (48 psi)	***170 kPa (25 psi)***	***138 kPa (20 psi)***
429	Zone 1	619 kPa (90 psi)	623 kPa (90 psi)	619 kPa (90 psi)	622 kPa (90 psi)	484 kPa (70 psi)

In general, the scenarios where the existing Zone 2 Elevated Tank are decommissioned result in lower-than-acceptable pressures in the east end of Stouffville, which is where the Zone 2 high elevation is located. This is due to the fact that there is not a fixed minimum HGL in that location, as is provided through proximity to the existing elevated tank.

4 Conclusion

The various water storage options were reviewed and analysed.

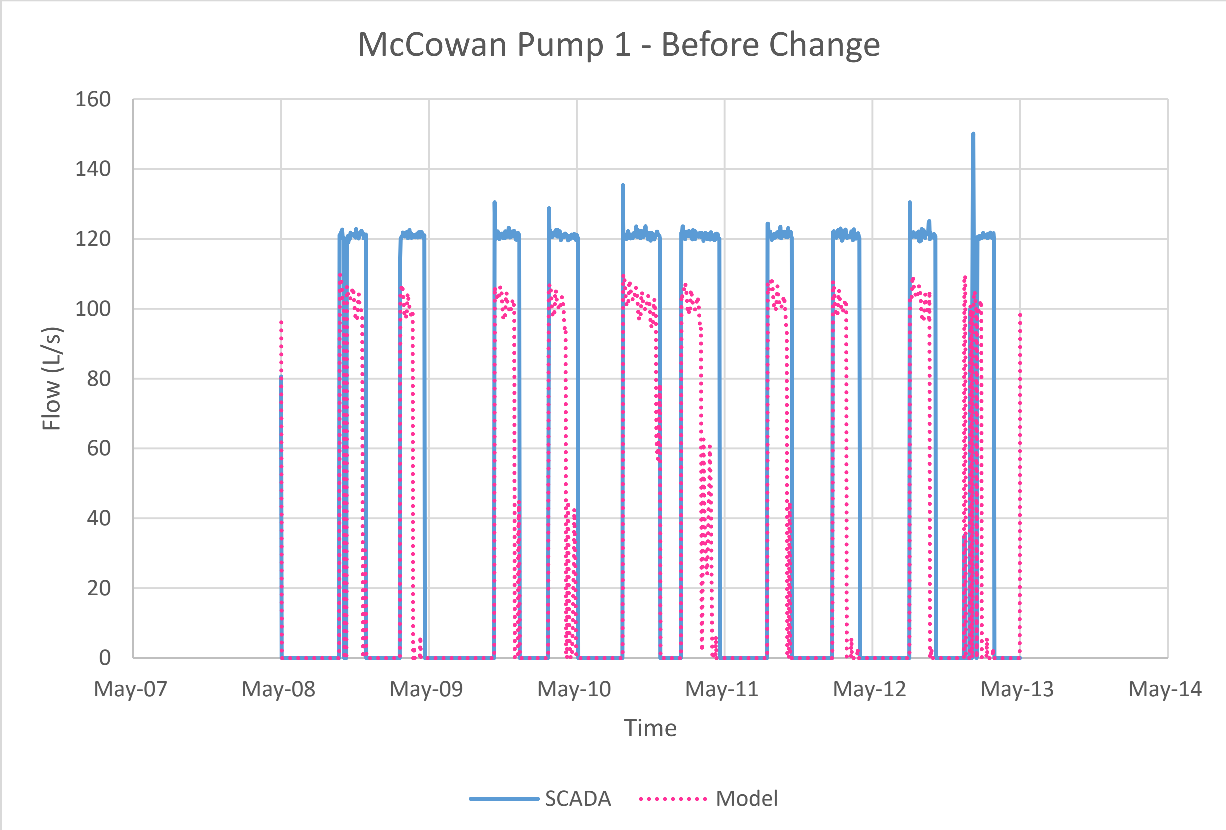
From a system hydraulics perspective, the primary conclusions of this assessment are:

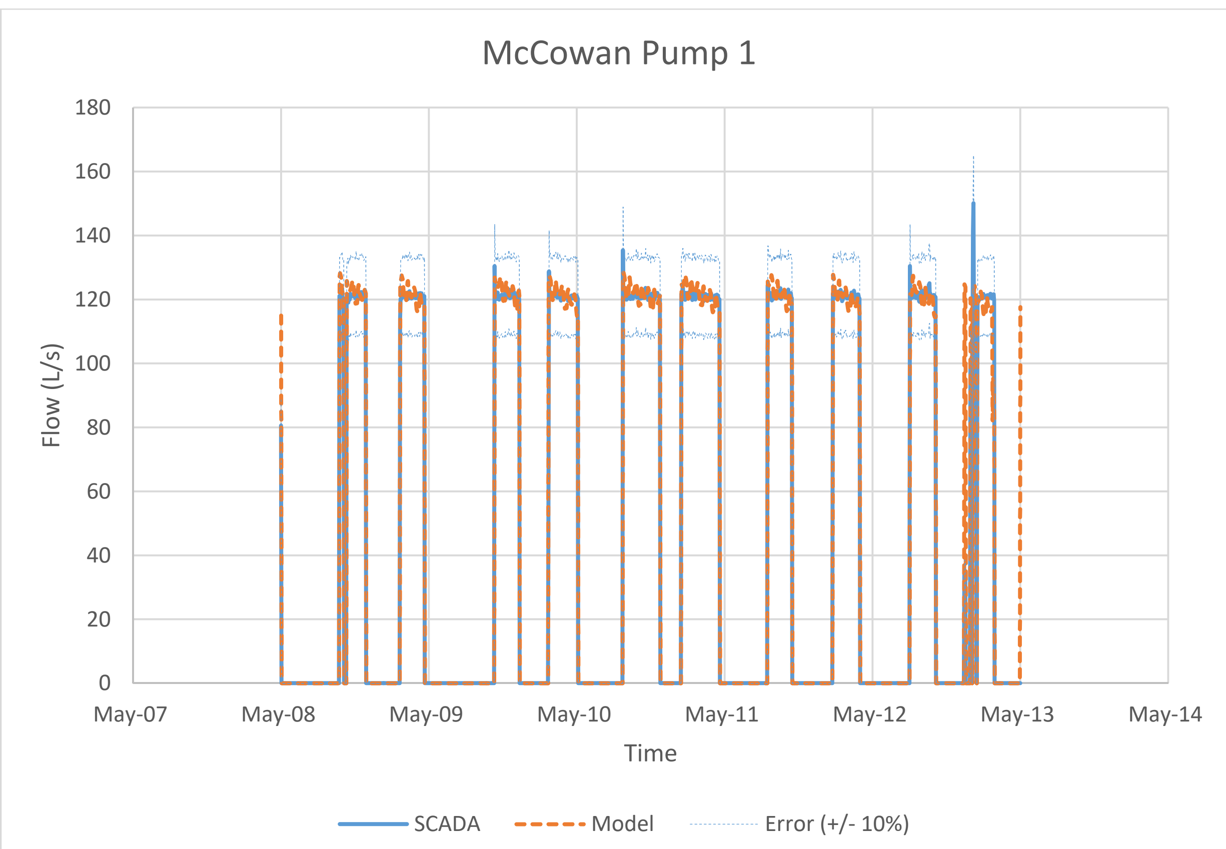
1. Additional pumped storage can be provided at the existing Stouffville Reservoir site without the need for feedermain upgrades.
2. Additional floating storage is viable at the existing Stouffville Reservoir Site
3. Decommissioning the existing Zone 2 elevated tank would result in pressure deficiencies in the eastern portion of Stouffville. Possible solutions are:
    a. Providing a new elevated storage tank on a new site in the east end of Stouffville;
    b. Making some operational changes to how the wells are cycled to trigger Wells 1, 2, and/or 3 to operate in instances where pressures are low in the east end of Stouffville. This solution would not be as reliable as having an elevated tank in that location.
    c. Supplying water to the east end of Stouffville from the PRV connected to Zone 1 in instances where the pressures are low. This would not be cost-efficient, as it would result in wasted energy.

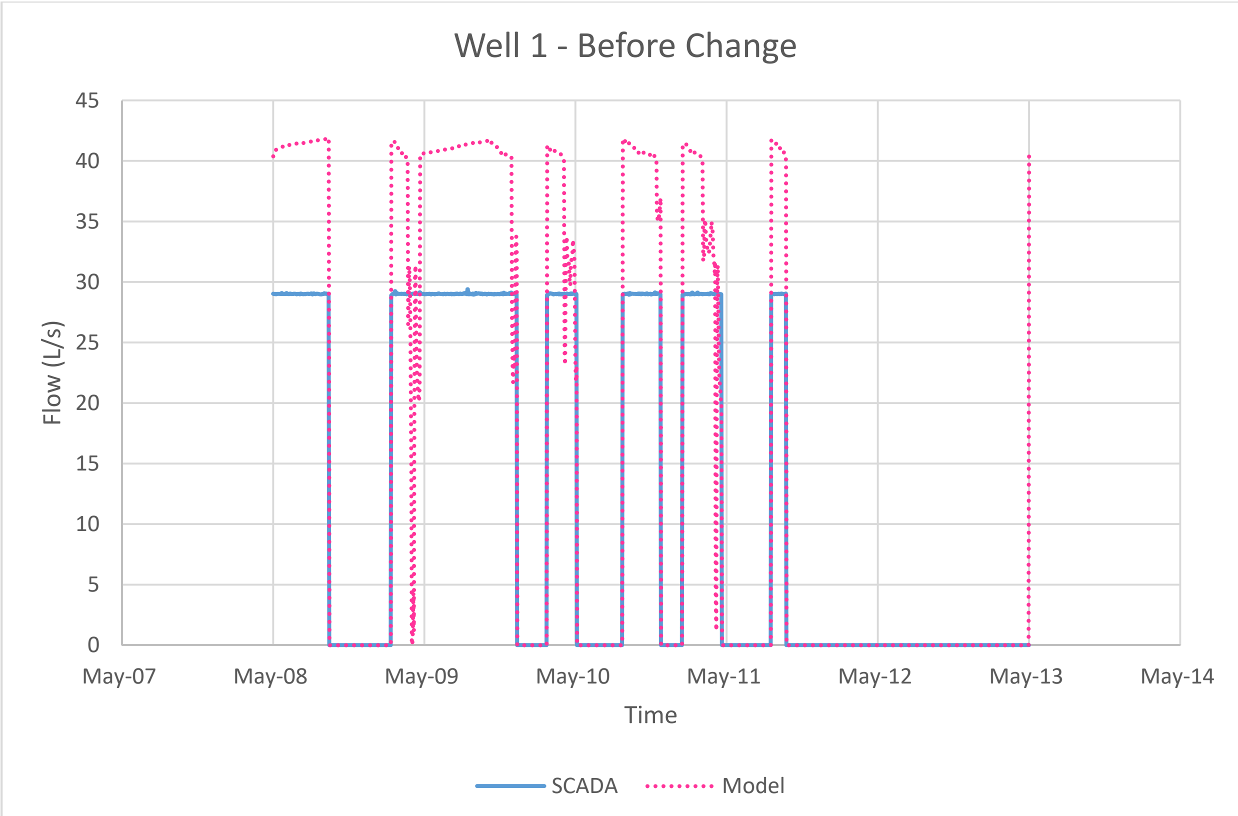
Appendix A

SCADA vs Model Output

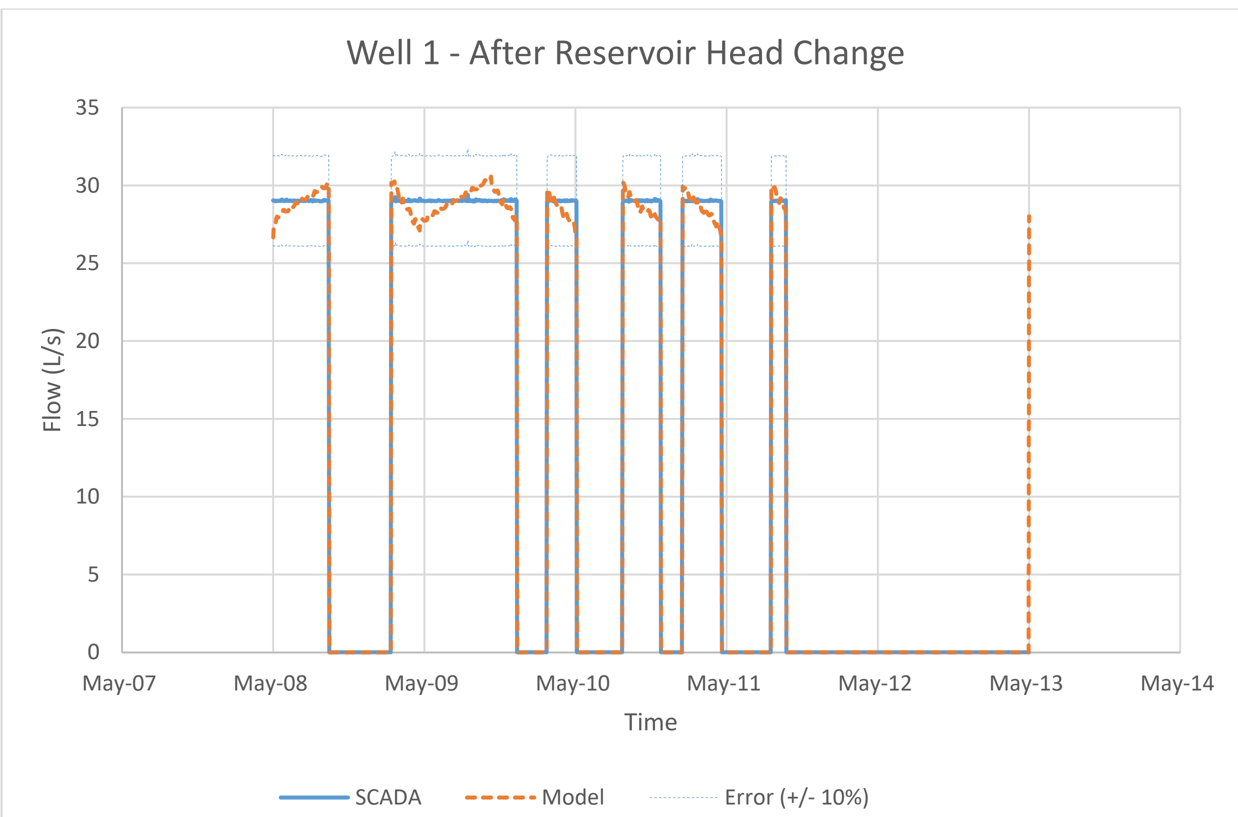
Before and after parameter change


McCowan Pump 1 - Before Change
160
140
120
100
80
60
40
20
0
Flow (L/s)
May-07
May-08
May-09
May-10
May-11
May-12
May-13
May-14
Time
SCADA
Model

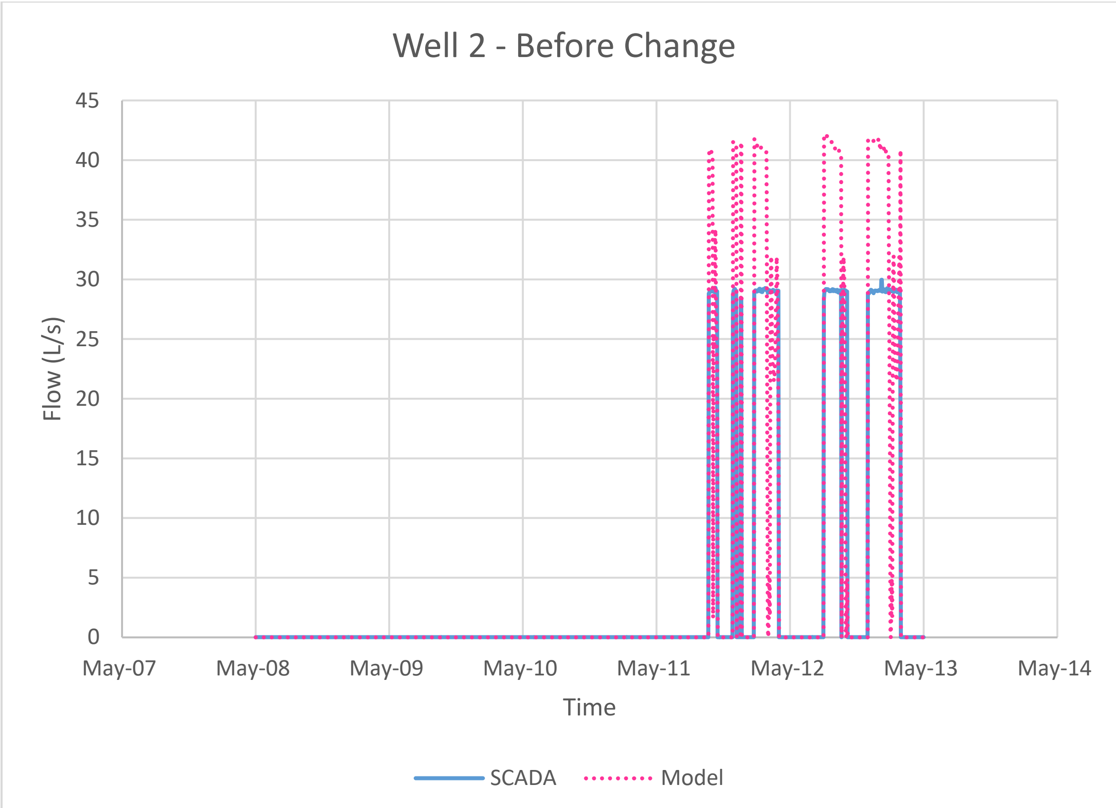

McCowan Pump 1
180
160
140
120
100
80
60
40
20
0
Flow (L/s)
May-07
May-08
May-09
May-10
May-11
May-12
May-13
May-14
Time
SCADA
Model
Error (+/- 10%)

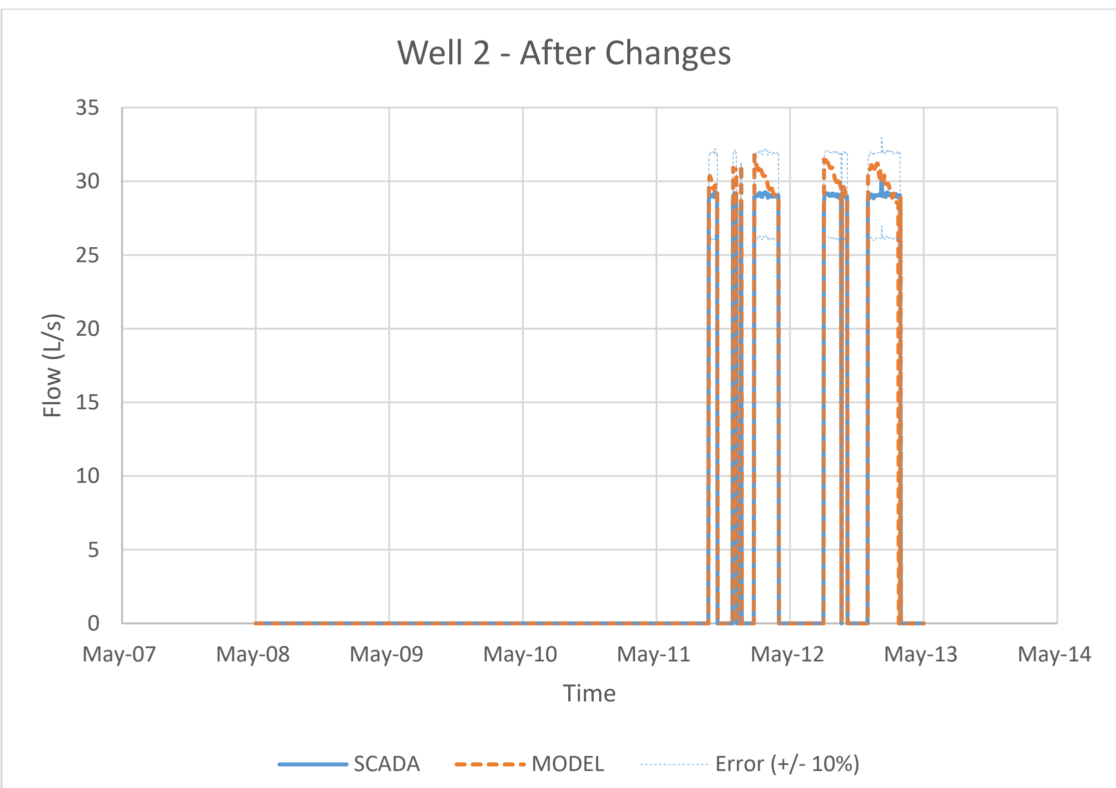


Well 1 - Before Change
Flow (L/s)
45
40
35
30
25
20
15
10
5
0
May-07
May-08
May-09
May-10
May-11
May-12
May-13
May-14
Time
SCADA
Model

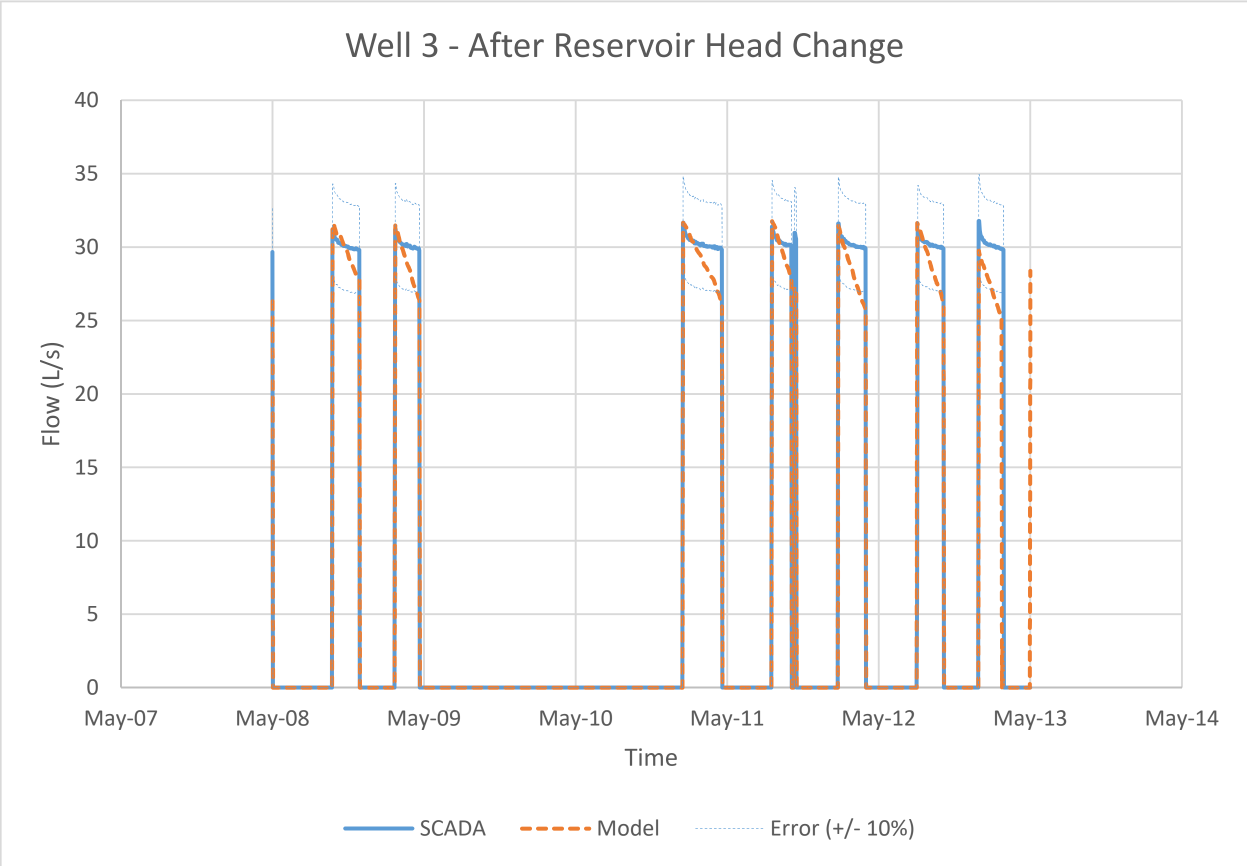


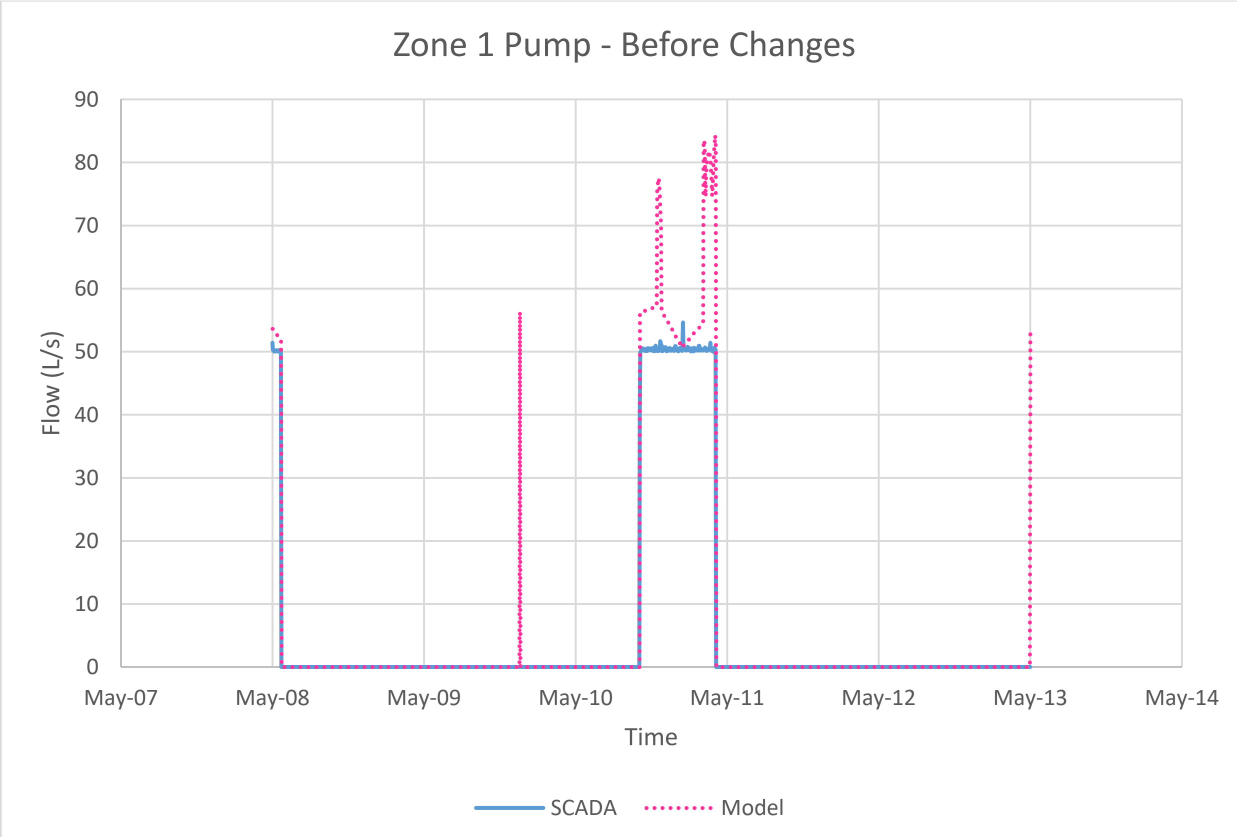
Well 1 - After Reservoir Head Change
Flow (L/s)
35
30
25
20
15
10
5
0
May-07
May-08
May-09
May-10
May-11
May-12
May-13
May-14
Time
SCADA
Model
Error (+/- 10%)

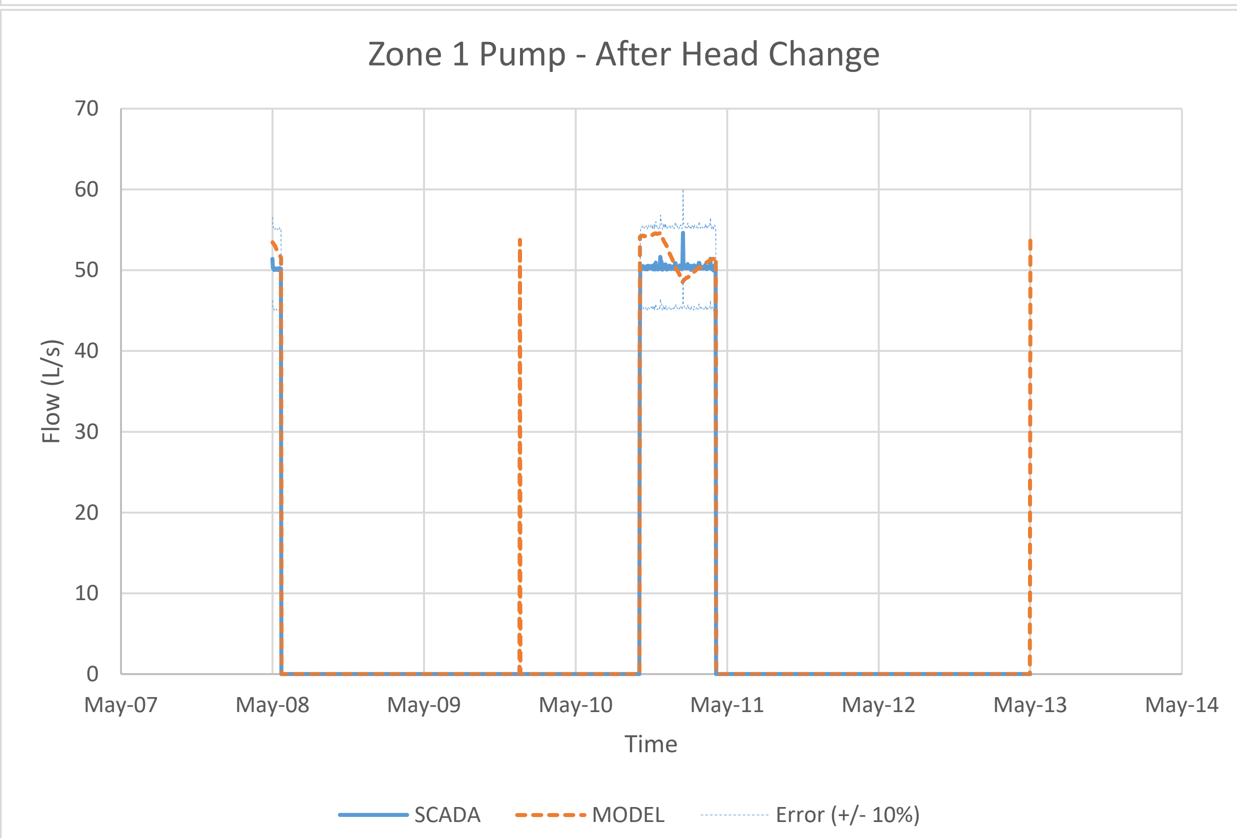

Well 2 - Before Change
45
40
35
30
25
20
15
10
5
0
Flow (L/s)
May-07
May-08
May-09
May-10
May-11
May-12
May-13
May-14
Time
SCADA
Model

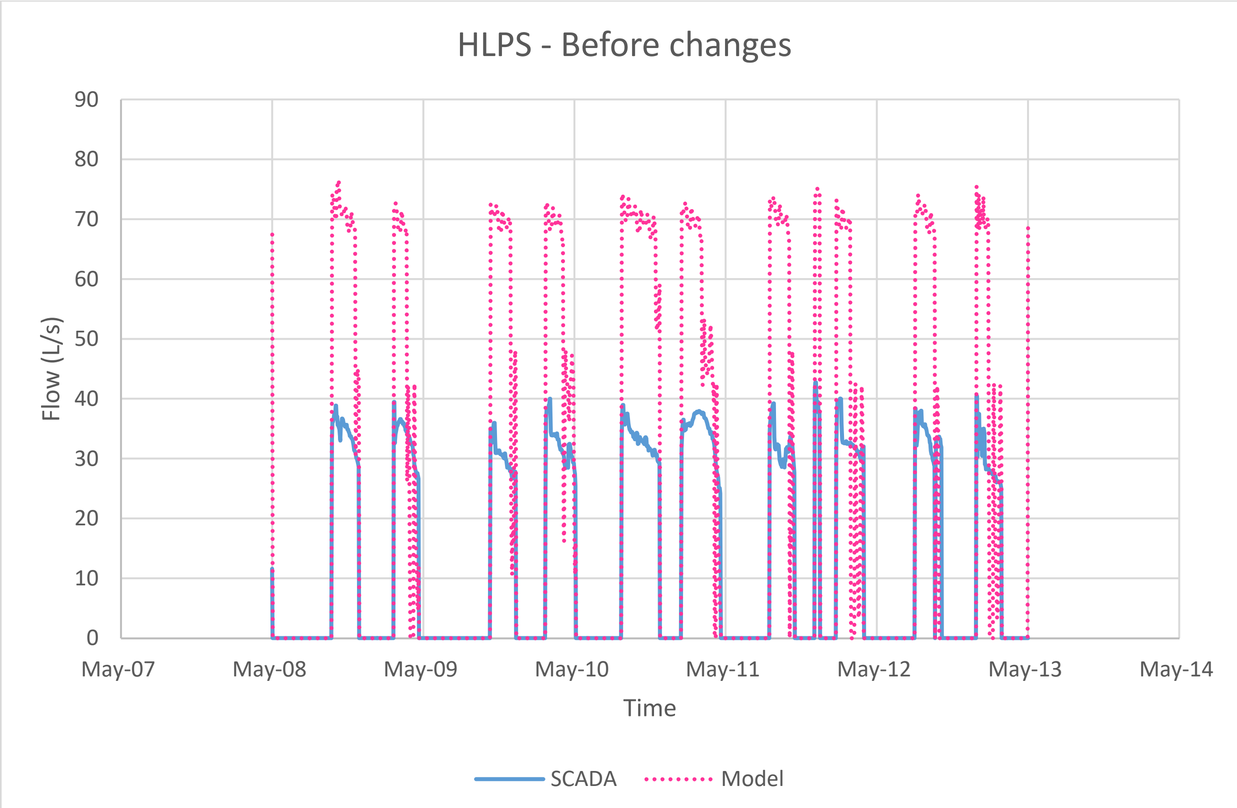

Well 2 - After Changes
35
30
25
20
15
10
5
0
Flow (L/s)
May-07
May-08
May-09
May-10
May-11
May-12
May-13
May-14
Time
SCADA
MODEL
Error (+/- 10%)

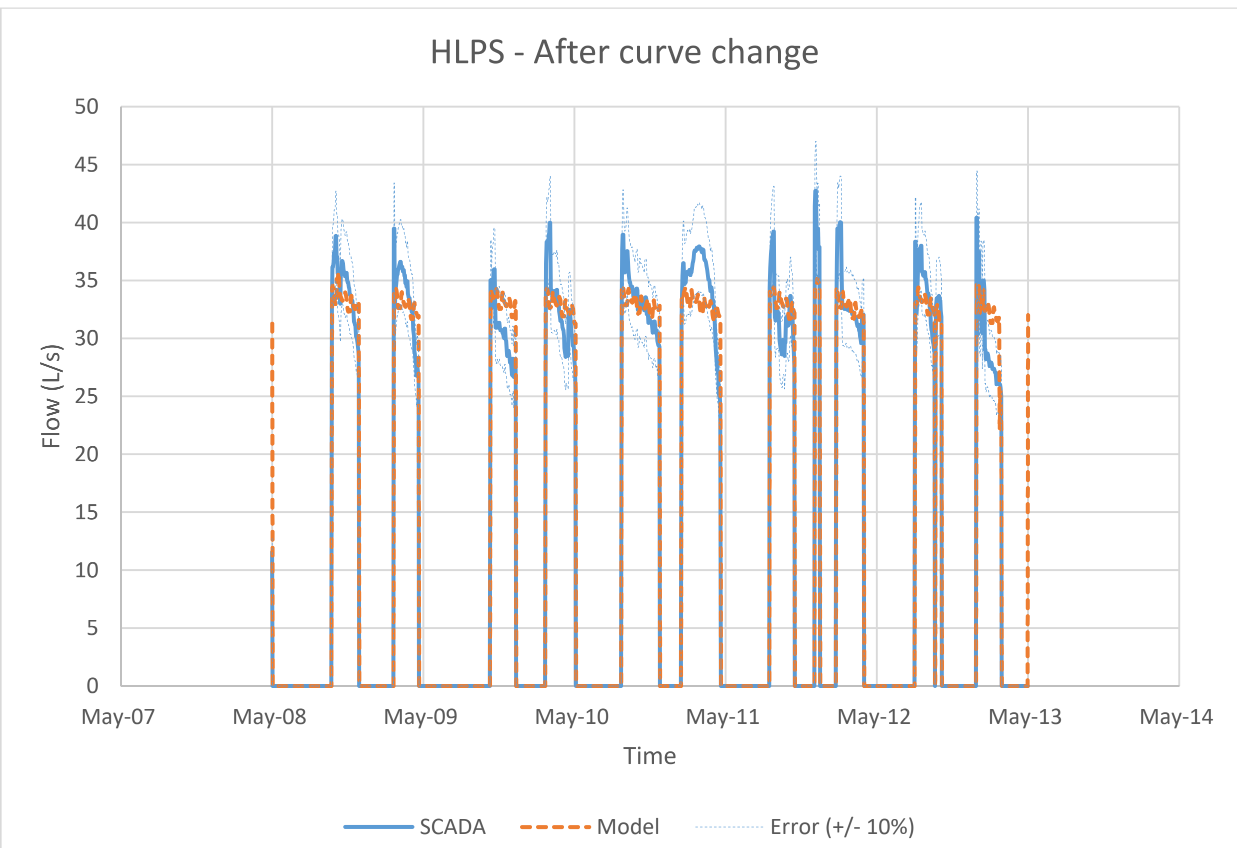

Well 3 - Before Change
Flow (L/s)
70
60
50
40
30
20
10
0
May-07
May-08
May-09
May-10
May-11
May-12
May-13
May-14
Time
SCADA
Model

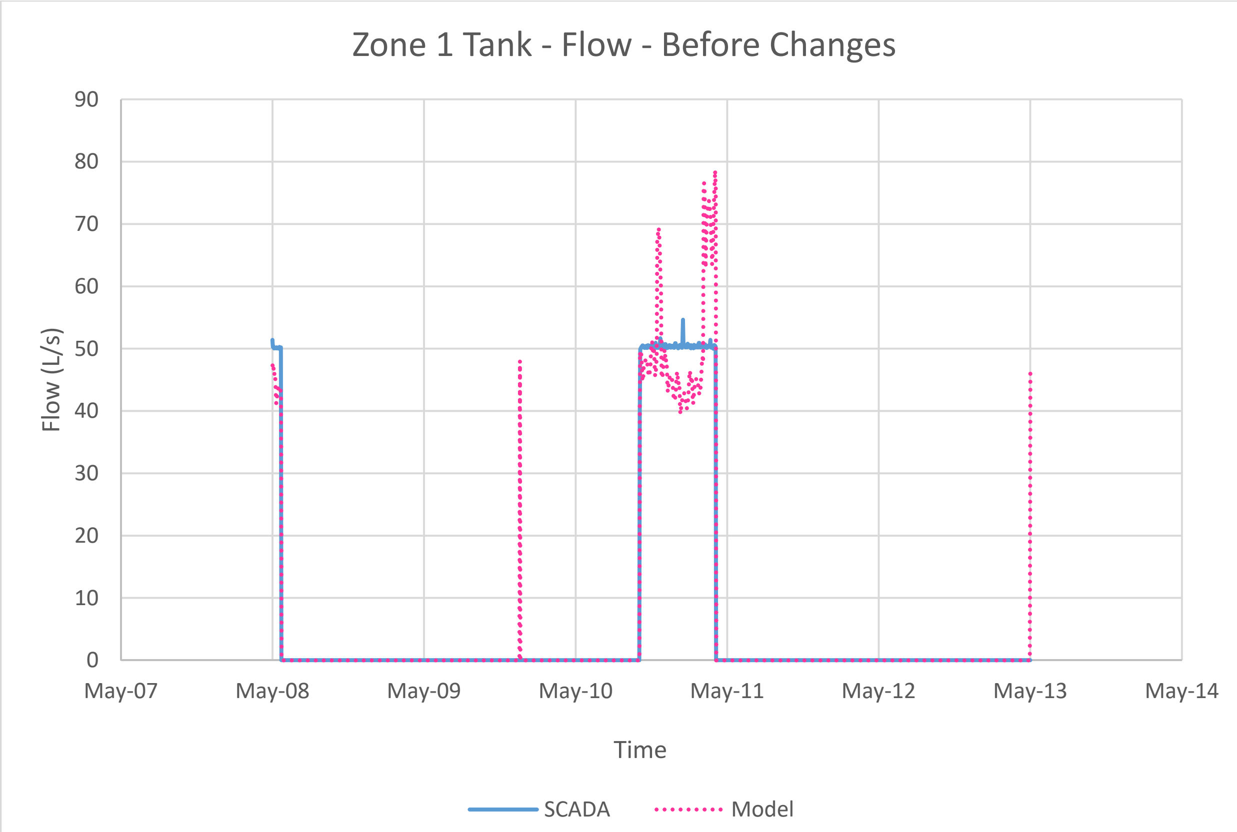

Well 3 - After Reservoir Head Change
Flow (L/s)
40
35
30
25
20
15
10
5
0
May-07
May-08
May-09
May-10
May-11
May-12
May-13
May-14
Time
SCADA
Model
Error (+/- 10%)

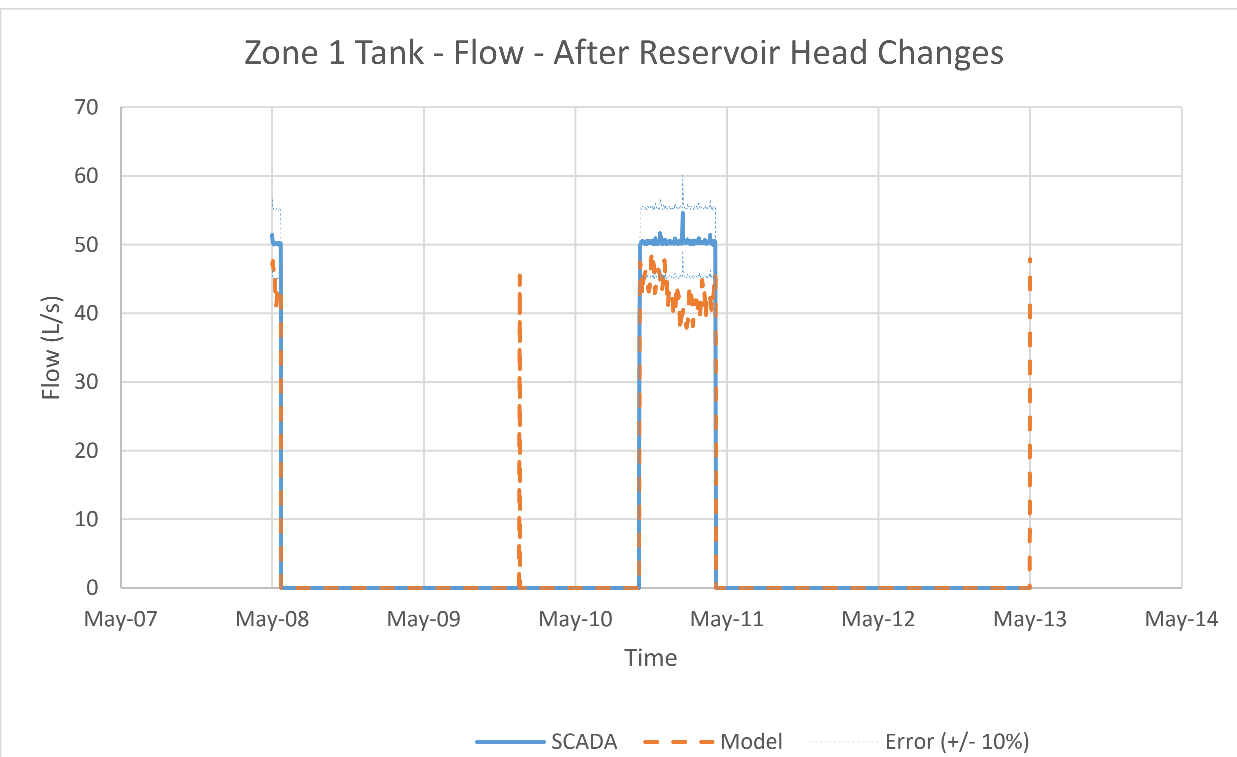

Zone 1 Pump - Before Changes
Flow (L/s)
90
80
70
60
50
40
30
20
10
0
May-07
May-08
May-09
May-10
May-11
May-12
May-13
May-14
Time
SCADA
Model

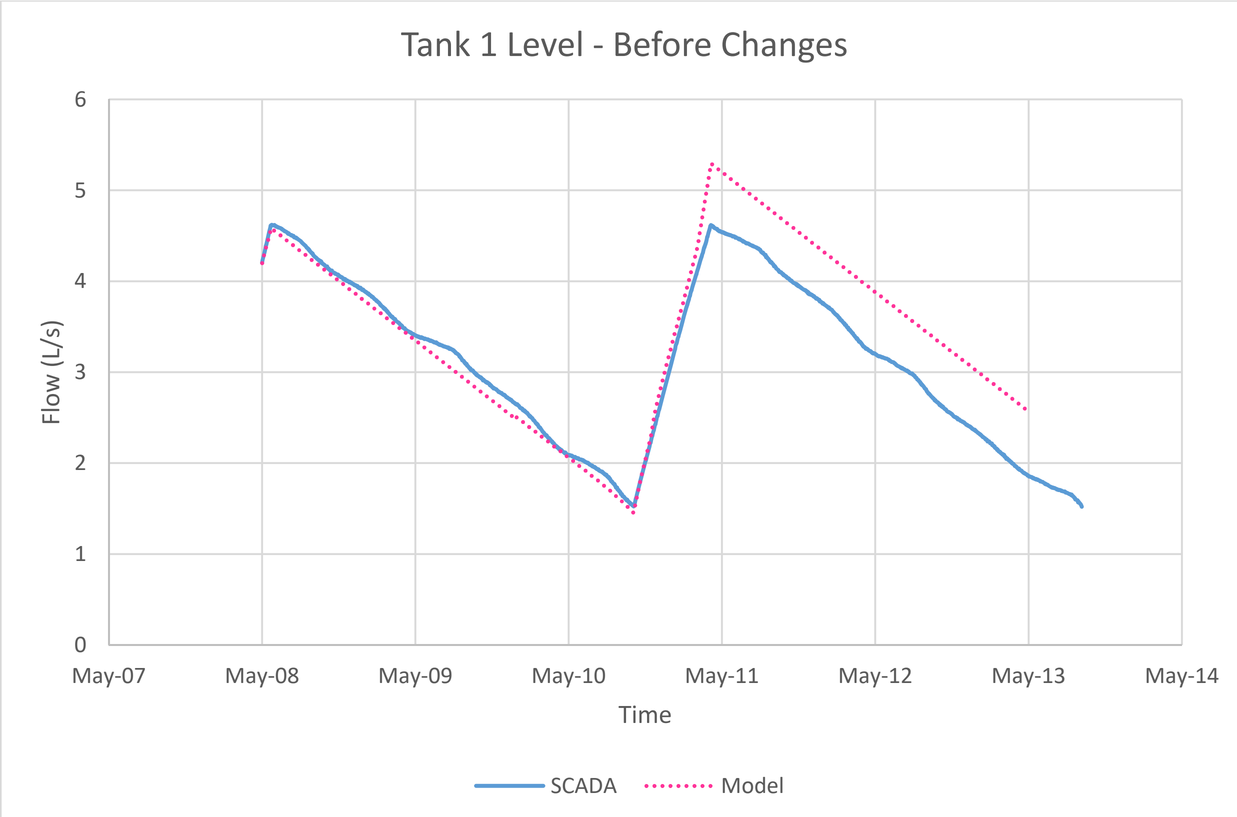

Zone 1 Pump - After Head Change
Flow (L/s)
70
60
50
40
30
20
10
0
May-07
May-08
May-09
May-10
May-11
May-12
May-13
May-14
Time
SCADA
MODEL
Error (+/- 10%)


HLPS - Before changes
90
80
70
60
50
40
30
20
10
0
Flow (L/s)
May-07
May-08
May-09
May-10
May-11
May-12
May-13
May-14
Time
SCADA
Model

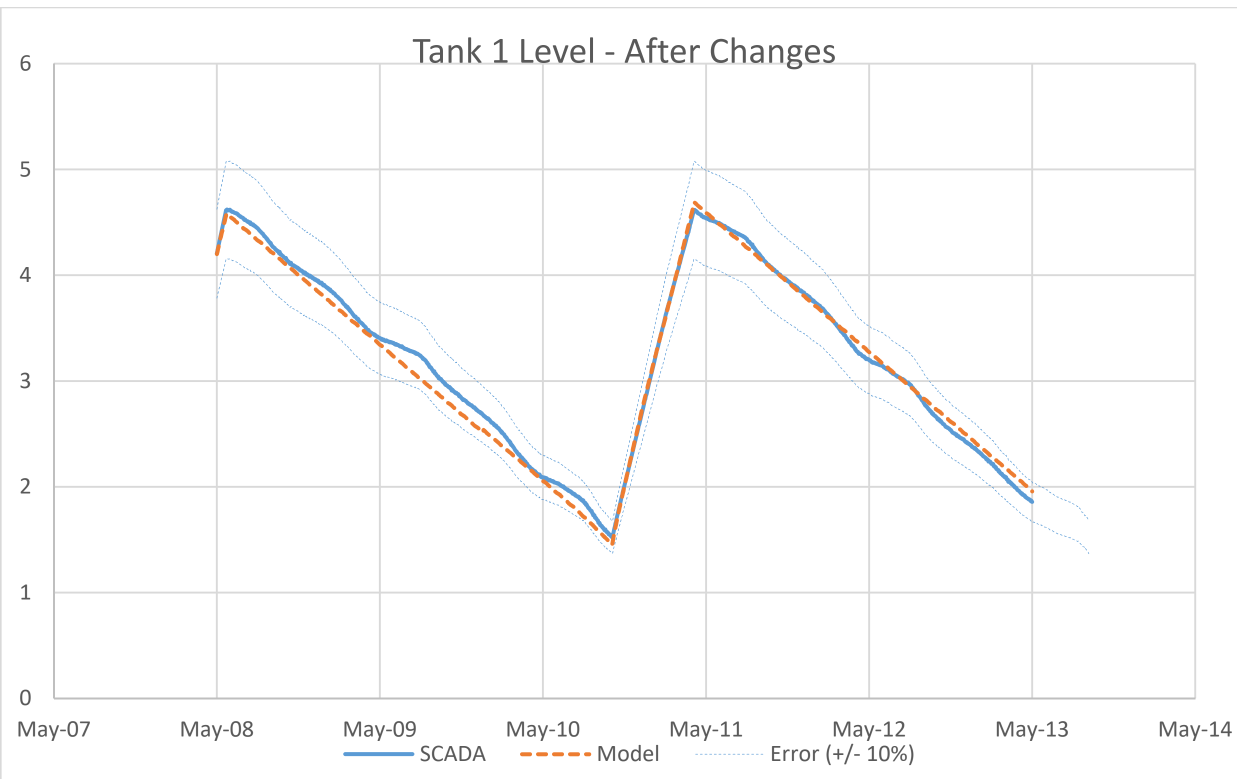

HLPS - After curve change
50
45
40
35
30
25
20
15
10
5
0
Flow (L/s)
May-07
May-08
May-09
May-10
May-11
May-12
May-13
May-14
Time
SCADA
Model
Error (+/- 10%)


Zone 1 Tank - Flow - Before Changes
90
80
70
60
50
40
30
20
10
0
Flow (L/s)
May-07
May-08
May-09
May-10
May-11
May-12
May-13
May-14
Time
SCADA
Model

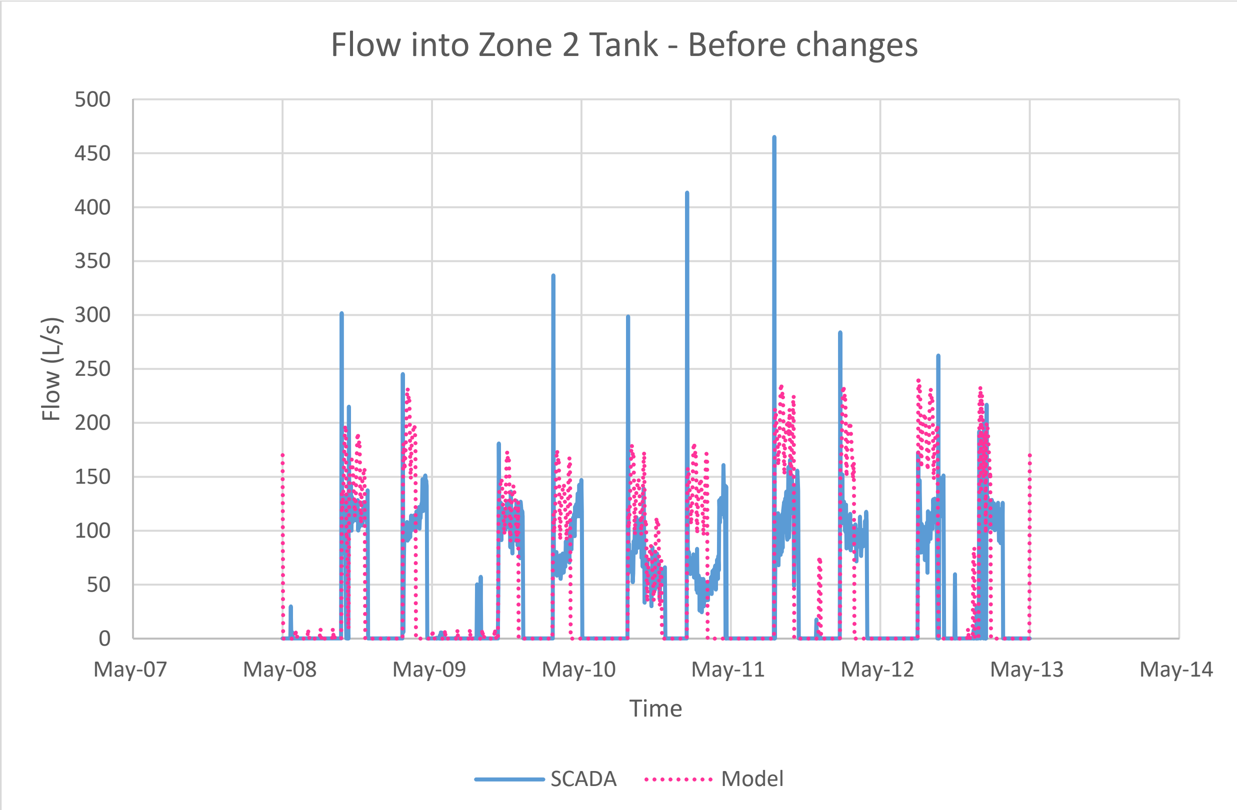

Zone 1 Tank - Flow - After Reservoir Head Changes
70
60
50
40
30
20
10
0
Flow (L/s)
May-07
May-08
May-09
May-10
May-11
May-12
May-13
May-14
Time
SCADA
Model
Error (+/- 10%)

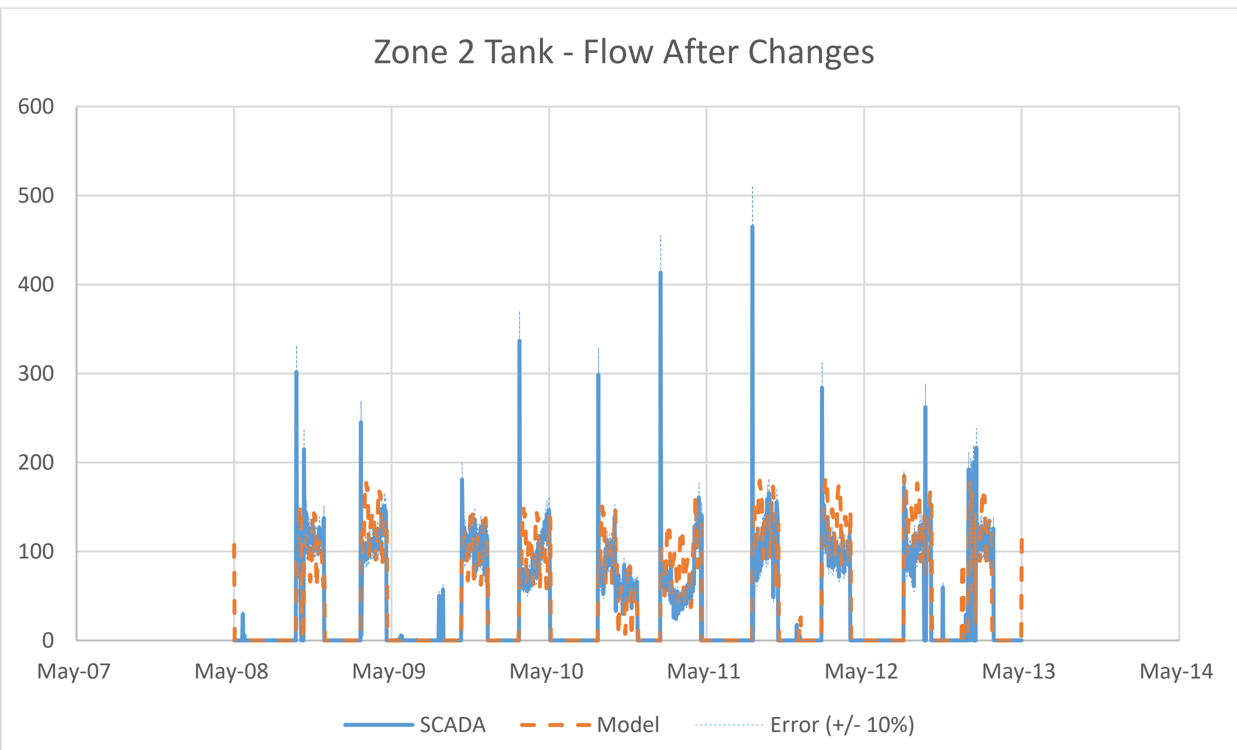


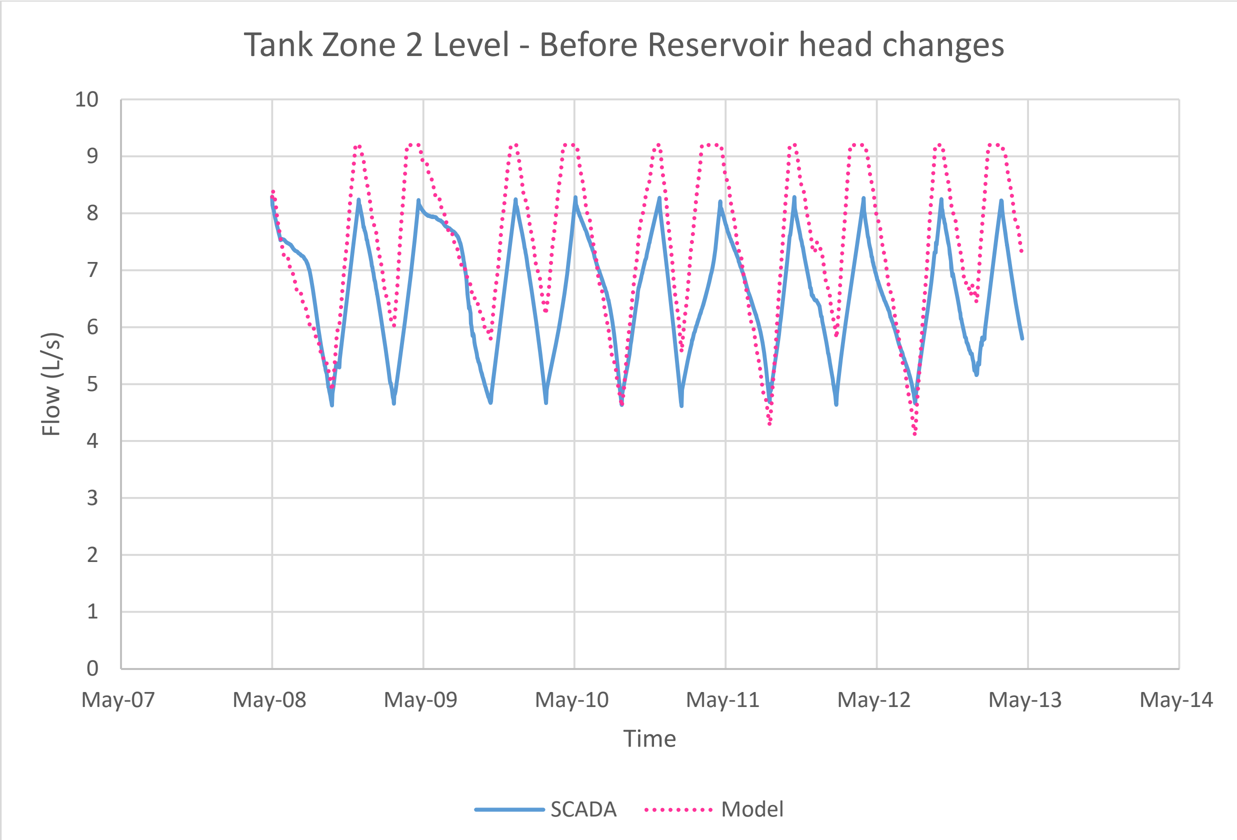
Tank 1 Level - Before Changes
Flow (L/s)
Time
0
1
2
3
4
5
6
May-07
May-08
May-09
May-10
May-11
May-12
May-13
May-14
SCADA
Model

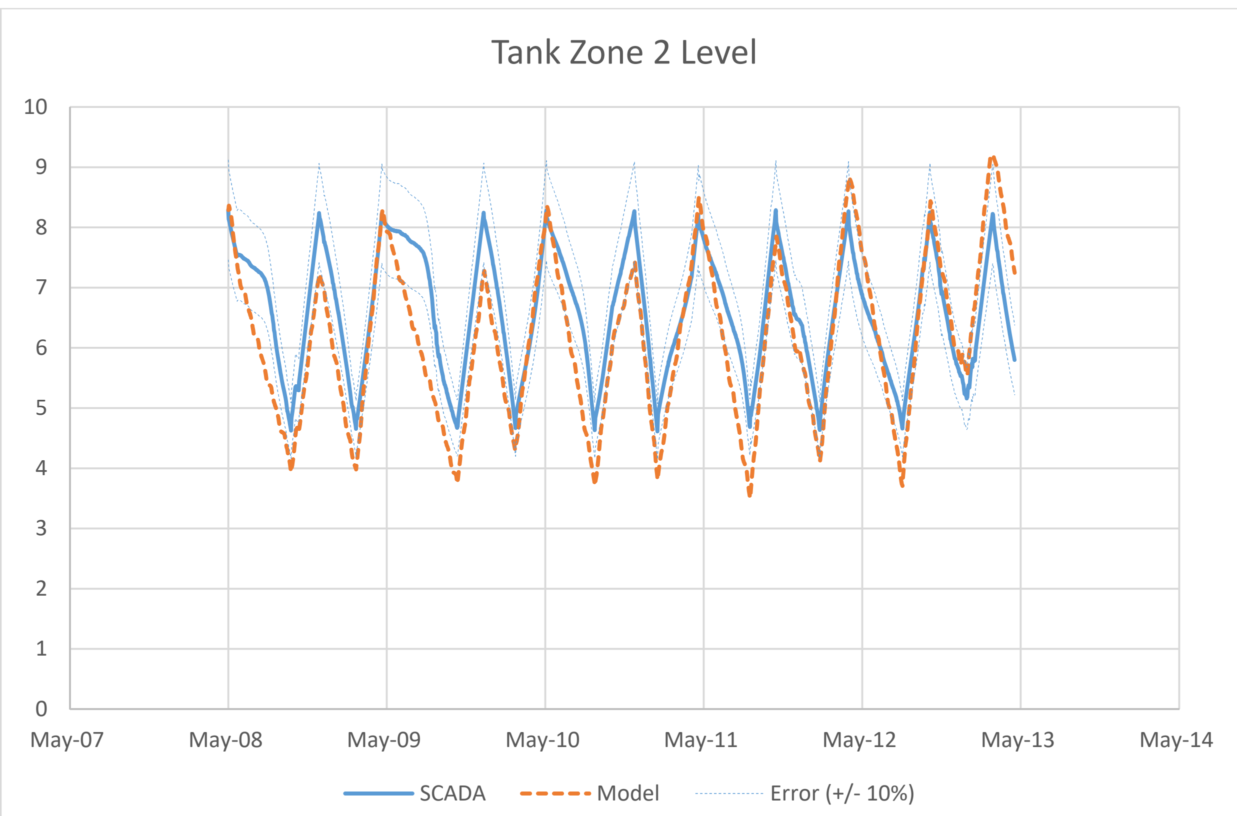


Tank 1 Level - After Changes
0
1
2
3
4
5
6
May-07
May-08
May-09
May-10
May-11
May-12
May-13
May-14
SCADA
Model
Error (+/- 10%)


Flow into Zone 2 Tank - Before changes
Flow (L/s)
500
450
400
350
300
250
200
150
100
50
0
May-07
May-08
May-09
May-10
May-11
May-12
May-13
May-14
Time
SCADA
Model

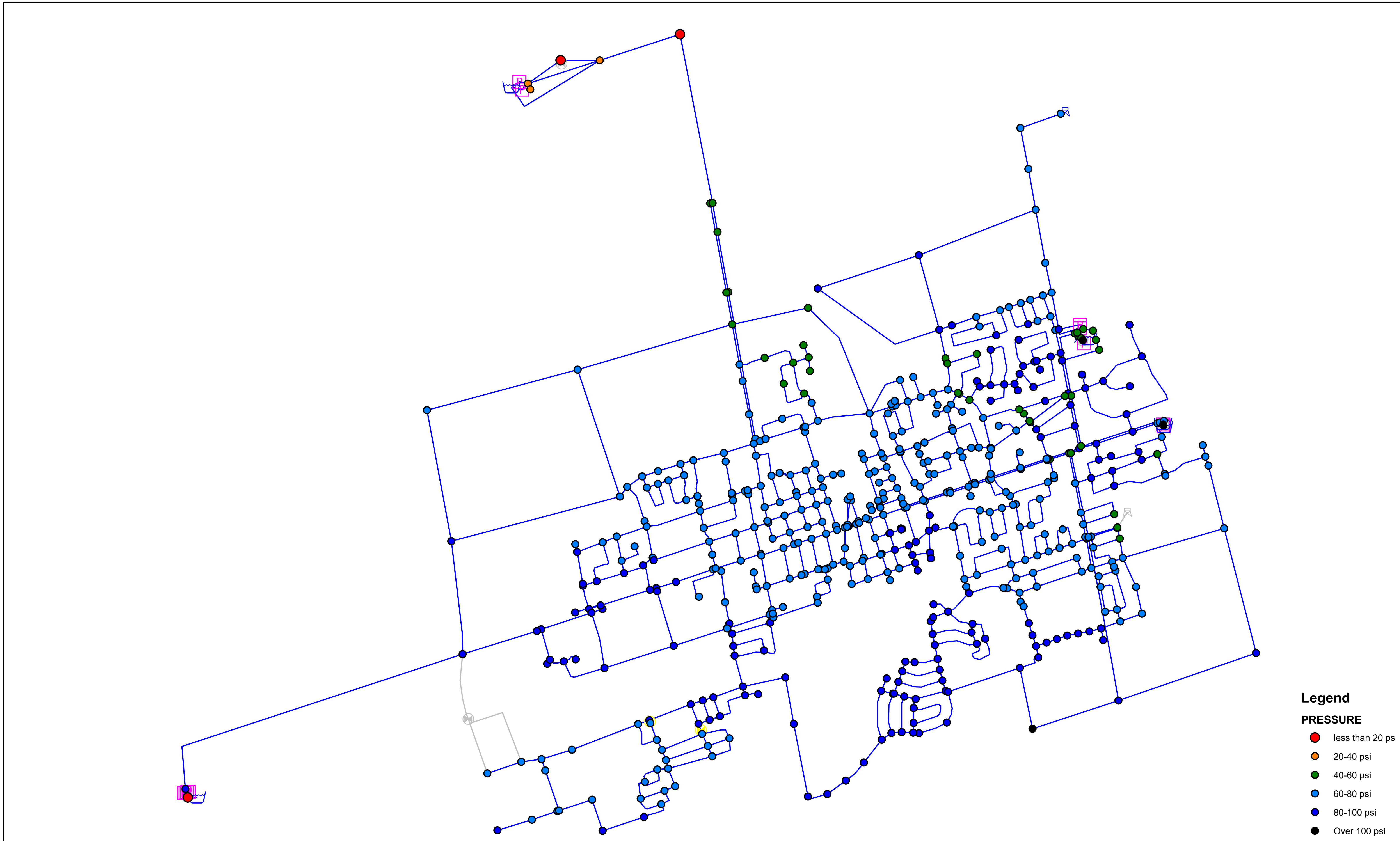

Zone 2 Tank - Flow After Changes
600
500
400
300
200
100
0
May-07
May-08
May-09
May-10
May-11
May-12
May-13
May-14
SCADA
Model
Error (+/- 10%)


Tank Zone 2 Level - Before Reservoir head changes
10
9
8
7
6
5
4
3
2
1
0
Flow (L/s)
May-07
May-08
May-09
May-10
May-11
May-12
May-13
May-14
Time
SCADA
Model


Tank Zone 2 Level
10
9
8
7
6
5
4
3
2
1
0
May-07
May-08
May-09
May-10
May-11
May-12
May-13
May-14
SCADA
Model
Error (+/- 10%)

Appendix B

Storage Location Pressure Maps



TMIG
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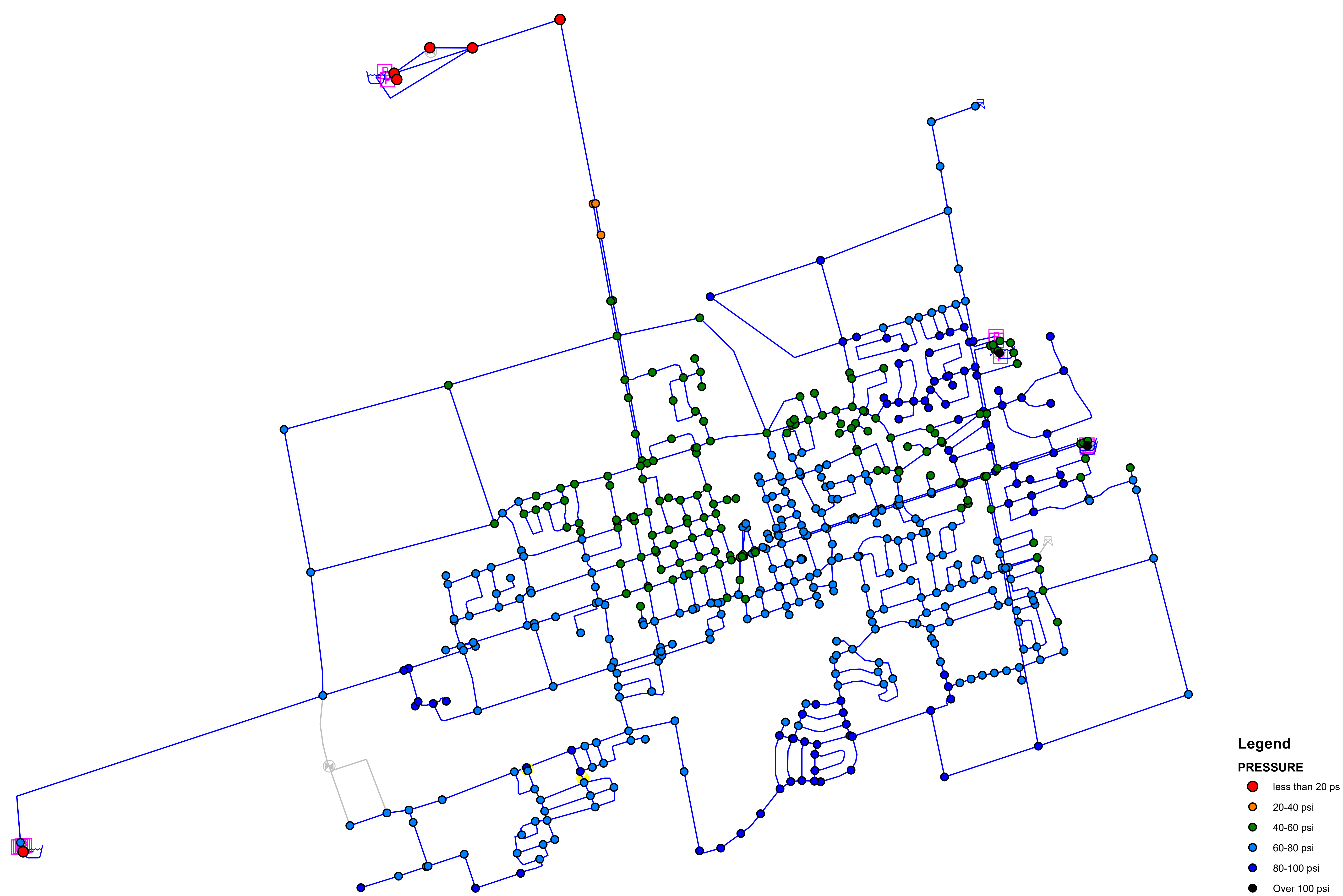
Stouffville Class EA - Existing Conditions
2041 Maximum Day Demand

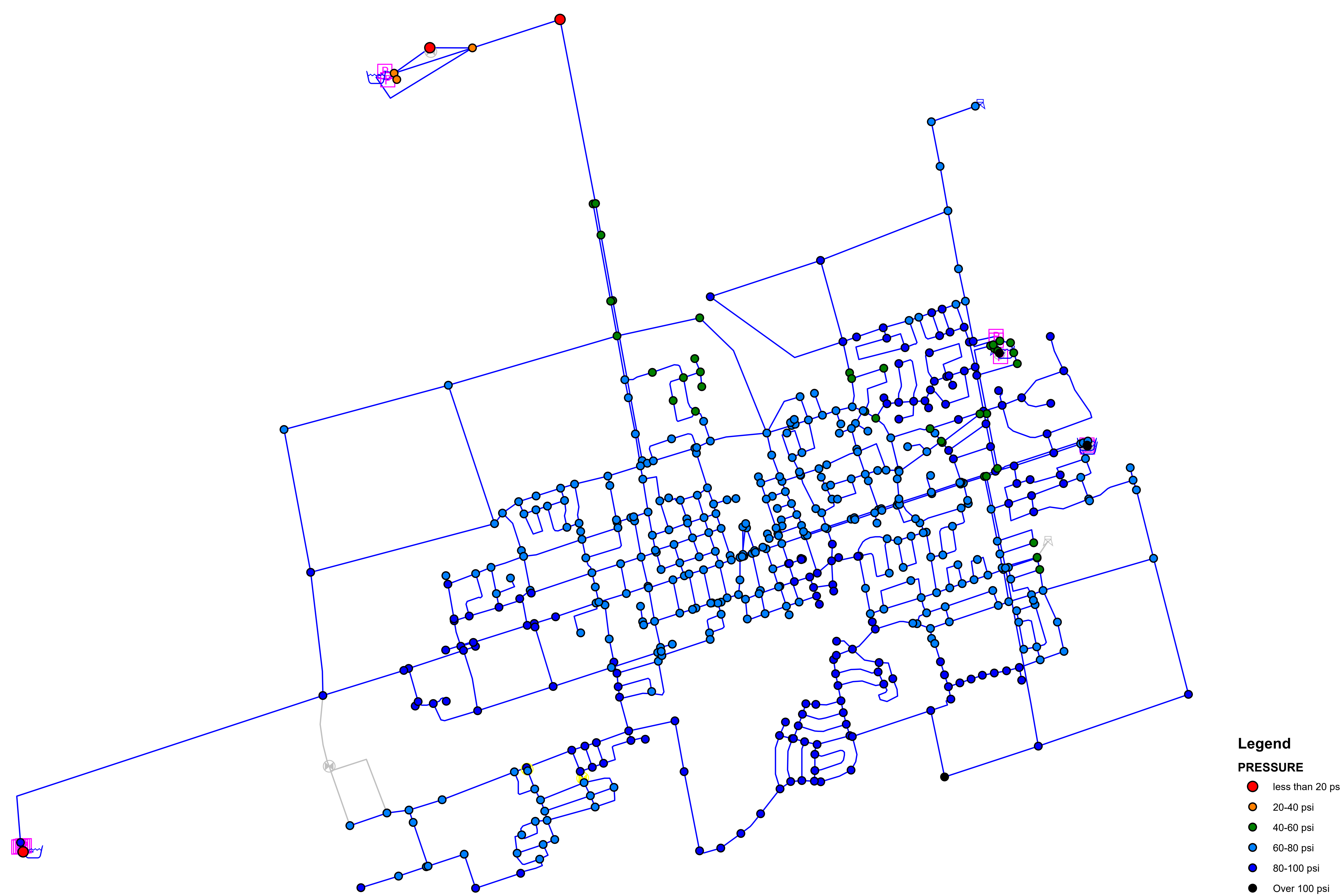
January 2020
PN: 17100



TMIG
A T·Y·LIN INTERNATIONAL COMPANY

Stouffville Class EA - Existing Conditions
2041 Maximum Day Demand
HLPS Pump Increased to Flow of 110 L/s (A1)

January 2020
PN: 17100



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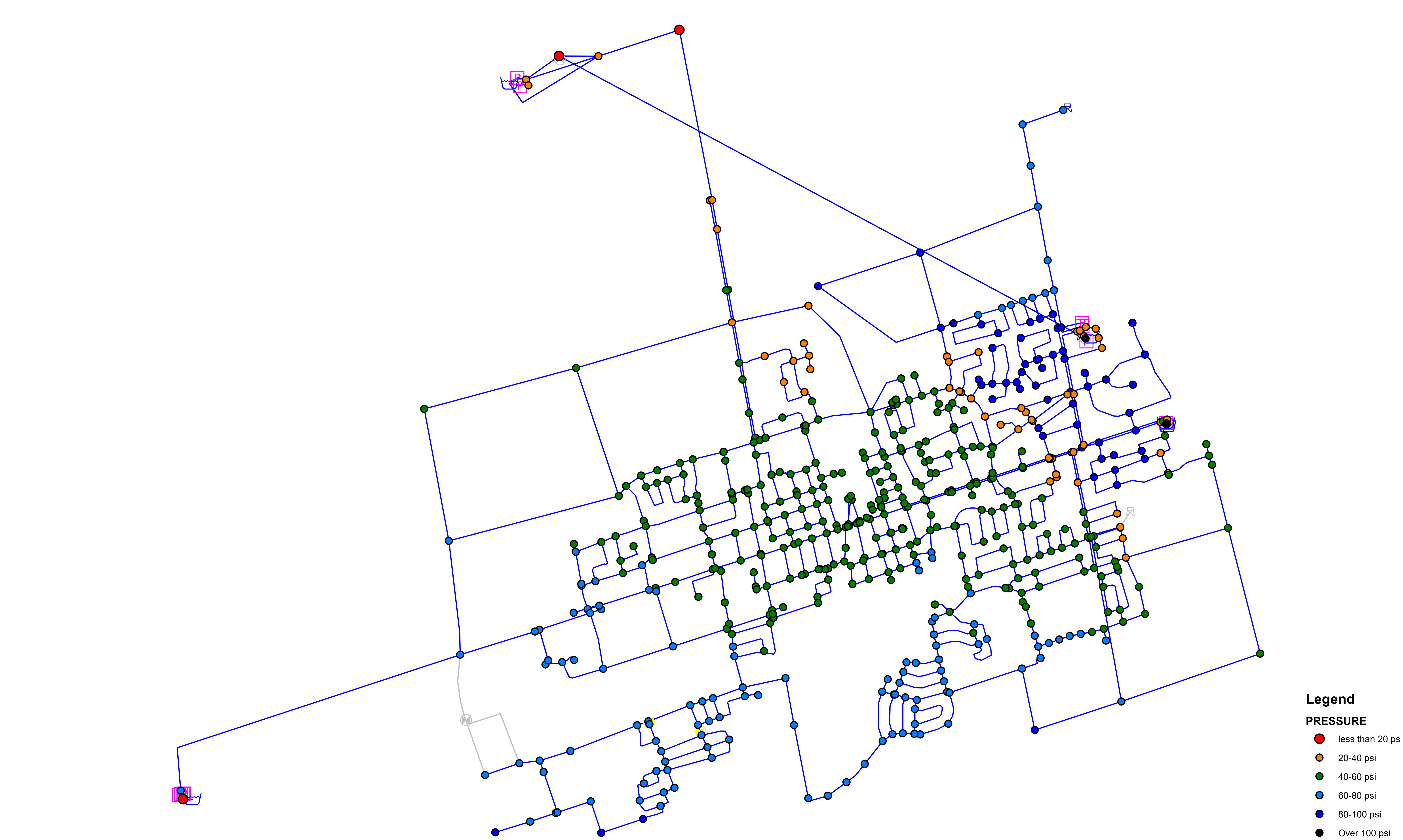
Stouffville Class EA - Existing Conditions
2041 Maximum Day Demand
HLPS Pump Increased to Flow of 190 L/s (A2)

January 2020
PN: 17100



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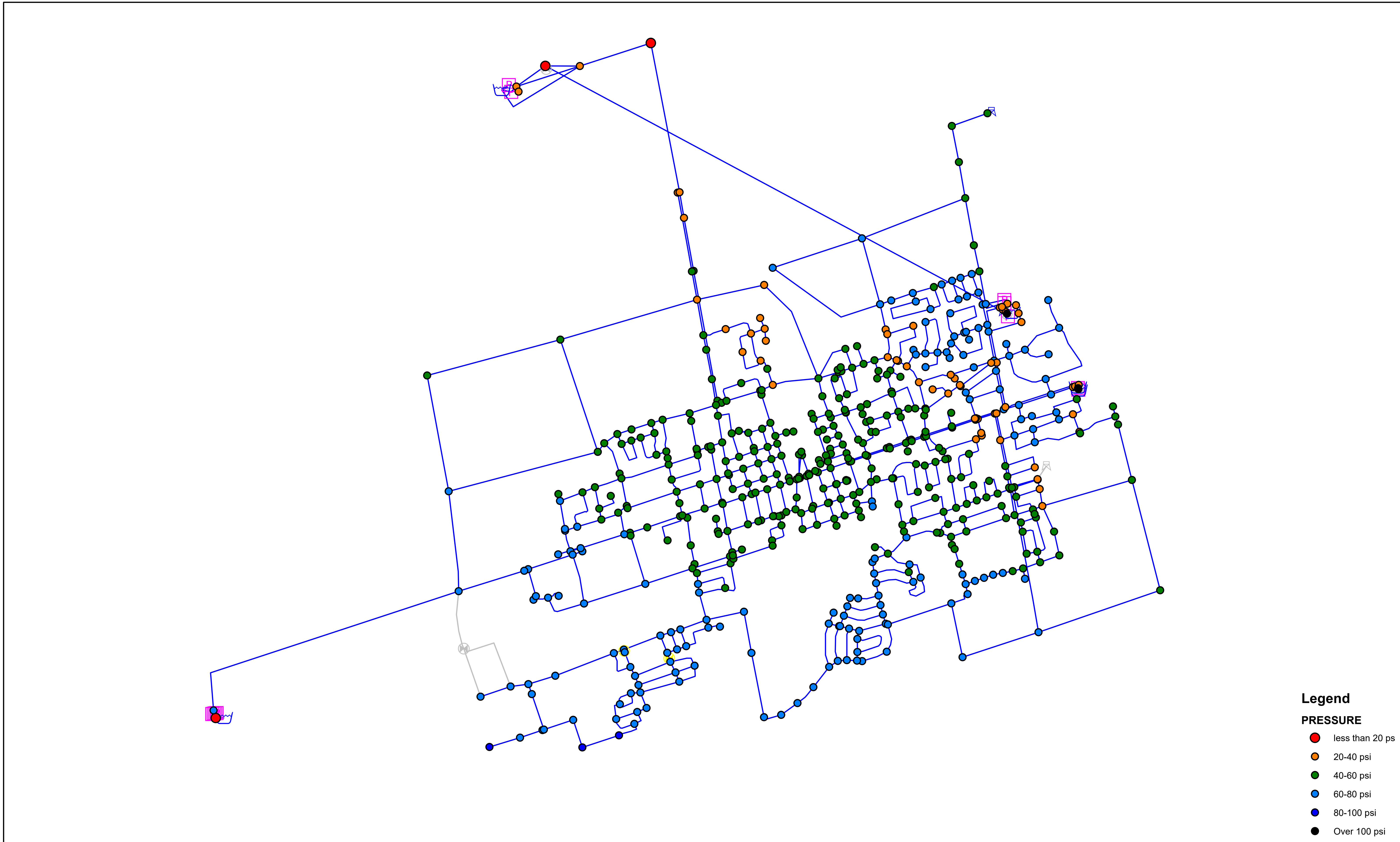
Stouffville Class EA - Existing Conditions
2041 Maximum Day Demand
HLPS Pump Increased to Flow of 110 L/s Plus Extra Storage at Stouffville Reservoir Location (B1)

January 2020
PN: 17100



TMIG
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Stouffville Class EA - Existing Conditions
2041 Maximum Day Demand
HLPS Pump Increased to Flow of 190 L/s Plus Extra Storage at Stouffville Reservoir Location (B2)

January 2020
PN: 17100