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VIA EMAIL and RESS

October 5, 2022

Nancy Marconi
Registrar
Ontario Energy Board
2300 Yonge Street, Suite 2700
Toronto, Ontario, M4P 1E4

Dear Nancy Marconi:

Re: Enbridge Gas Inc. (Enbridge Gas)
Ontario Energy Board (OEB) File No. EB-2022-0157
Panhandle Regional Expansion Project
Response to Federation of Rental-housing Providers of Ontario ("FRPO")
Request for Simulation Verification Results

Within FRPO's September 29, 2022 submission, FRPO stated that it would "ask that EGI file the results of its last system verification with the Board and distribute to the parties to aid in our discussions regarding simulating this system."

Please find enclosed the results of three separate verifications that were completed within the last four years, in response to FRPO's request.

If you have any questions, please contact the undersigned.

Sincerely,

(Original Digitally Signed)

Haris Ginis
Technical Manager, Leave to Construct Applications

Panhandle System Verification (Summary)

There are three separate verifications that were completed within the last 4 years, each with a different pipeline focus. These verifications are completed approximately every 5 years or when a new facility is added to the system.

A verification is a critical component in the hydraulic modeling process. Since a hydraulic model is a mathematical representation of a physical pipeline system it needs to be calibrated to match its field operation. This step is required to ensure the hydraulic model is providing accurate results. A verification compares modelled flows and pressures to those measured in the field (actuals) and if the comparison is within the required tolerance, the modelled is considered verified and thus accurate. If the model is outside the required tolerance, parameters within the model are adjusted to minimize the percent difference between modelled and actual results and bring the model results into tolerance.

The tolerance chosen for the transmission systems is 2% of the actual measurement. This value is in alignment with the tolerances inherent in the flow and pressure measurement devices in the field.

The results are reported in imperial units with flow rates in millions of standard cubic feet per day (MMscfd) and pressure in pounds per square inch gauge (psig).

Each of the three last reports are included below:

1) Panhandle System Verification (September 12, 2018) – Panhandle mainlines, Essex and Mersea Lines.
2) Panhandle System Verification (March 30, 2020) – Lateral Verification, excluding Leamington North Line and Loop
3) Panhandle System Verification (February 23, 2022) – Leamington North Line and Loop

Panhandle System Verification

September 12, 2018

Scope:

Verification of the Panhandle mainlines, Essex and Mersea Lines.

Introduction

A verification study of the Panhandle transmission system model was performed to validate the updated model. The purpose of the study is to compare actual pressure and flow rates recorded in the field to the model results. The model roughness and efficiency is adjusted to minimize the pressure difference between the field data and model results to a 2% tolerance.

Weather

To perform the verification, a series of cold winter days were chosen for comparison. The dates of January 2-8, 2018 (W17/18) were chosen as the weather was very cold during this period.

Model Segmentation

The model was separated into two separate sections. The NPS 20 and the NPS 16 were analyzed separately. The NPS 36/20 has telemetry at each station and flow sources. The NPS 16 has many non-telemetered sites and as such assumptions need to be made to complete the analysis. The high pressures lines into Leamington were not analyzed.

Analysis Type

The model was run using the Unsteady State analysis tool for 125 (for NPS 20) and 336 (NPS 16) hours. Once the flow data in the model is adjusted to match the actual measured flow rates the analysis was completed. The hourly pressure results at each demand point in the Synergi model was compared to the pressures recorded in the field.

Data

For each day, the actual hourly flow, pressure and temperature data at the telemetered points along the system was extracted from the Enterprise Data Warehouse. Using this data, a volumetric flow profiles totalling 125 or 336 hours were created for each demand point. Similar profiles were created for the source pressure nodes.

Gas Control was consulted to determine the operation for the chosen days to know how the NPS 20 and NPS 36 were operated at Dawn, Dover Transmission, Tupperville Valve site and Dover Centre Valve site.

NPS 36/20 Results

The NPS 36/20 verification consists of the NPS 36 between Dawn and Dover Transmission Station and the NPS 20 from Dover Transmission Station to Sandwich Transmission / Compressor Station. The verification does not include the laterals into the Leamington / Kingsville system. The verification is straight forward since 100% of the volume entering and exiting this system is measured. It was determined from consultation with Capacity Planning that the Dawn 20 measurement was flowing to the NPS 36 pipeline, Dover Centre was fed from the NPS 36, the NPS 36 and NPS 20 were not operating in common and the NPS 36 was feeding the NPS 20 only at Dover Transmission station.

Volumetric Data

The volumetric data is input into the model as measured at each station. Figure 1 shows the summation of the actual measured flow at Comber, Mersea, Essex, Sandwich and Dover Centre compared to the data input into the model. Since the model data matches actuals the resulting Total Dawn Flow should also match, however they do not as shown in Figure 2 and 3. The differences between the model results and actual total flow measurement are due to linepack. The pressure entering the system at Dawn is shown. When pressure is increasing at Dawn there should be an increased amount of gas being packed that is not measured leaving the downstream stations. There is an average of 10.5 MMcfd difference between Dawn modelled flow and the average (172 MMcfd) actual Dawn flow from the NPS 20 measurement or a 6% difference, with the largest differences occurring at the high and low points.

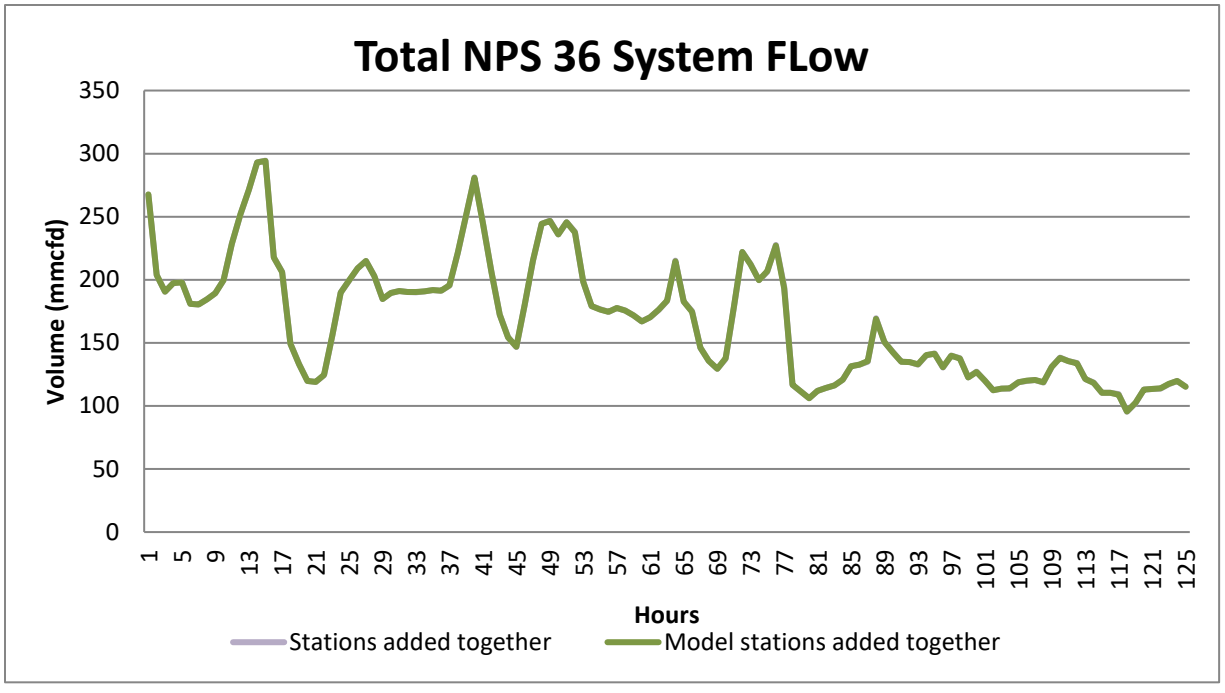

Figure 1: Total NPS 36 System Flow

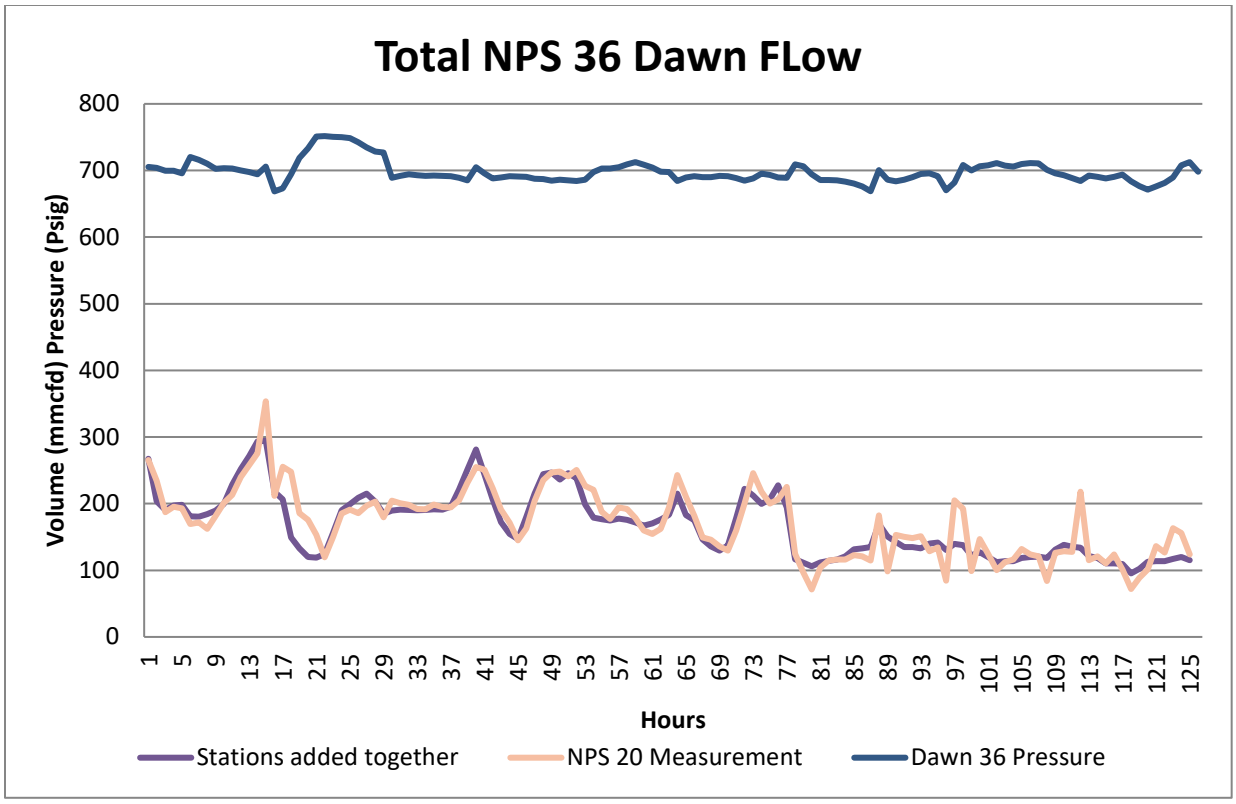

Figure 2: Total NPS 36 System Flow and Dawn Pressure

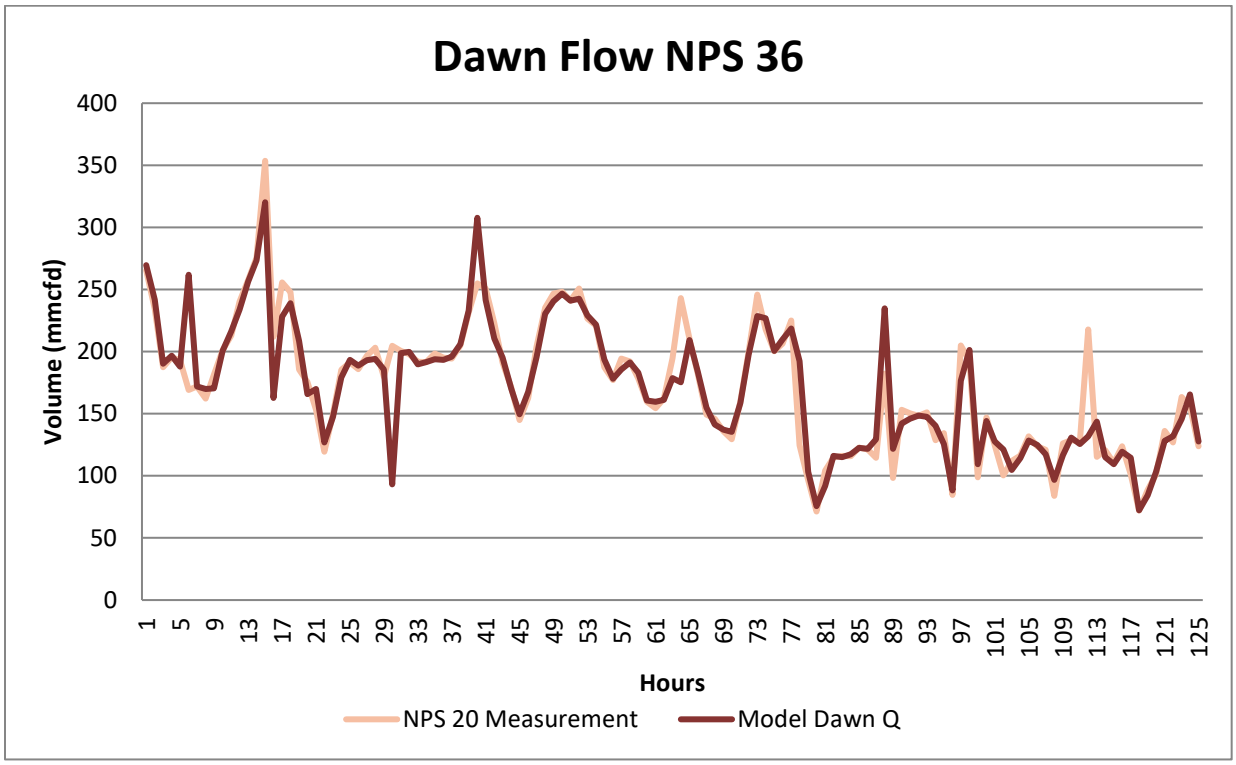

Figure 3: Total NPS 36 System Flow Model and Actual difference

Pressure

It has been determined that the majority of the NPS 36/20 portion of the Panhandle Transmission model is calculating slightly lower pressures than measured in the field at the telemetered stations. Adjusting the model parameters reduced the absolute pressure differential to within model tolerance.

Table 1 shows the percentage of difference between the actual and the modelled results both before and after the pipeline parameter adjustments

Graphical results are shown in Figures 4 to 10.

Table 1 – Percentage of Absolute Pressure Differential between Actual and Model Conditions Before and After Model Parameter Adjustments

Absolute Pressure Differential Model vs. Actual	Dover Centre	Dover Transmission Inlet	Comber	Mersea	Essex	Sandwich
Percent Differential Before Adjustment	0.50%	0.06%	0.79%	3.55%	0.68%	0.98%
Percent Differential After Adjustment	0.19%	0.06%	0.24%	0.45%	0.45%	0.25%

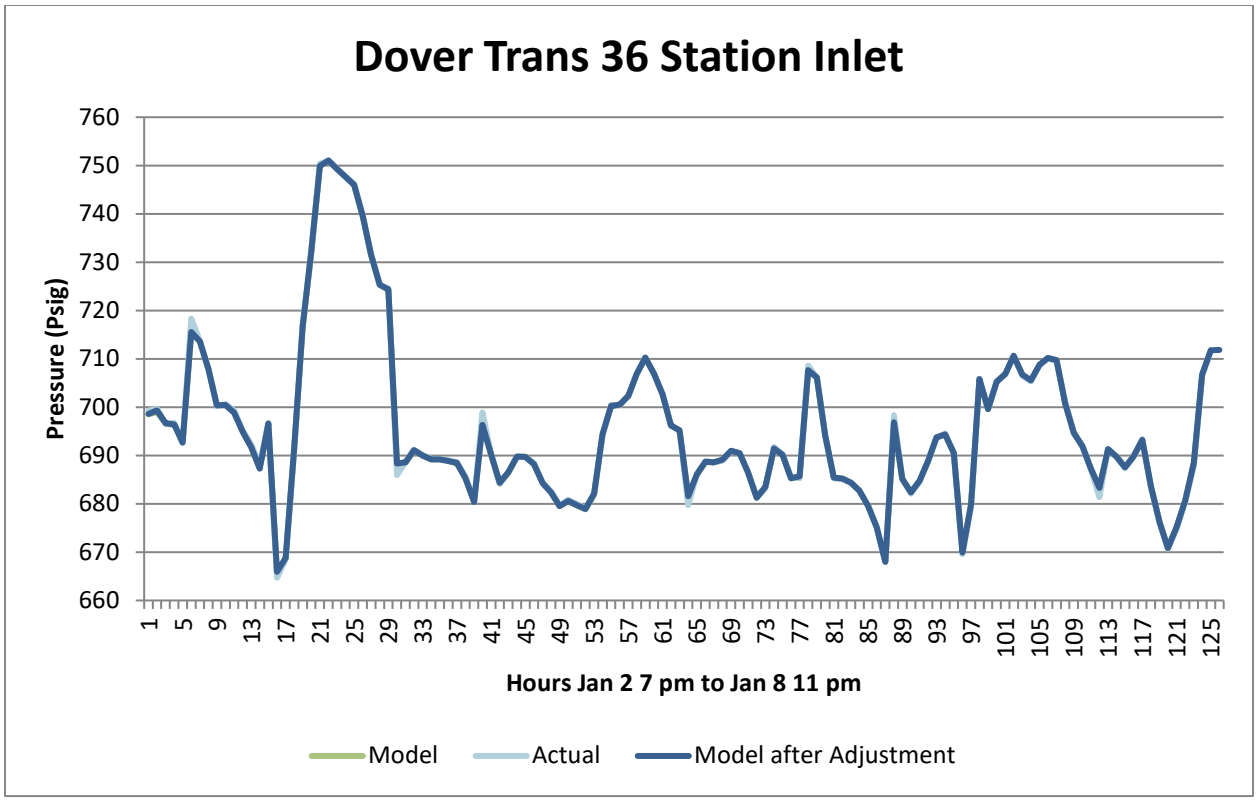

Figure 4: Dover Trans NPS 36 Station Inlet Pressure Model and Actual

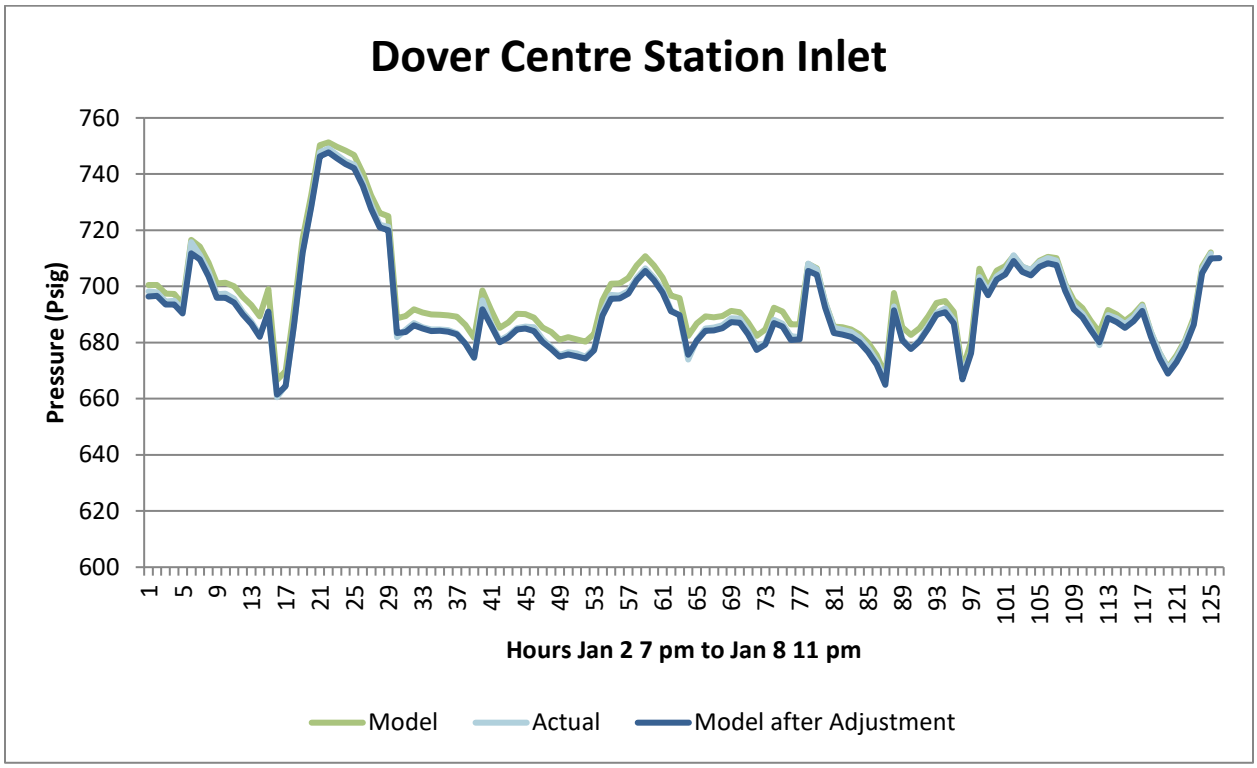

Figure 5: Dover Centre Station Inlet Pressure Model and Actual

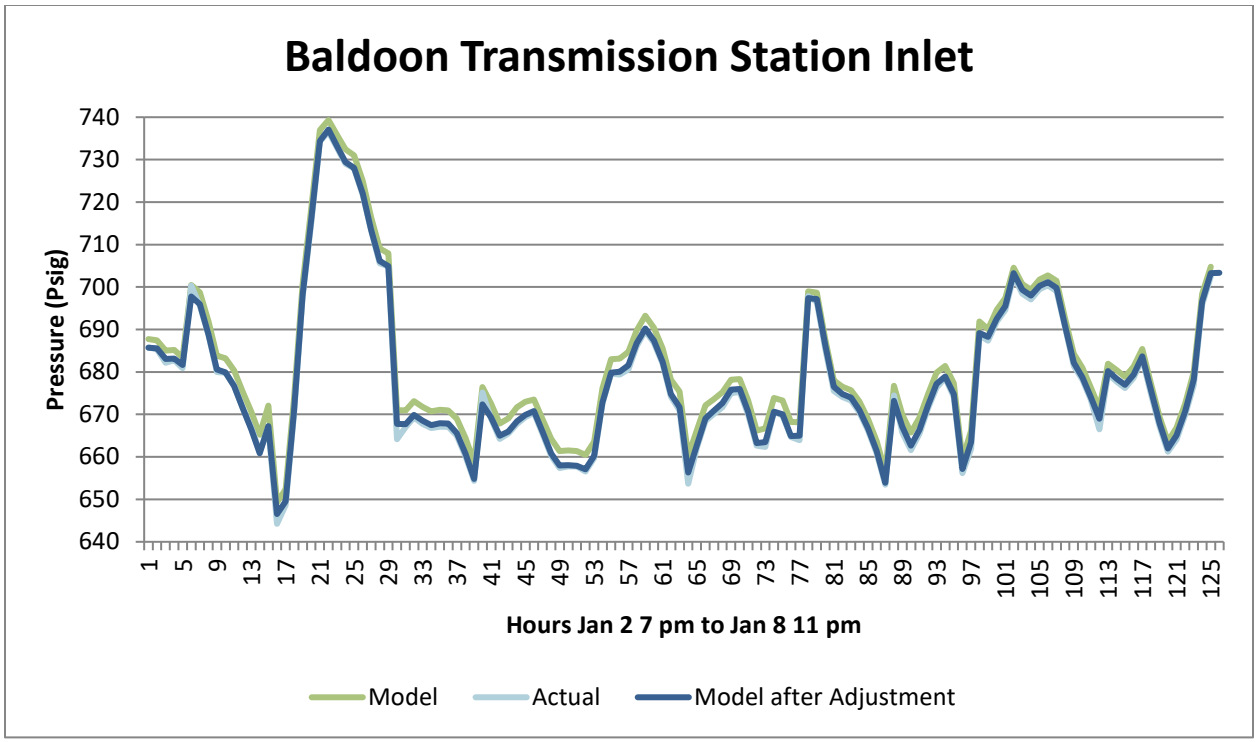

Figure 6: Baldoon Transmission Station Inlet Pressure Model and Actual

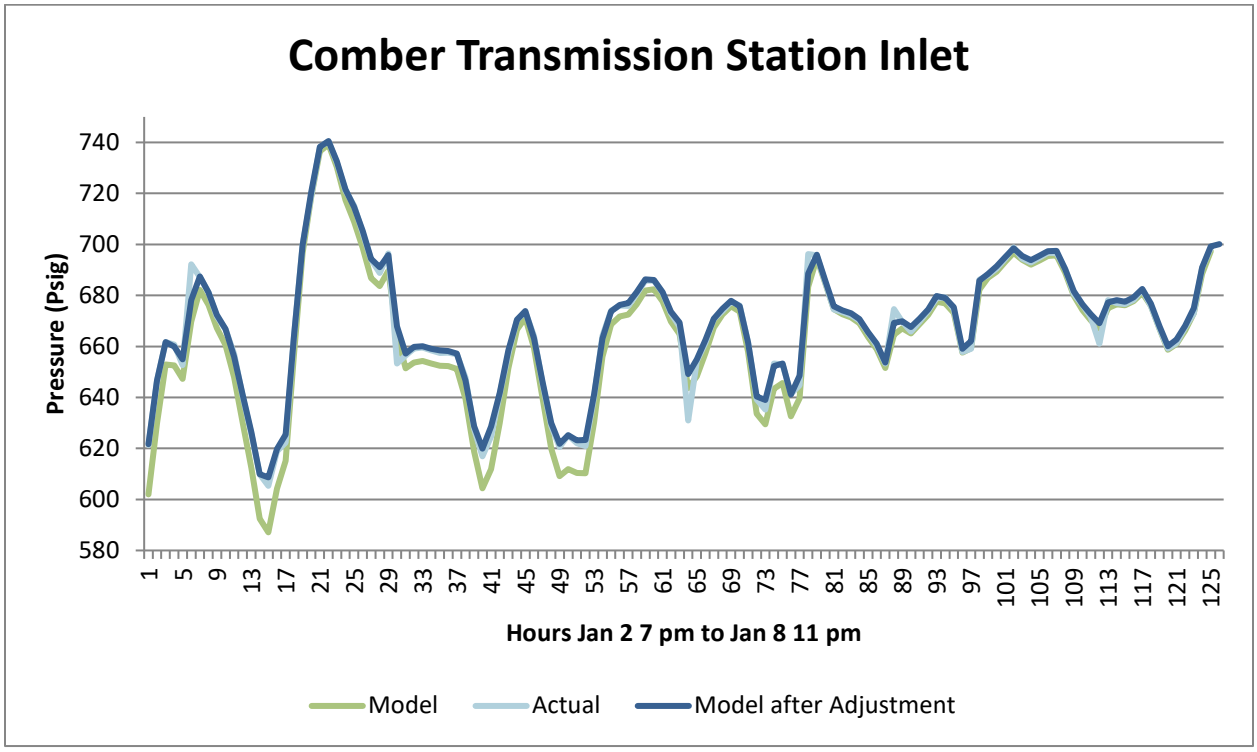

Figure 7: Comber Transmission Station Inlet Pressure Model and Actual

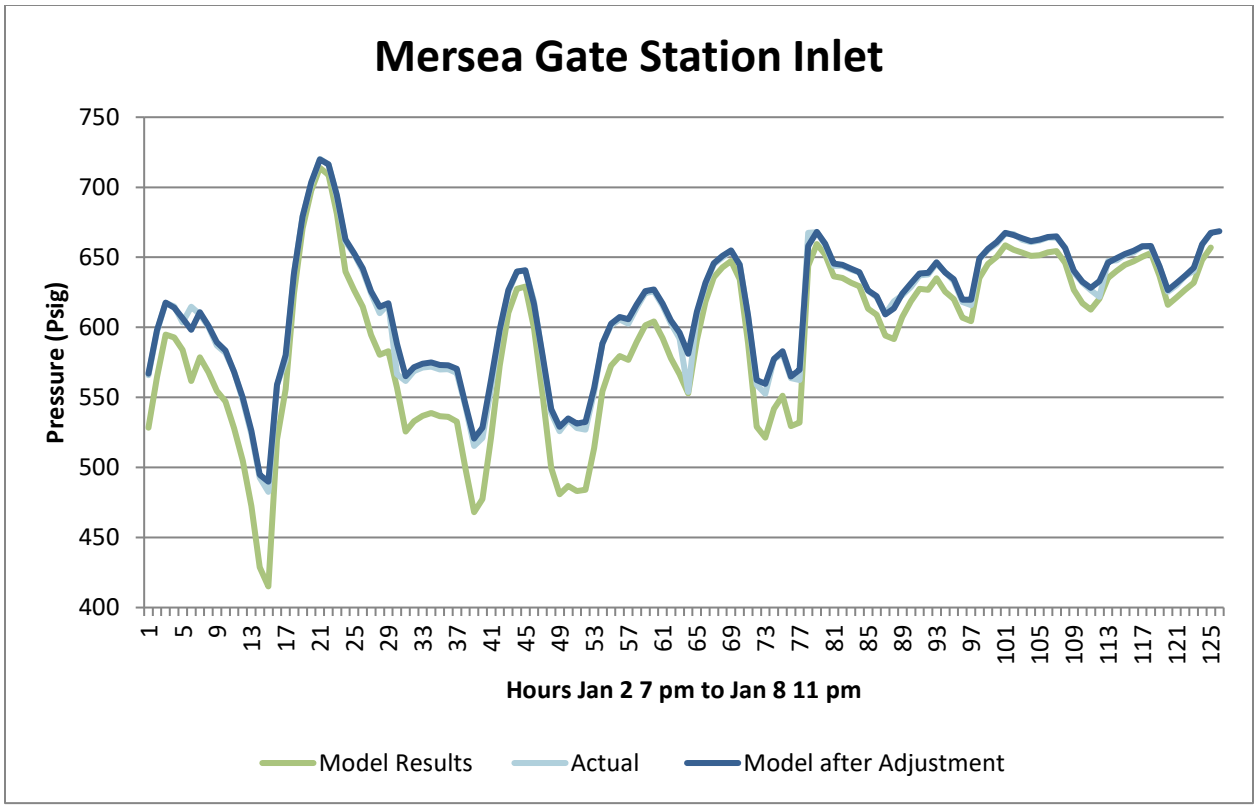

Figure 8: Mersea Gate Station Inlet Pressure Model and Actual

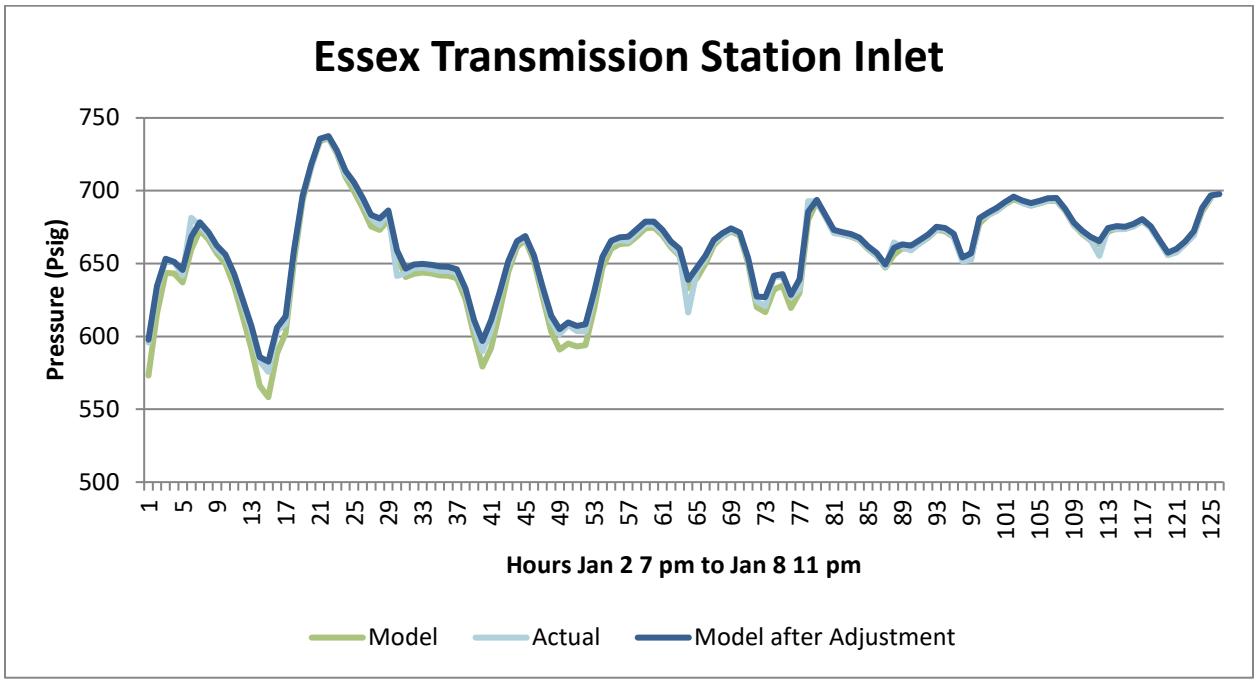

Figure 9: Essex Transmission Station Inlet Pressure Model and Actual

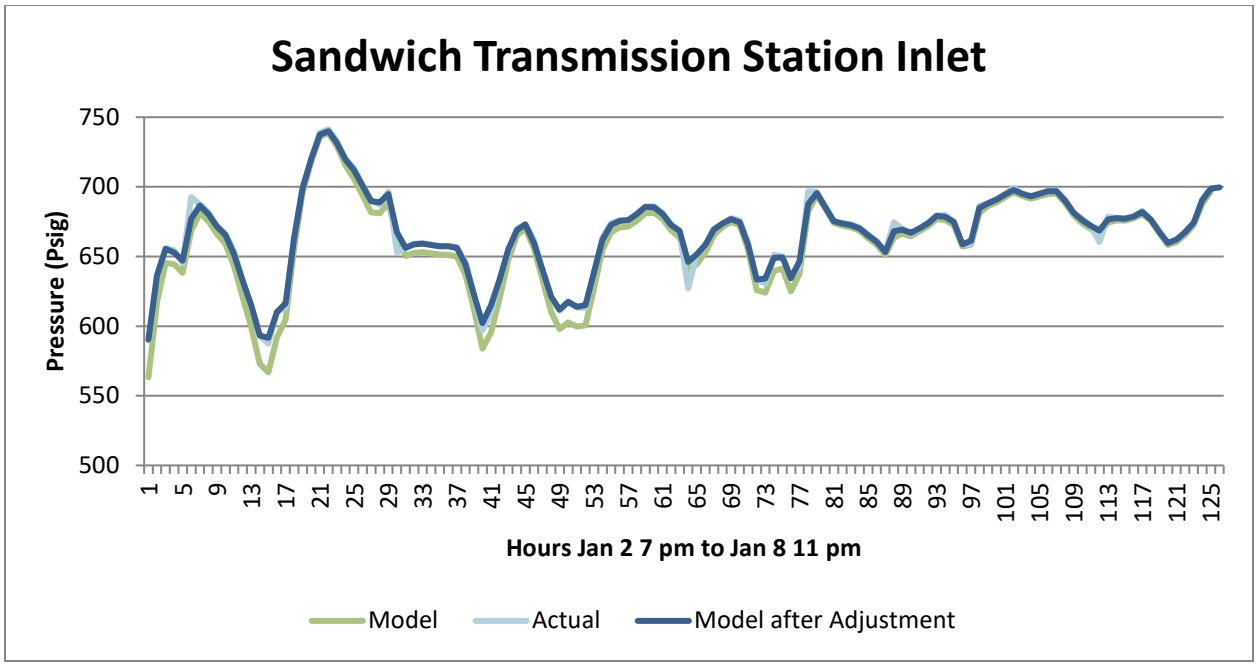

Figure 10: Sandwich Transmission Station Inlet Pressure Model and Actual

NPS 20/16 Results

The NPS 20/16 verification consists of the NPS 20 between Dawn and Dover Transmission Station and the NPS 16 from Dover Transmission Station to Turkey Creek Station. The verification includes the laterals into the 4 power generating plants and some select laterals with telemetered pressures. The verification is difficult due to the large number of stations without telemetry. It was determined from consultation with Capacity Planning that the Dawn 16 measurement was flowing to the NPS 20 pipeline, Tupperville Line was fed from the NPS 20, the NPS 36 and NPS 20 were not operating in common and the NPS 20 was feeding Dover Transmission station but not the NPS 20 towards Sandwich.

Volumetric Data

The volumetric data is input into the model as measured at each telemetered station including Ojibway import volumes (Figure 11) and Sandwich station flow (Figure 12) into the system. The Design Day Spreadsheet is used to determine the volumetric data from un-telemetered stations. The demands for a 43.1 HDD were input as a demand on each node and will be profiled based on the design day profile. The model was run and the Total Dawn Flow on the NPS 20 was determined. The differences between the model results and actual total flow measurement are due to non-telemetered data (Figure 13). The difference was calculated (Figure 14) and a profile created and placed at a chosen location (in this instance at Walker Road Take-off). There is an average of 2.76 MMcfd difference between Dawn modelled flow and the average (173 MMcfd) actual Dawn flow from the NPS 16 measurement or a 1.5% difference, with the largest differences occurring at the high and low points.

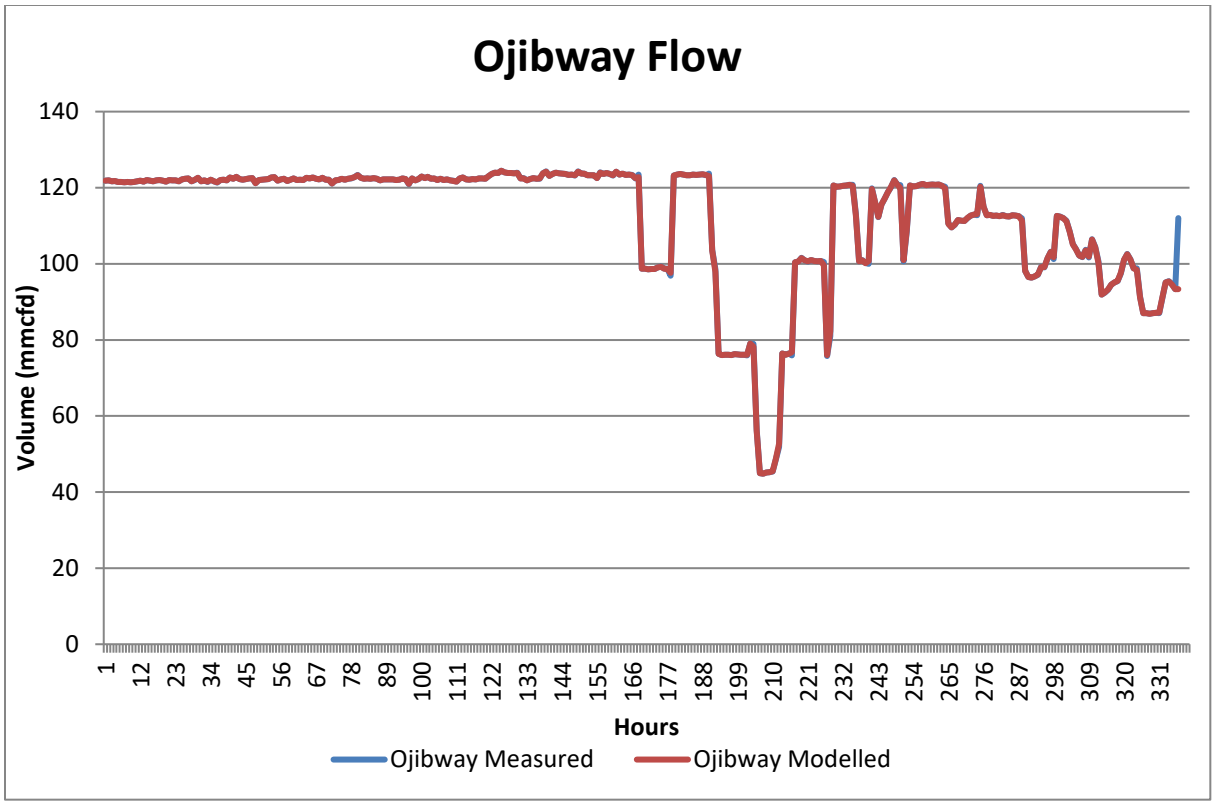

Figure 11: Ojibway Flow Imported into Model

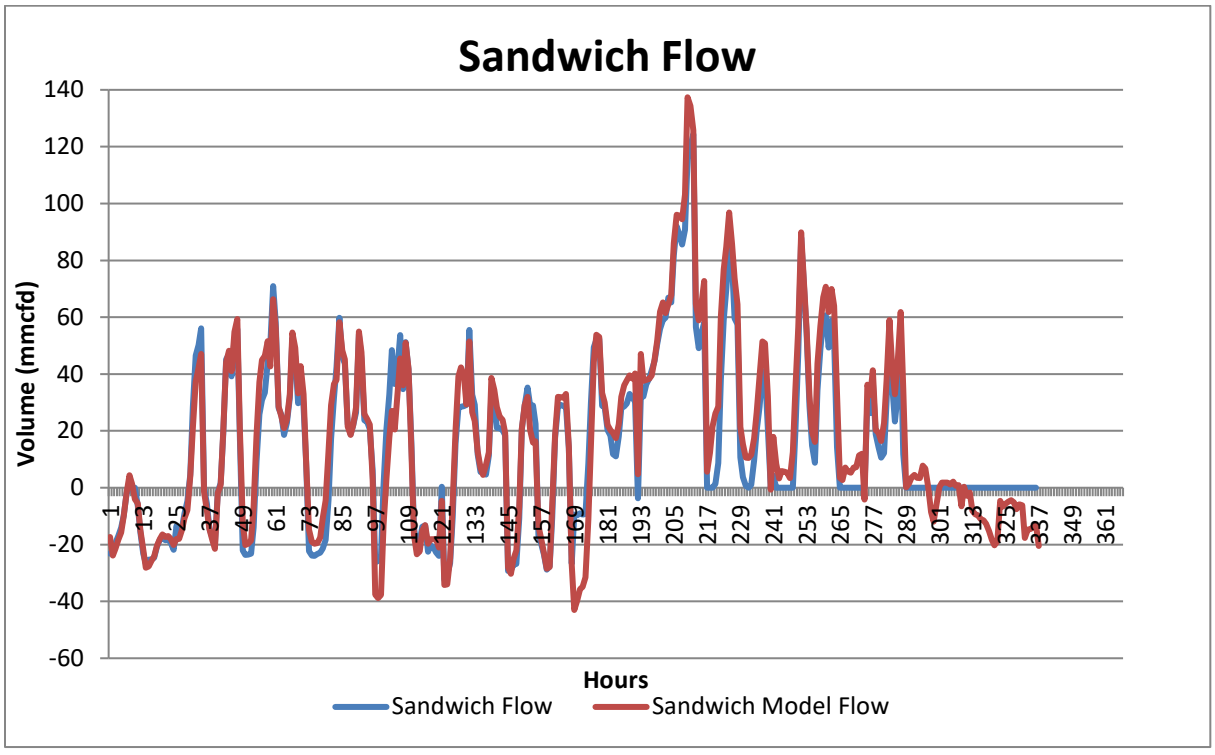

Figure 12: Sandwich Flow Imported into Model

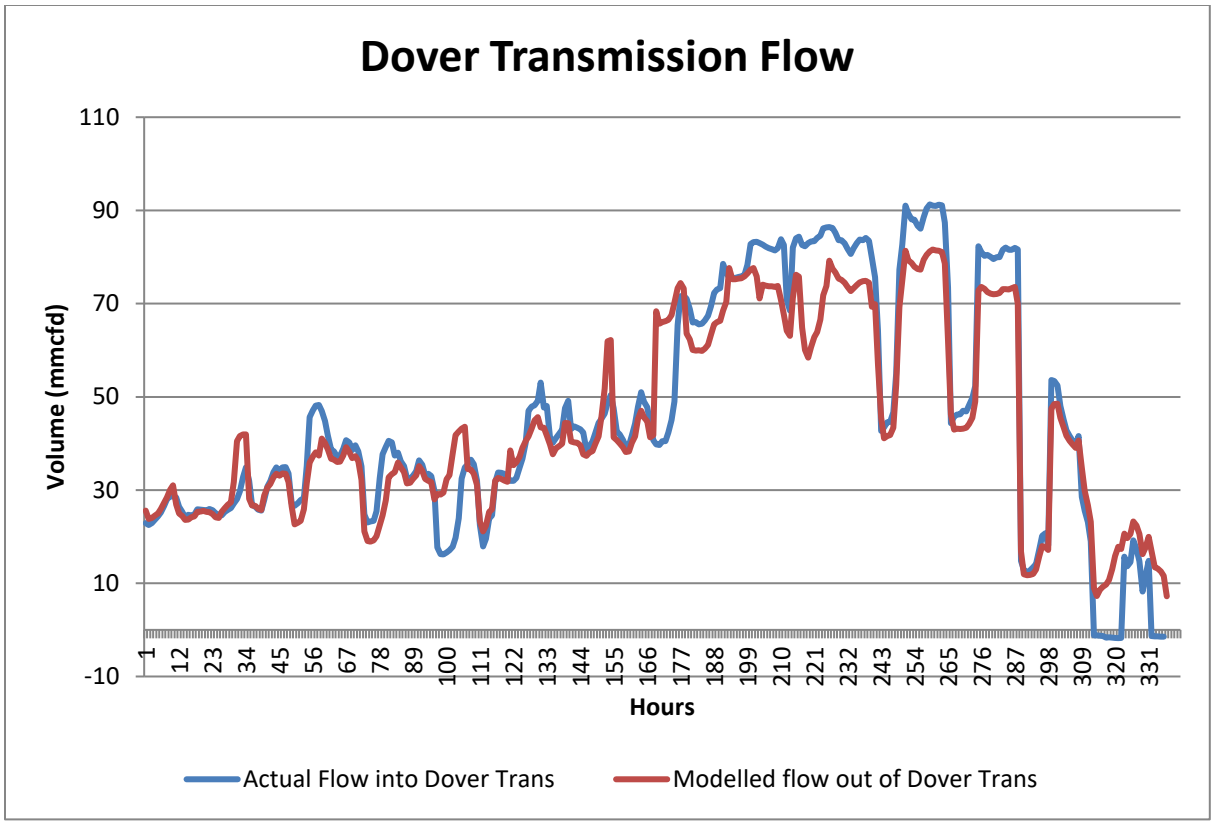

Figure 13: Difference between Actual and Model flow at Dover Transmission Station

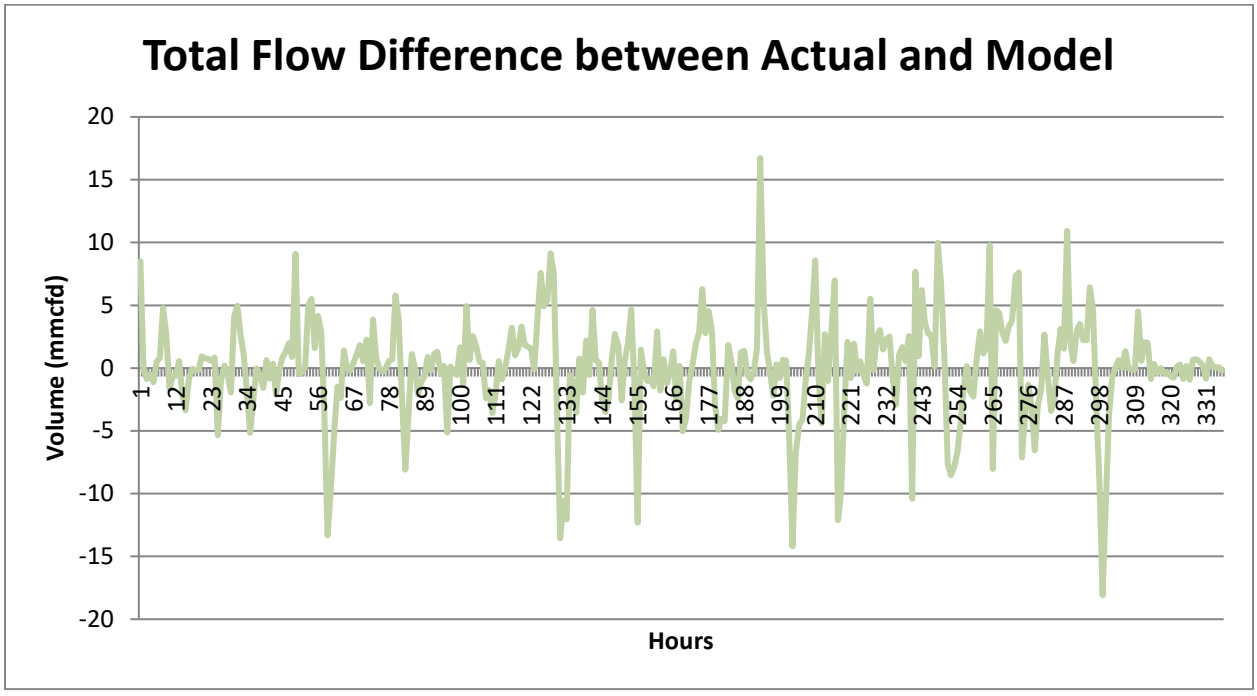

Figure 14: Volume Added to Model from Difference between Actual and Model flow at Dover Transmission Station

Pressure

It has been determined that the majority of the NPS 16 portion of the Panhandle Transmission model is calculating slightly lower pressures than measured in the field at the telemetered stations. Adjusting the model parameters reduced the absolute pressure differential to within model tolerance.

Table 2 shows the percentage of difference between the actual and the modelled results both before and after the pipeline parameter adjustments. Graphical results are shown in Figures 15-29.

Table 2 – Percentage of Absolute Pressure Differential between Actual and Model Conditions Before and After Model Parameter Adjustment

Absolute Pressure Differential Model vs. Actual	Dover Trans	Tilbury N	Patillo	Lauzon	Walker	Ojibway	Sandwich	Turkey Creek	Grand Marais
Percent Differential Before Adjustment	0.01%	0.64%	0.32%	0.80%	0.50%	0.67%	0.02%	0.52%	1.11%
Percent Differential After Adjustment	0.01%	0.21%	0.23%	0.37%	0.41%	0.42%	0.02%	0.33%	1.13%

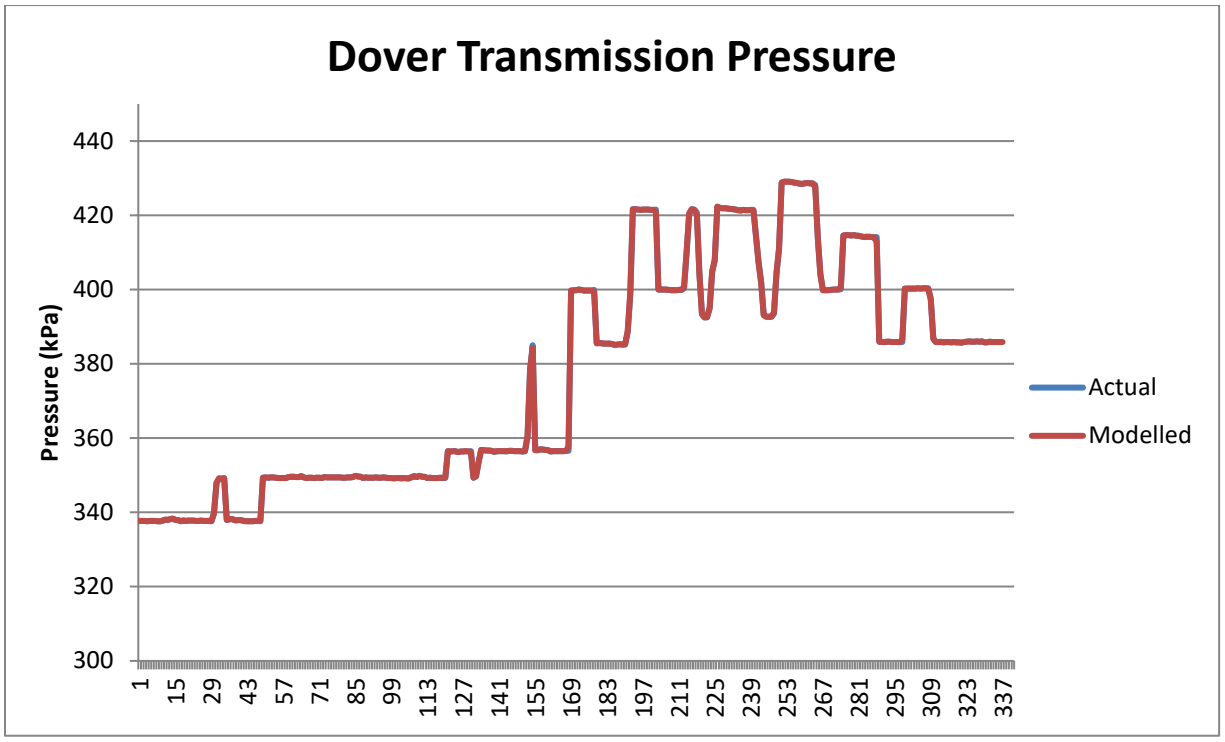

Figure 15: Dover Trans NPS 36 Station Outlet Pressure Model and Actual

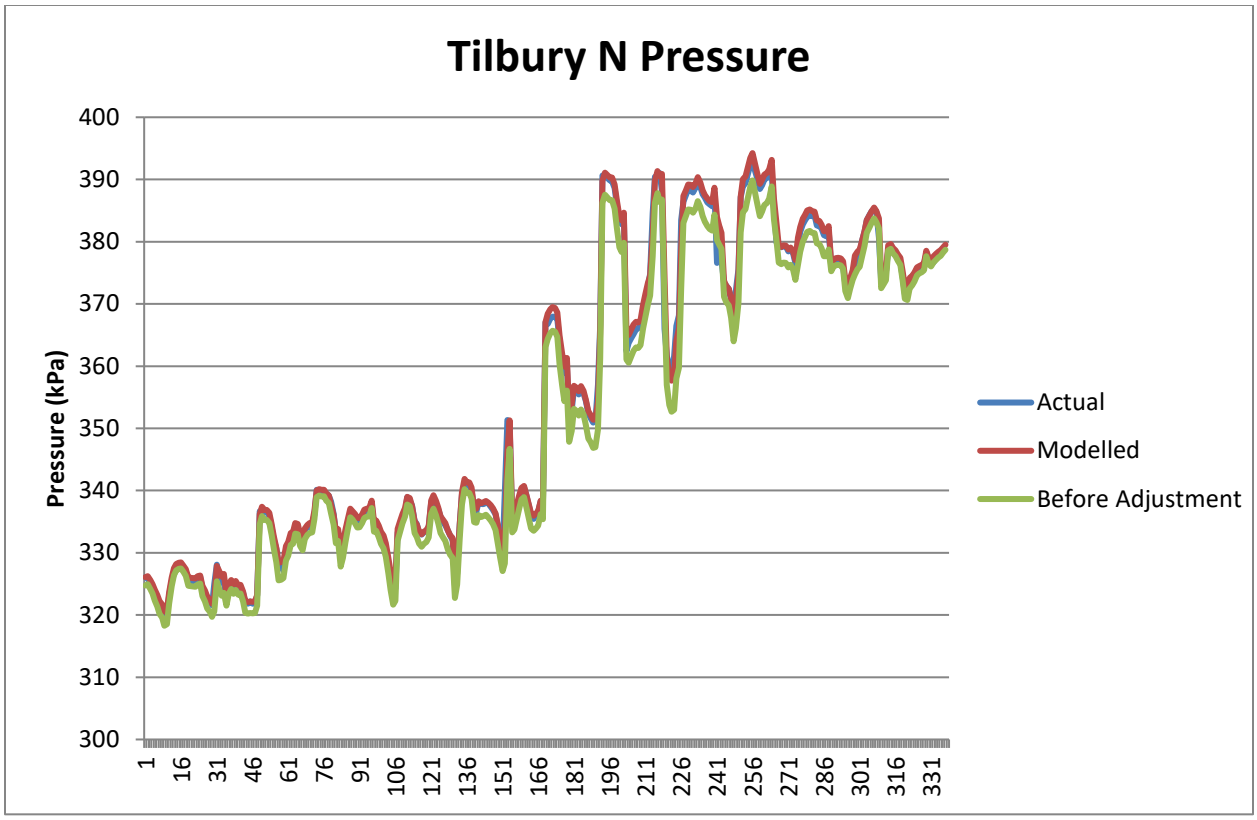

Figure 16: Tilbury North Station Inlet Pressure Model and Actual

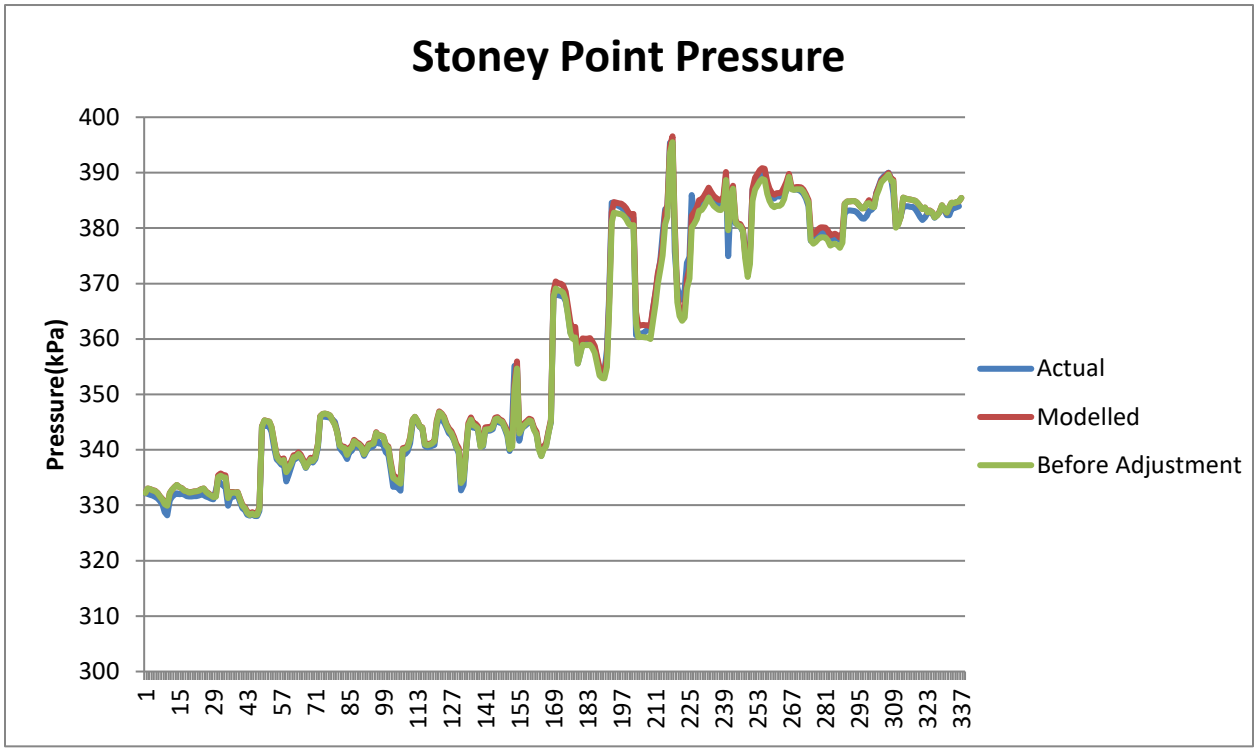

Figure 17: Stoney Point Station Inlet Pressure Model and Actual

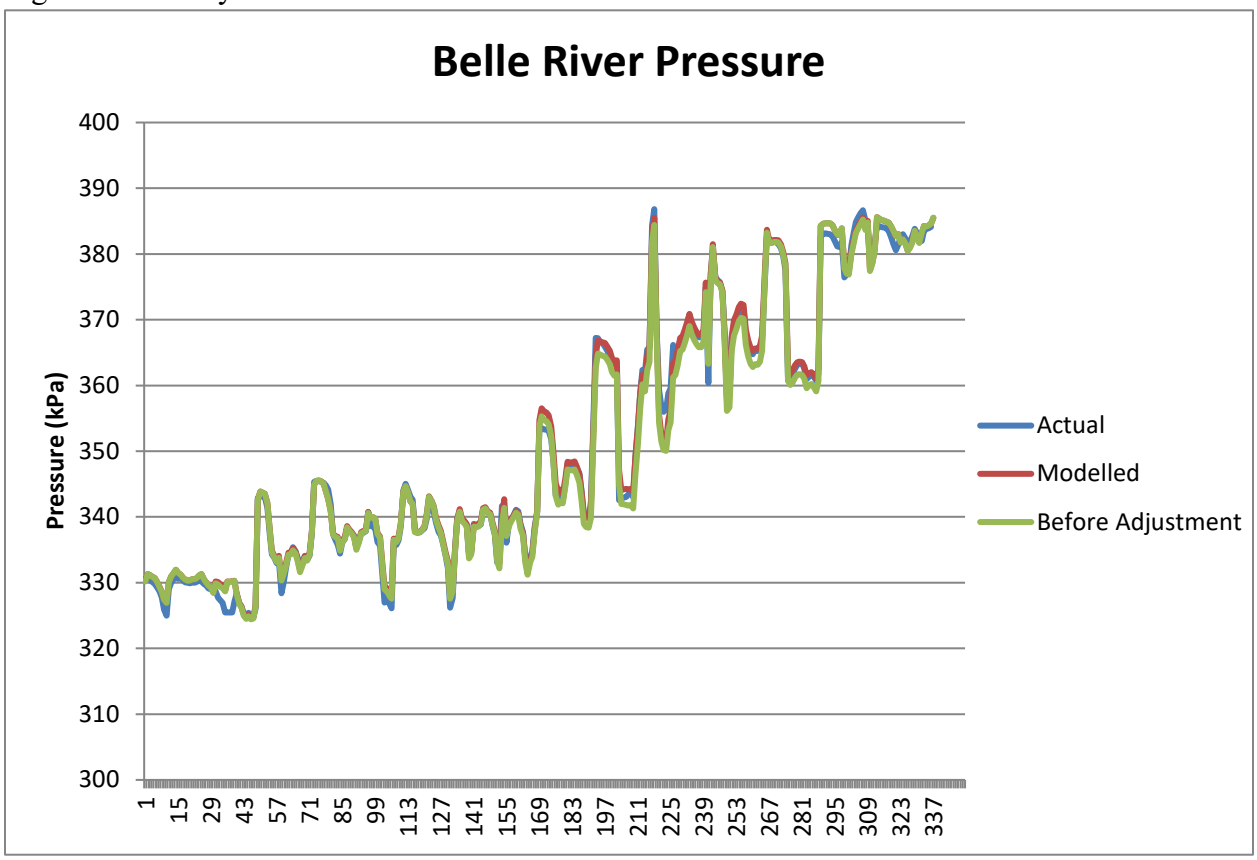

Figure 18: Belle River Station Inlet Pressure Model and Actual

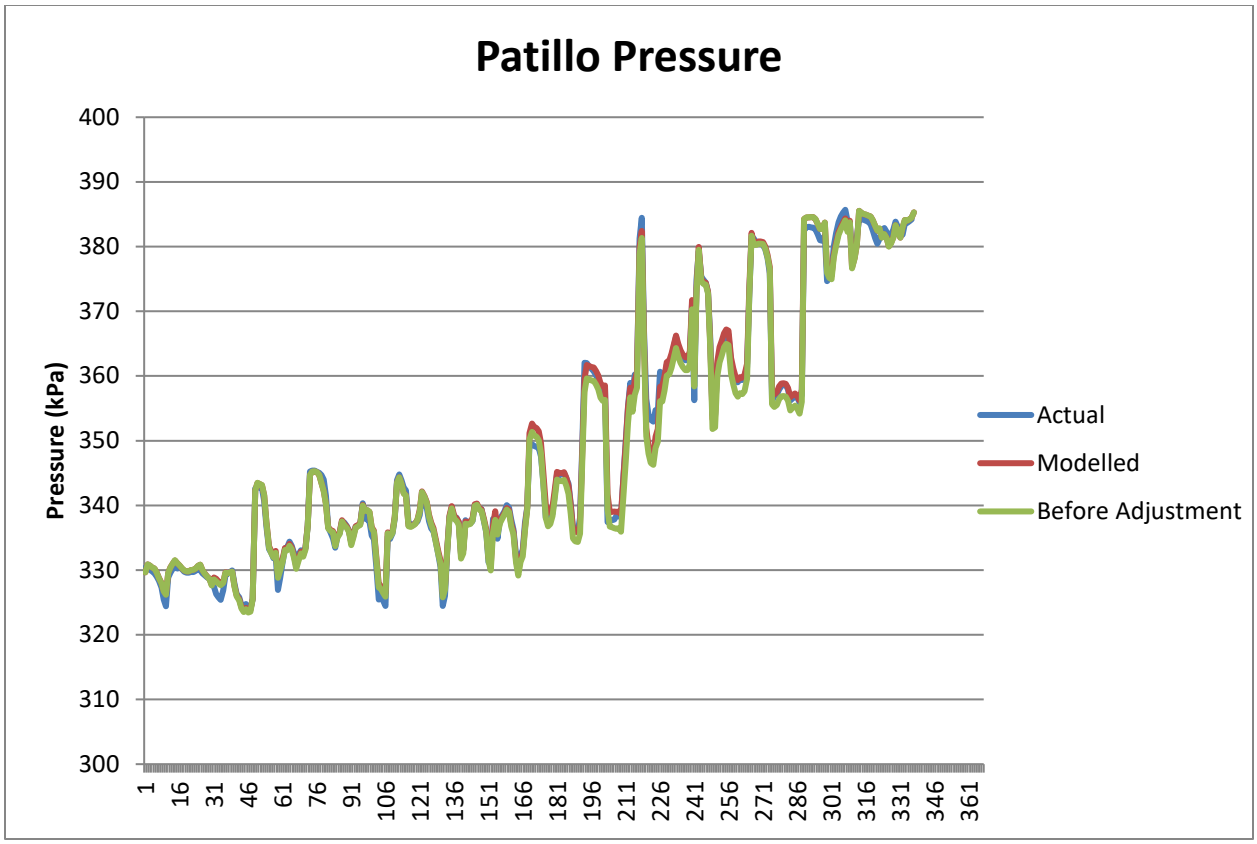

Figure 19: Patillo Station Inlet Pressure Model and Actual

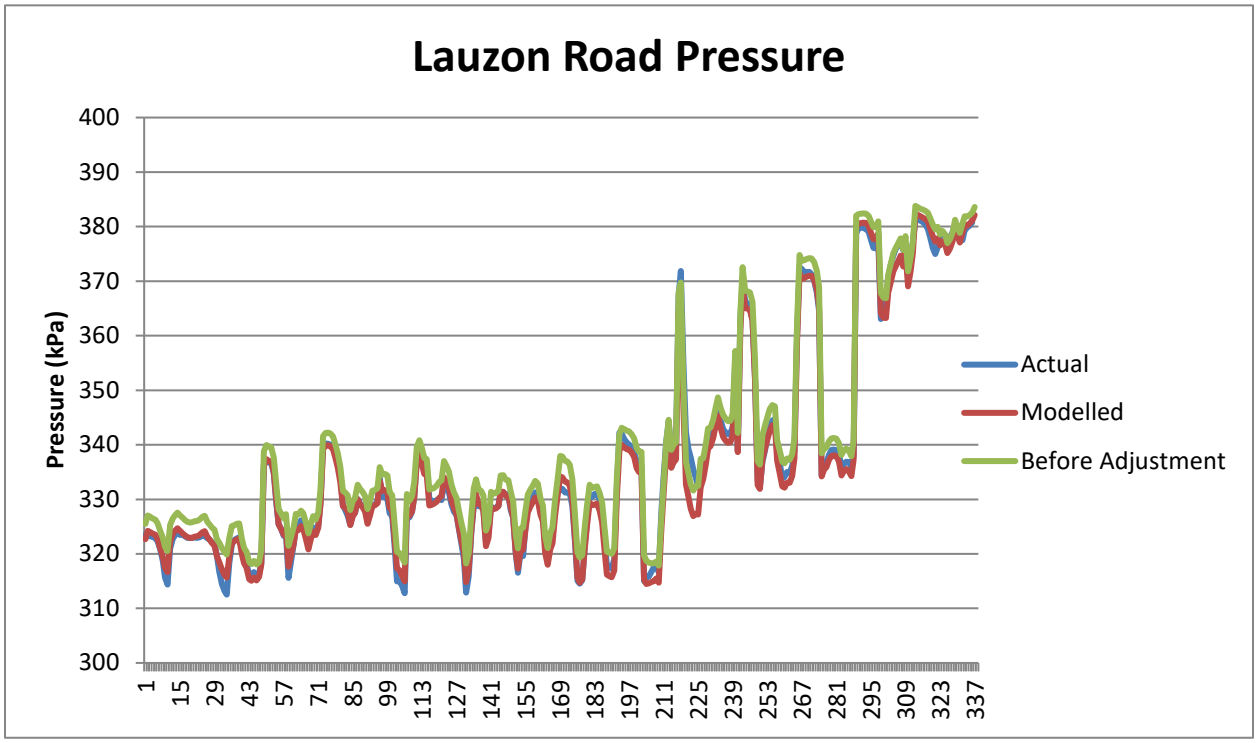

Figure 20: Lauzon Road Station Inlet Pressure Model and Actual

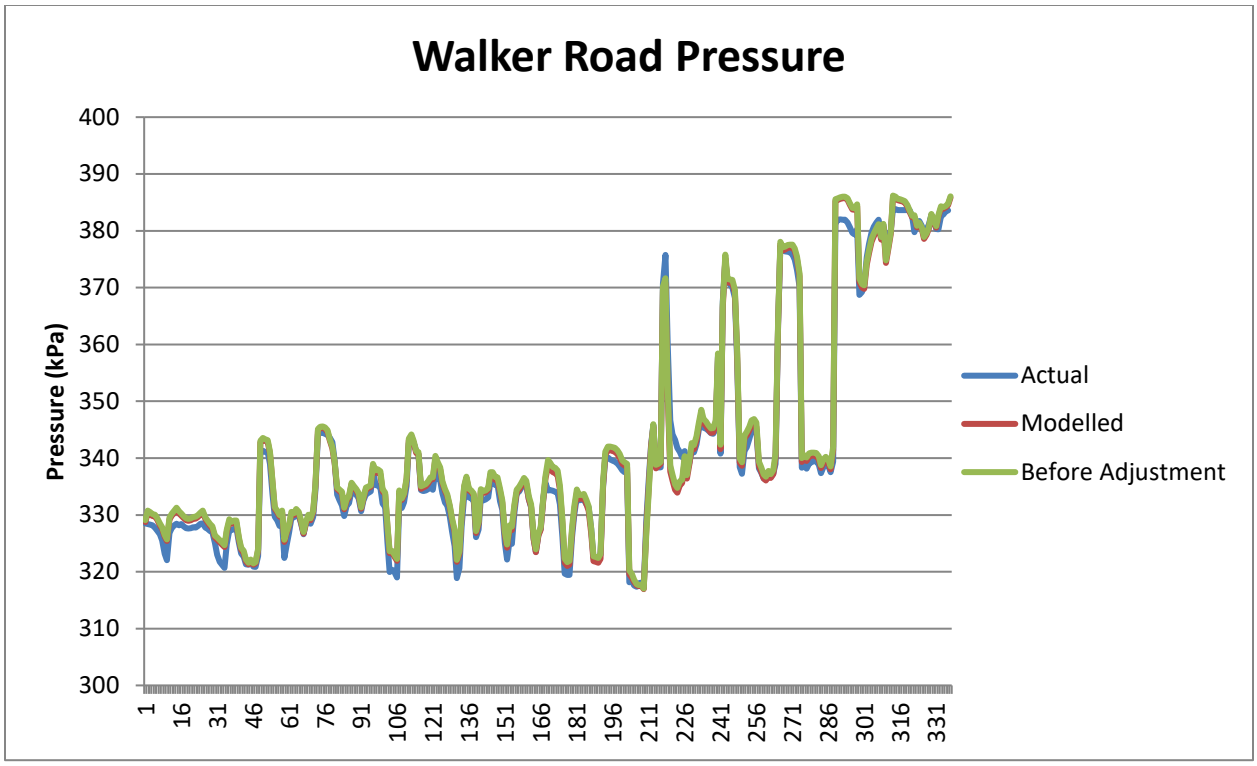

Figure 21: Walker Road Station Inlet Pressure Model and Actual

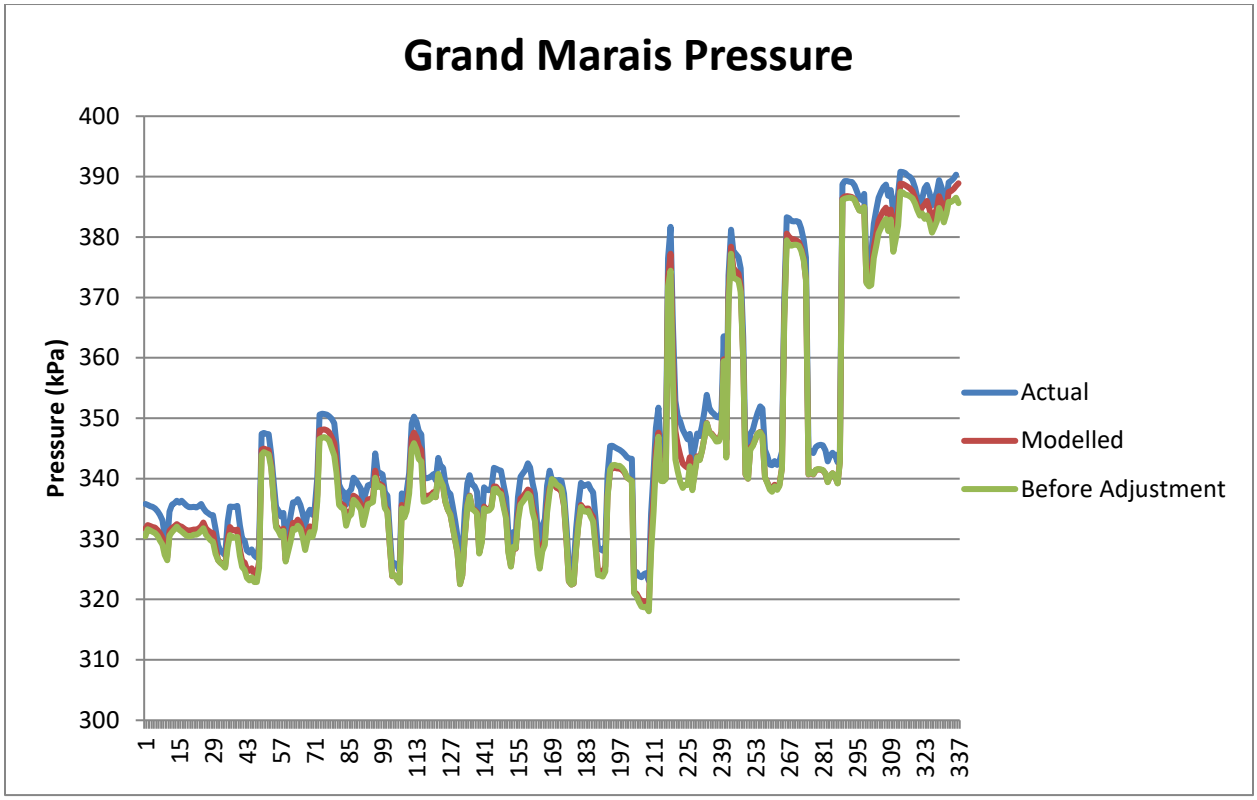

Figure 22: Grand Marais Station Inlet Pressure Model and Actual

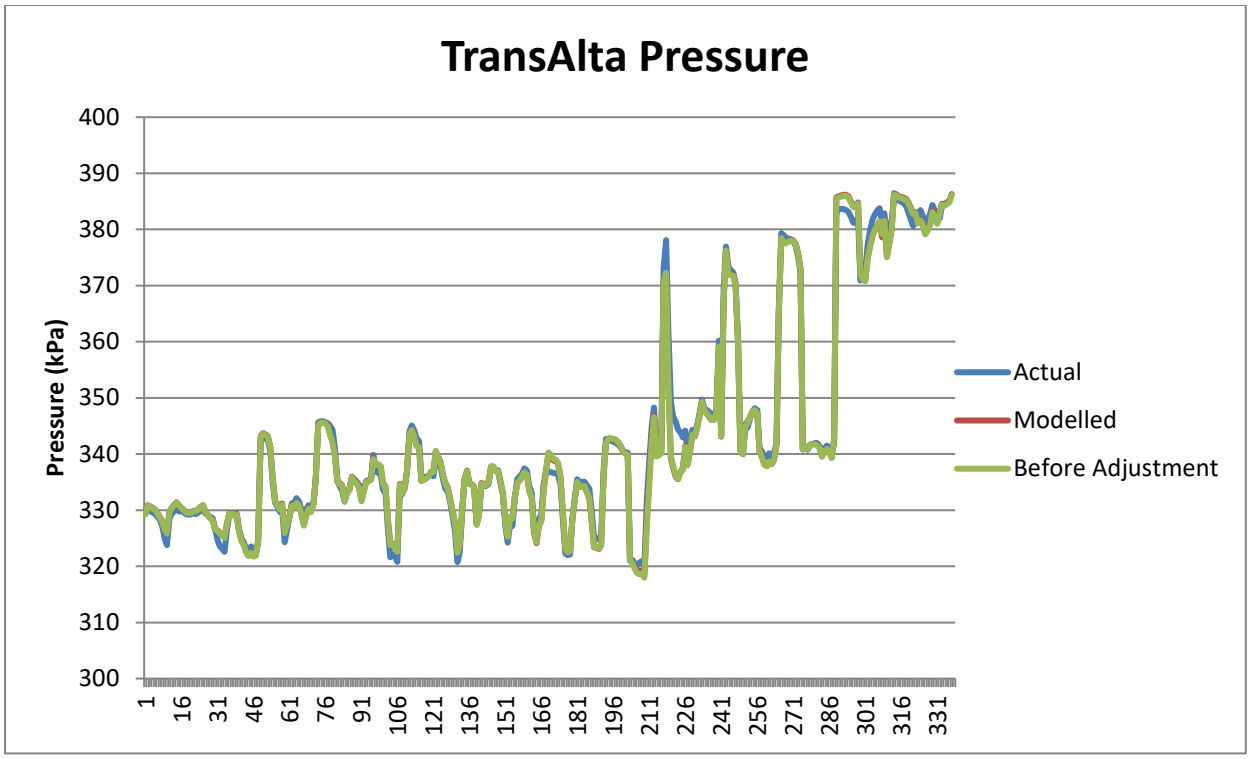

Figure 23: TransAlta Station Inlet Pressure Model and Actual

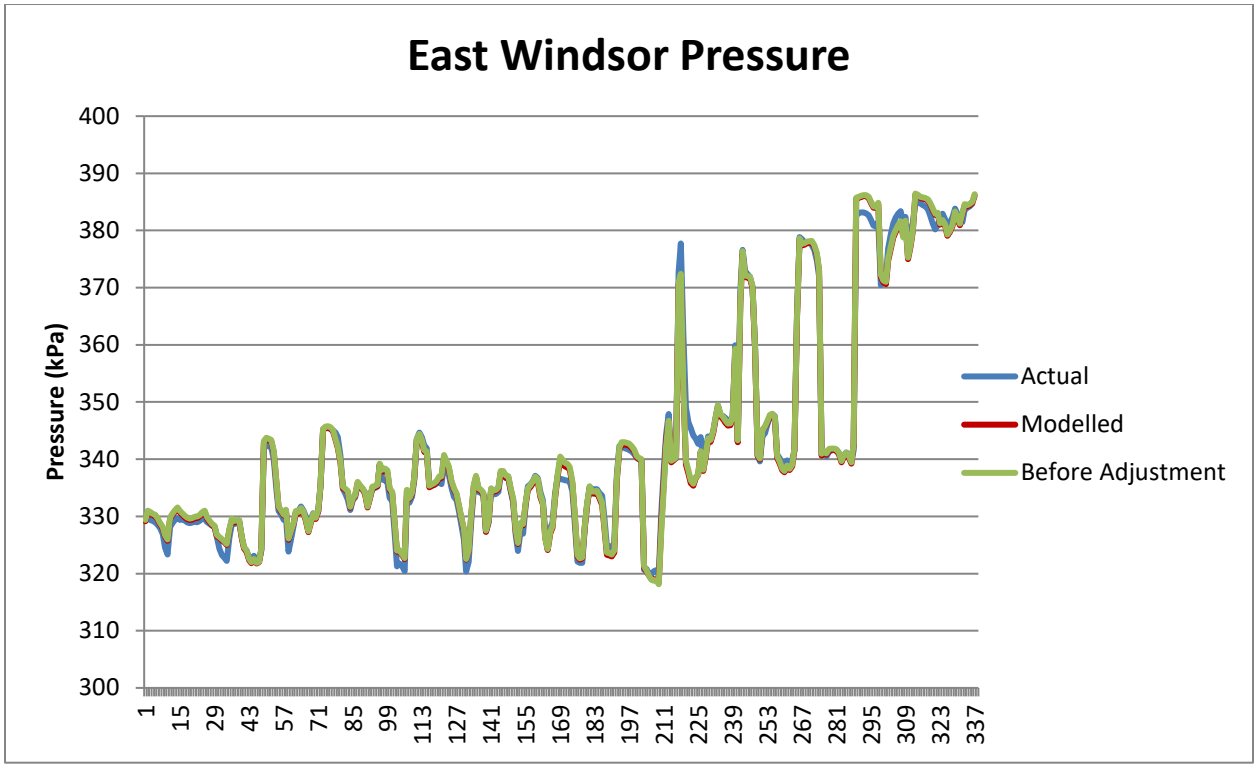

Figure 24: East Windsor Station Inlet Pressure Model and Actual

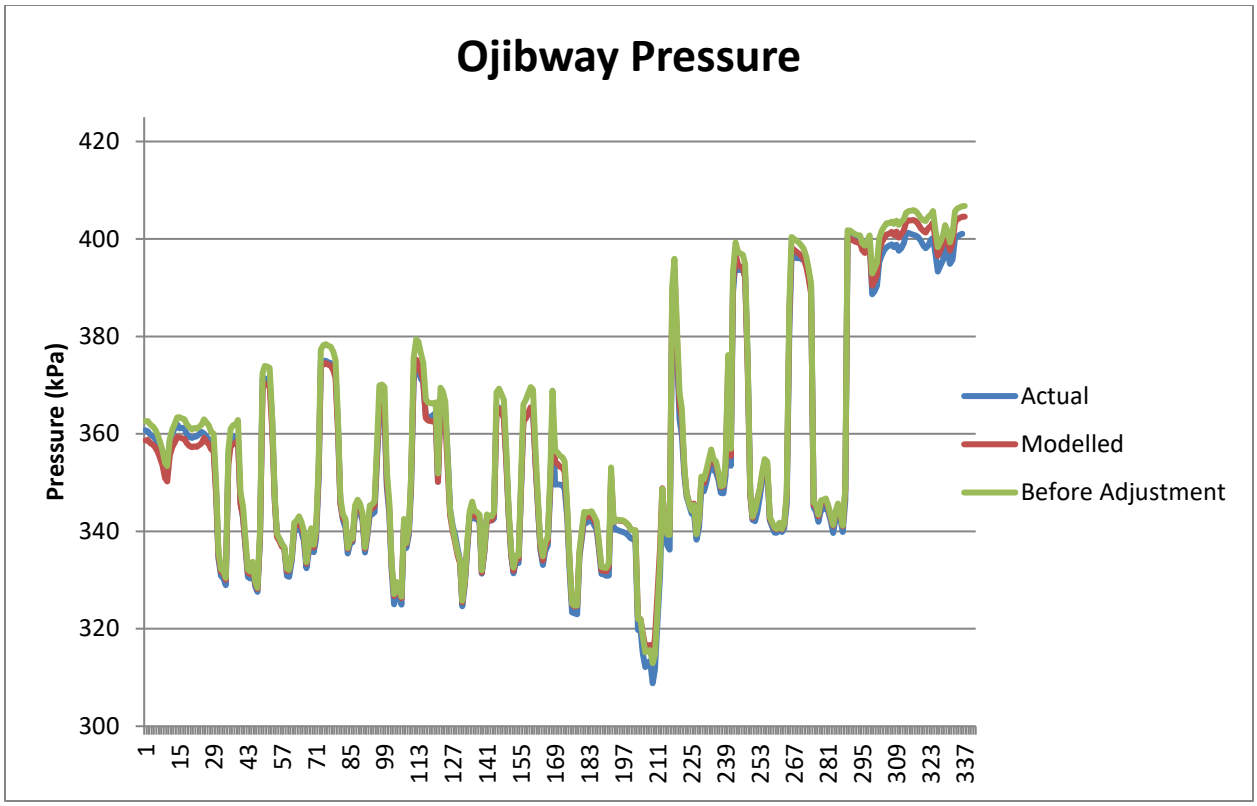

Figure 25: Ojibway Station Inlet Pressure Model and Actual

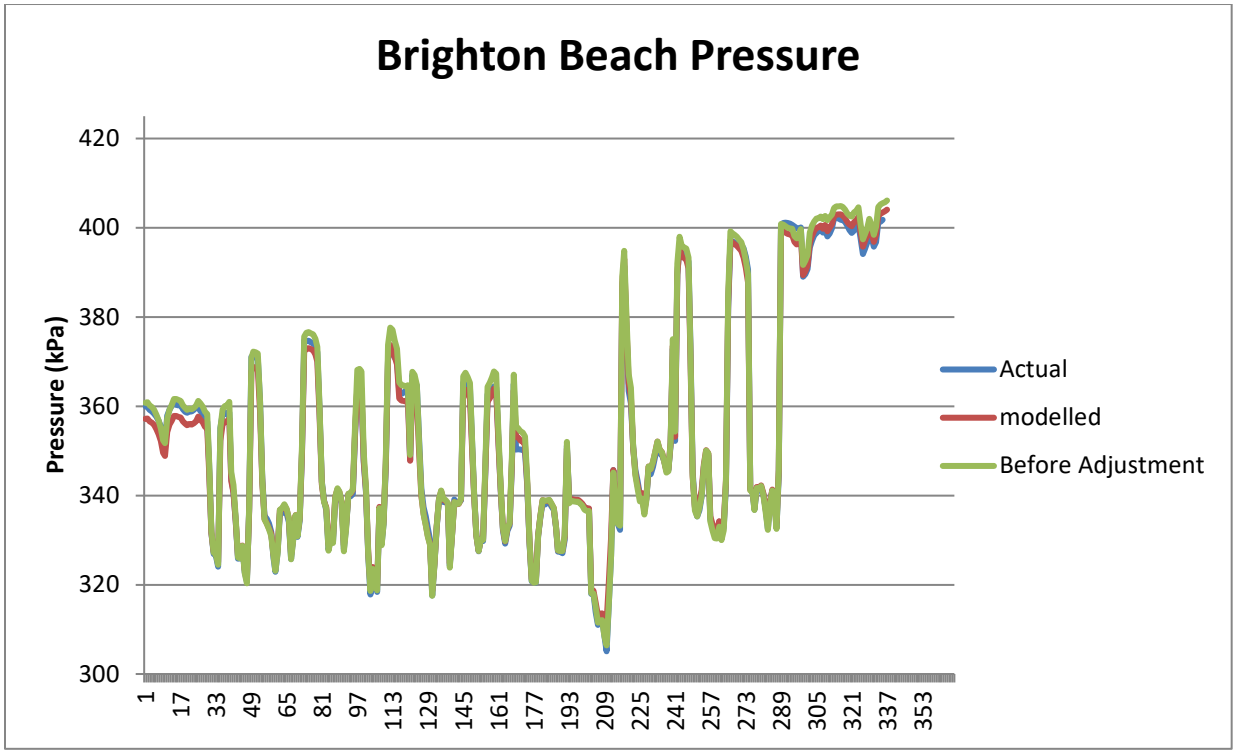

Figure 26: Brighton Beach Station Inlet Pressure Model and Actual

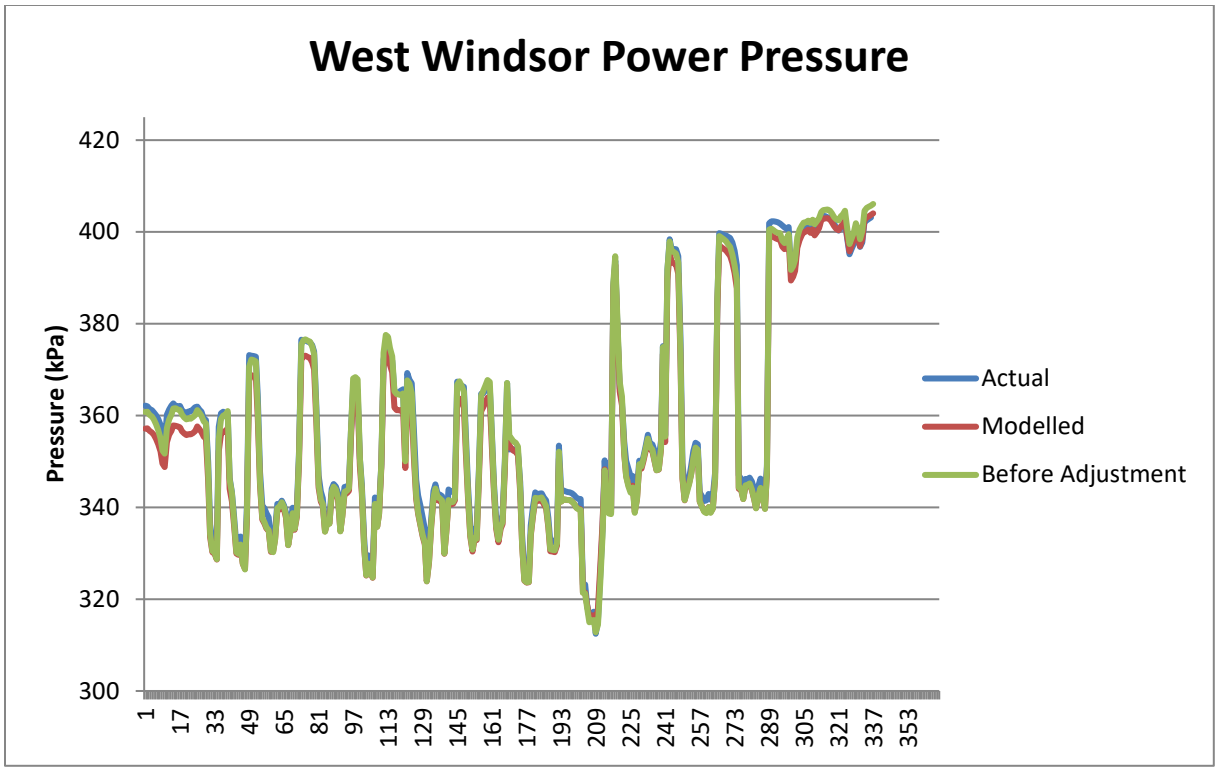

Figure 27: West Windsor Station Inlet Pressure Model and Actual

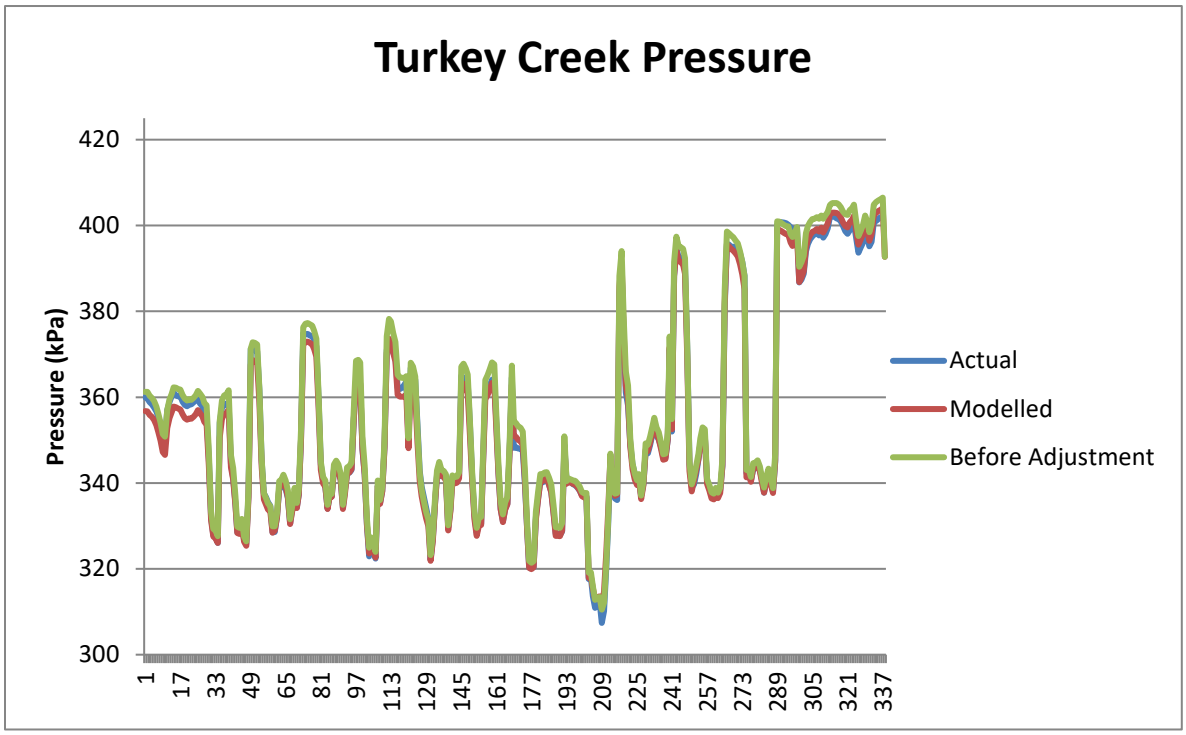

Figure 28: Turkey Creek Station Inlet Pressure Model and Actual

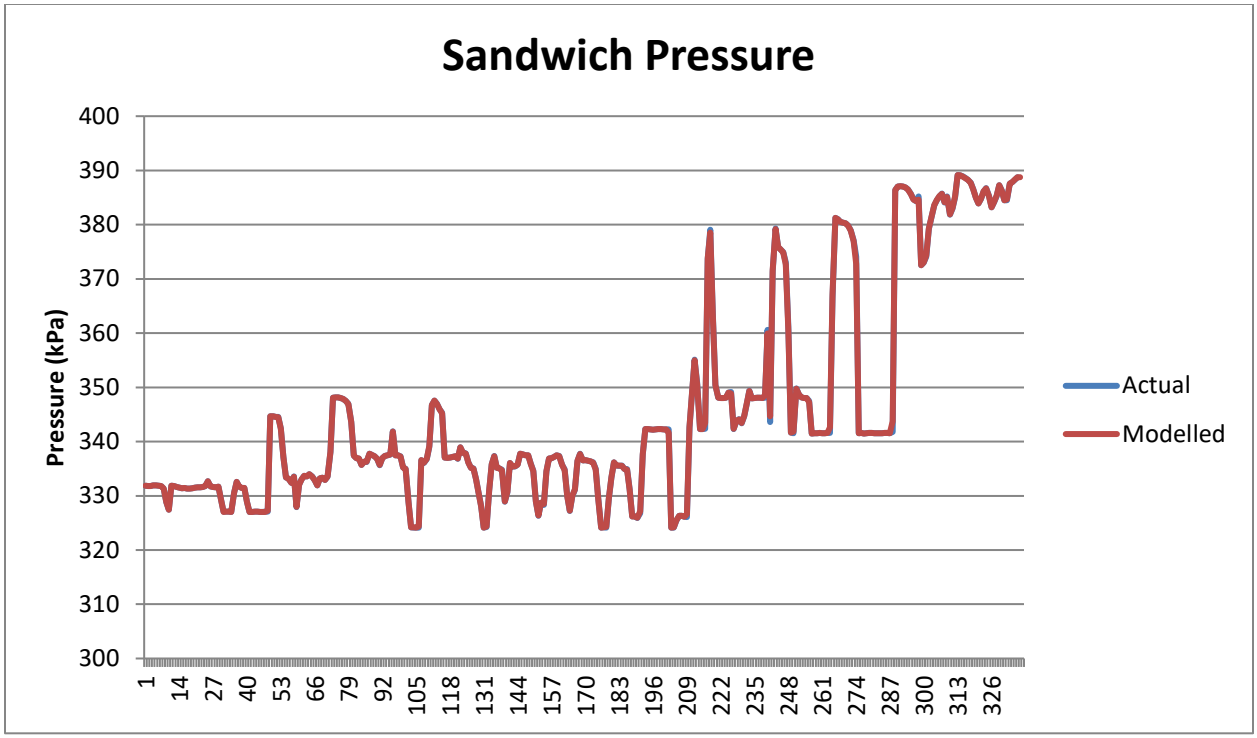

Figure 29: Turkey Creek Station Inlet Pressure Model and Actual

Results and Impact

It has been determined that model was slightly conservative compared to the slightly higher pressures observed in the field measurement compared to the pressures the model is calculating. While the model results should err on the lower than field measurement, the differential could be reduced. The verification process resulted in model parameter adjustments as some sections were outside of the 2% tolerance. Adjusting the model parameters, reduced the pressure between the field and the to a minimum and are within the 2% tolerance.

Panhandle System Verification

March 30, 2020

Scope:

Lateral Verification, excluding Leamington North Line and Loop

Introduction

A verification study of the Panhandle transmission system hydraulic model was performed to validate its response to system conditions. The purpose of the study is an addendum to the 2018 system verification to evaluate specifically the laterals off the NPS 20 Panhandle Line including Essex Line, Kingsville East Line, and Mersea Line.

This study compares actual pressure and flow rates recorded in the field to results from the hydraulic model to a defined percentage of pressure difference. If the model segments are more than 2% out of tolerance, the model is tuned by adjusting pipeline roughness and efficiency to minimize the pressure difference between the field data and modelled results.

Weather

To perform the verification, an isolated system test was planned for during a cold period within the winter season under a specific system set-up. The duration of the test propagated as long as this system set up was feasible to maintain downstream pressures. The test ran officially from 06:00 January 20th, 2020 to 21:00 January 21st, 2020 (approximately 40 hours).

It is important to note that the winter season during the 2019/2020 was relatively mild, the days chosen were not as ideal as planned but were the best opportunity to ensure verification occurred this year.

Model Segmentation

The focus of this model verification was to evaluate the modelled pipeline parameters of the laterals along the NPS 20 Panhandle pipeline. New pipeline segments to this model included the following:

- Kingsville Transmission Reinforcement Line (a.k.a. KTRP, in service October 2019)

The NPS 36 Panhandle supply was isolated from the NPS 20 Panhandle supply. Through Dover Transmission station the NPS 36 directly fed into the Panhandle NPS 20 towards Comber Station, isolated from the NPS 16 towards Windsor. The system segment under verification continued along the NPS 20 where it terminated at the Sandwich Transmission Station inlet.

Analysis Type

The model was run using the Unsteady State analysis tool for 40 hours along the NPS 20 Panhandle Lines. Once the flow data which is input into the model was confirmed to match actuals, the analysis was completed by first determining current percentage of deviation and if required, continue to tune the model to ensure the model is within tolerance. The hourly pressure results at each demand point in the Synergi model was compared to the pressures recorded in the field.

Data

For each day, the actual hourly flow and pressure data at the telemetered points along the system was extracted from the Enterprise Data Warehouse. Using this data, a volumetric flow profiles totalling 40 hours was created for each demand point. Similar profiles were created for the source pressure node, Dawn NPS 36 supply point (again, operating in isolation from the NPS 20 supply therefore it was not included in this analysis).

Gas Control was consulted to determine the system operation and set up for the chosen days. In addition, for the assessment it was paramount to ensure that Sandwich only operated in Transmission mode (thus the short window of opportunity that was available for this verification).

NPS 20 Downstream of Dover Transmission Results

The verification consists of NPS 20 from Dover Transmission Station to the Sandwich Transmission / Compressor station and the laterals into Leamington/Kingsville (Essex Line, Mersea Line and the new Kingsville East Line).

Volumetric Data

The volumetric flow SCADA data was collected from the WEBI GMDM program and flow profiles were created based upon actual data to upload into the Synergi 4.9.1.2 model. The model results were captured after running the model in USM and compared to the actual collected flow data.

Figure 1 shows the actual summation of SCADA flow for each station in the verification path including Sandwich, Essex, Kingsville East, Mersea, Comber and Dover Center compared to the data profiles that were created and input into the Synergi model. The two lines shown in Figure 1 should match since they are based upon the same data, which they do.

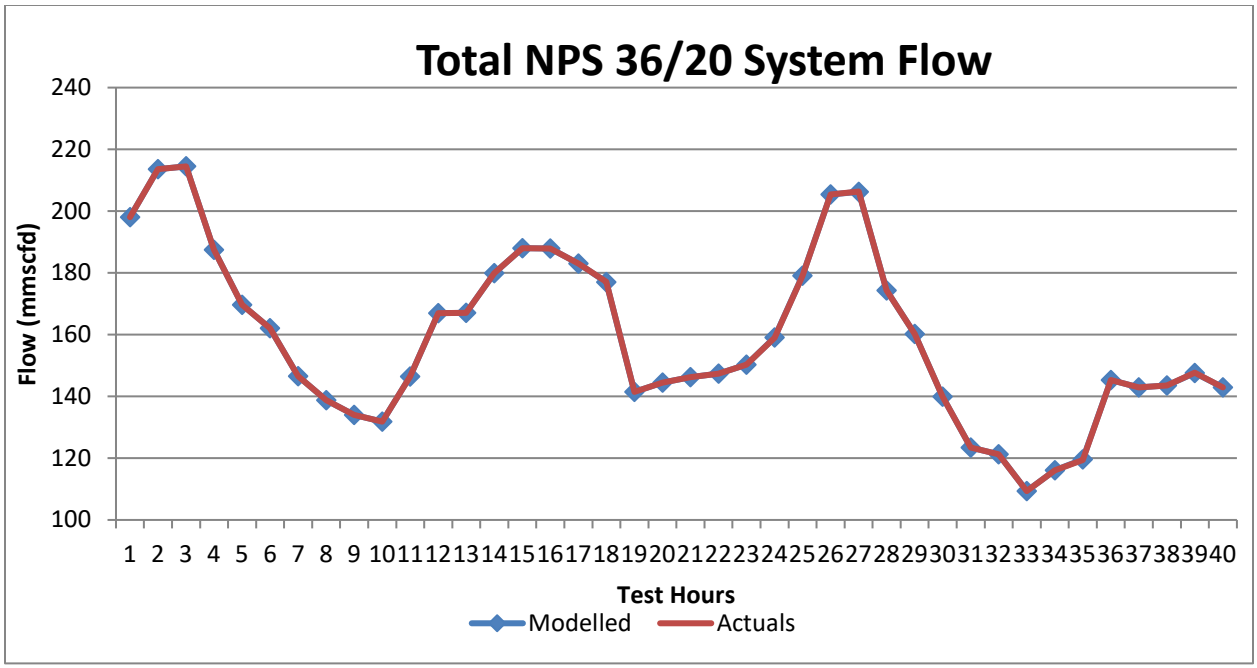

Figure 1: Flow profile from actual data Panhandle System compared to data in the model

Pressure Data

The absolute pressure differential between the field measured data and the modelled data was calculated and a percentage of difference was used to evaluate current model parameters compared to the field data. The percent tolerance of each point is less than 2% as shown in the Table 1 below and therefore no additional model adjustments were required for this verification.

Table 1: Percentage of Absolute Pressure Differential between Actual and Model Conditions Before Model Parameter Adjustment

Absolute Pressure Differential Model vs. Actual	Dover Trans Inlet (to NPS 20)	Comber Transmission Inlet	Mersea Gate Inlet	Kingsville East Line Inlet	Essex Gate Station Inlet	Sandwich Transmission Inlet
Percent Differential	0.19%	0.84%	0.83%	0.86%	0.77%	0.97%

The graphical results are depicted in Figures 2 to 5 below.

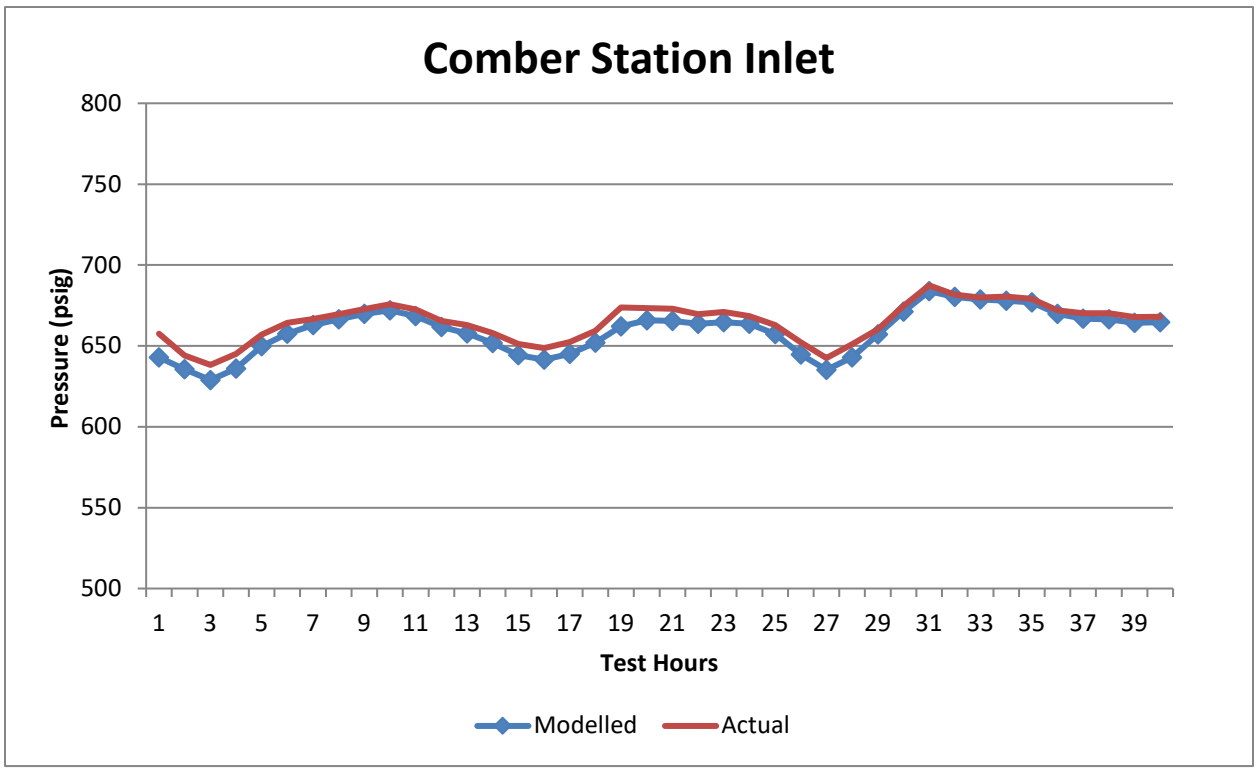

Figure 2: Comber Transmission Inlet Pressure Model and Actual

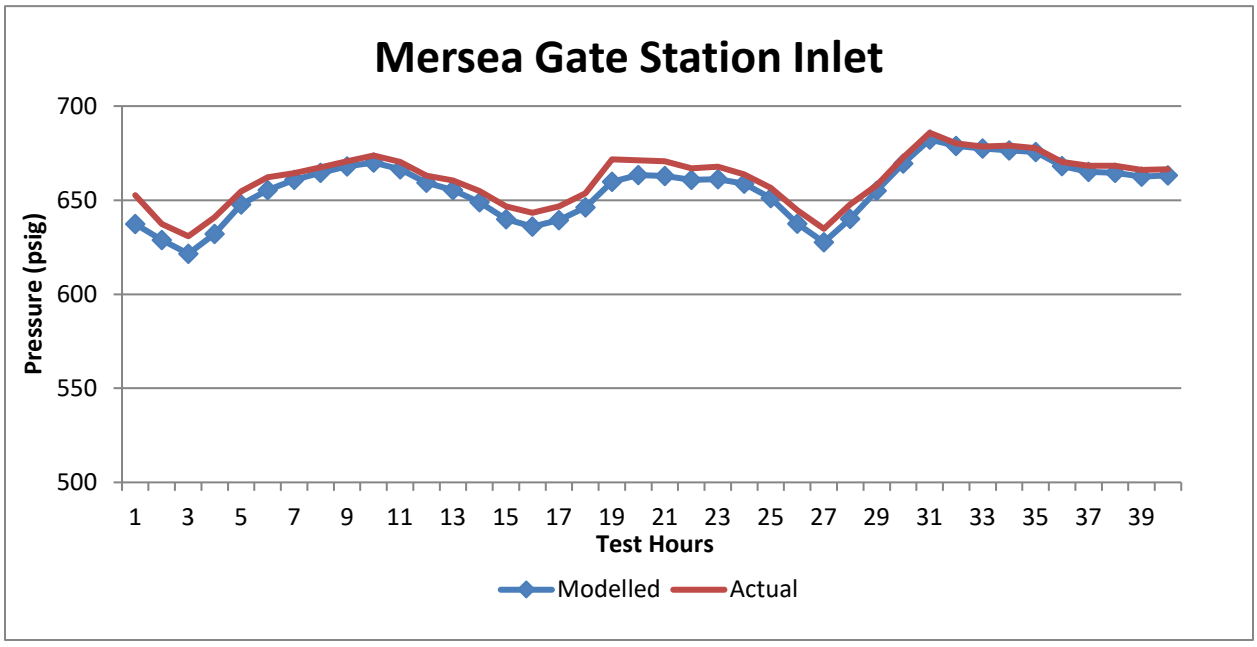

Figure 3: Mersea Gate Inlet Pressure Model and Actual

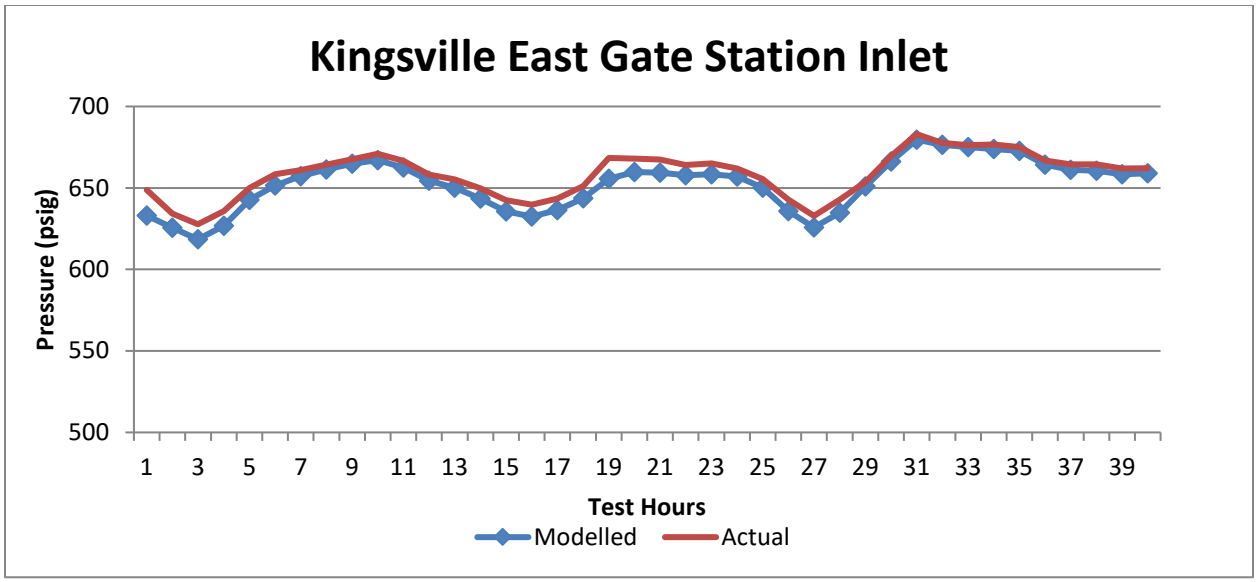

Figure 4: Kingsville East Gate Station Inlet Pressure Model and Actual

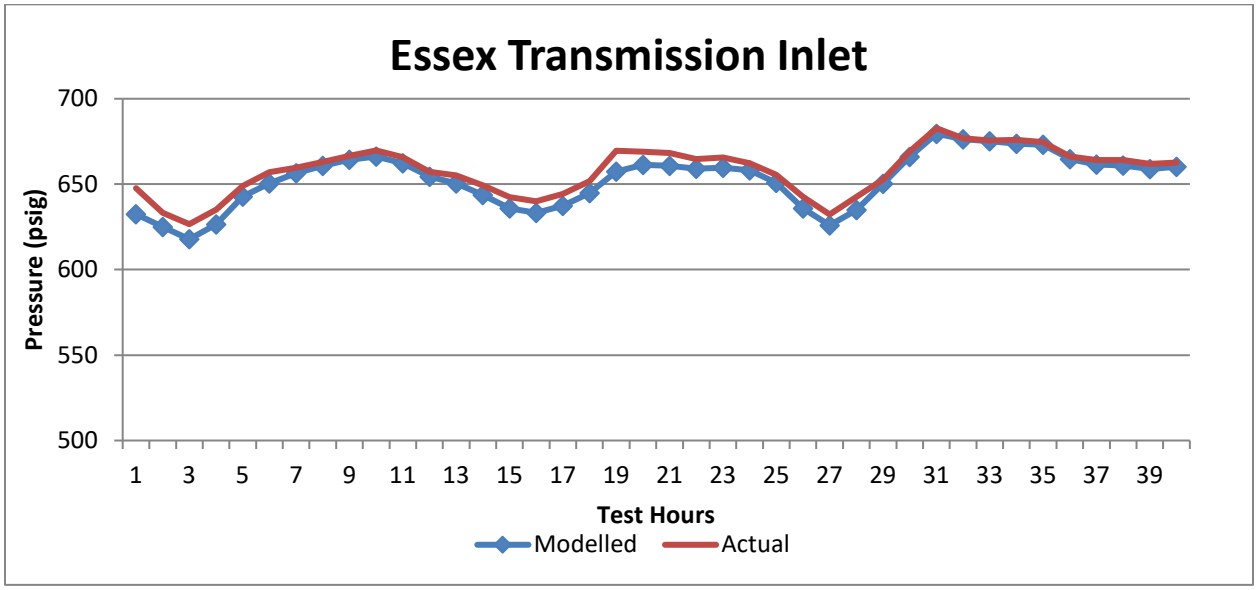

Figure 5: Essex Transmission Inlet Pressure Model and Actual

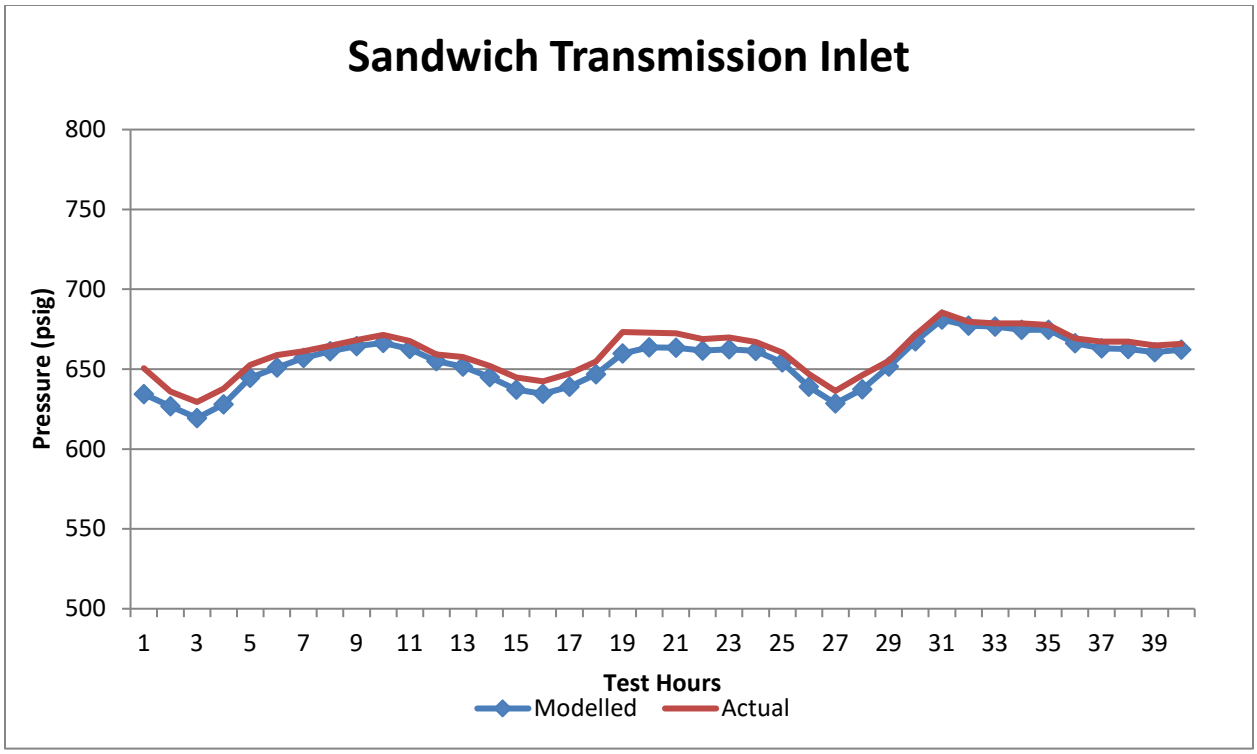

Figure 6 Sandwich Transmission Inlet Pressure Model and Actual

Results and Impact

No adjustments were required to the model parameters based on the results as the pressure differential between modelled and actual were within 2% tolerance.

Panhandle System Verification

February 23, 2022

Scope:

Leamington North Line and Loop

Introduction

A verification study of the Panhandle transmission system hydraulic model was performed to validate its response to system conditions. The purpose of the study is an addendum to the 2018 and 2020 system verification to evaluate specifically the Leamington North Line and Leamington North Loop from Comber Transmission to Leamington North Gate Station.

This study compares actual pressure and flow rates recorded in the field to results from the hydraulic model to define percentage of pressure difference. If the model segments are more than 2% out of tolerance, the model is tuned by adjusting pipeline roughness and efficiency to minimize the pressure difference between the field data and modelled results.

Weather

To perform the verification, a series of cold winter days were chosen for comparison. The dates of January 19-22, 2022 (W21/22) were chosen as the weather was very cold during this period.

Model Segmentation

The focus of this model verification was to evaluate the modelled pipeline parameters of the Leamington North Line and Leamington North Loop Line. The model was isolated from Comber Transmission to Leamington North Gate station.

Analysis Type

The model was run using the Unsteady State analysis tool for 96 hours along the NPS 8 and NPS 12 Leamington North Lines. Once the flow data which is input into the model was confirmed to match actuals, the analysis was completed by first determining current percentage of deviation and if required, continue to tune the model to ensure the model is within tolerance. The hourly pressure results at each demand point in the Synergi model was compared to the pressures recorded in the field.

Data

For each day, the actual hourly flow and pressure data at the telemetered points along the system was extracted from the Enterprise Data Warehouse. Using this data, a volumetric flow profiles totalling 96 hours was created for each demand point and the source pressure node.

Volumetric Data

The volumetric flow SCADA data was collected from the WEBI GMDM program and flow profiles were created based upon actual data to upload into the Synergi 4.9.1.2 model. The model results were captured after running the model in USM and compared to the actual collected flow data. Figure 1 below shows the total flow profile over the 96 hour period used within the verification. The two lines shown in Figure 1 should match since they are based upon the same data, which they do.

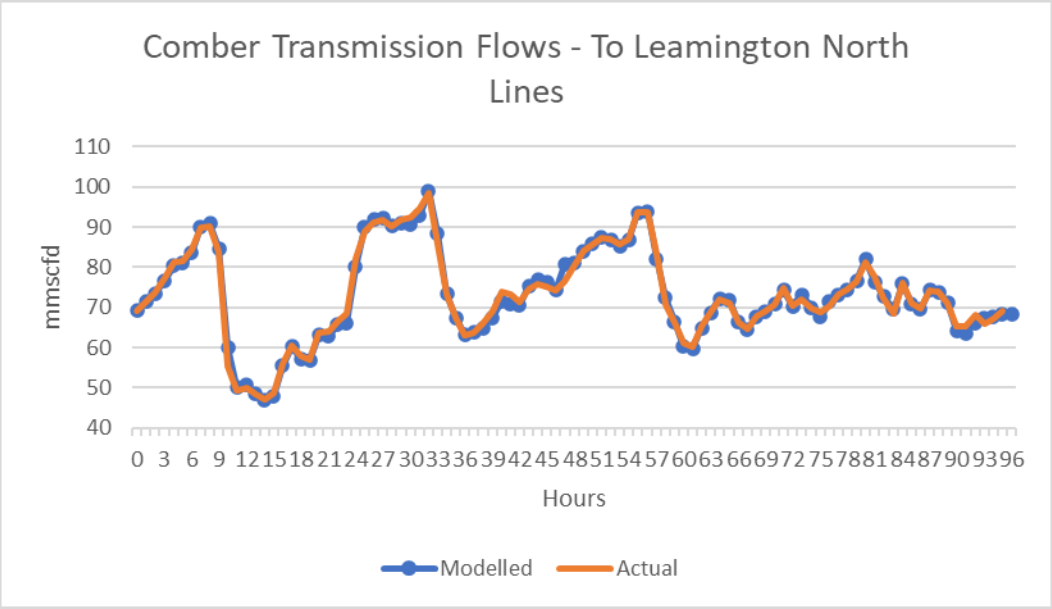

Figure 1: Flow profile from actual data to Leamington North Lines compared to data in the model

Pressure Data

The Leamington North Line and loop verification consists of the NPS 12 and NPS 8 lines between Comber Transmission to County Rd 14 station, Concession 6 Station, County Rd. 18 Station and Leamington North Gate Station. Pressure measurement is only available at Comber Transmission, County Rd. 14 Station and County Rd. 18 station. Flow measurement was only available at Comber Transmission and County Rd. 18 station for this study. There was no flow information available at the County Rd. 14 or Concession 6 Station. These flows were estimated based on design day station flow estimate percentages.

The absolute pressure differential between the field measured data and the modelled data was calculated and a percentage of difference was used to evaluate current model parameters compared to the field data. The percent tolerance of each point measured and subsequently

modelled is less than 2% as shown in Table 1 below and therefore no additional model adjustments were required for this verification.

Table 1: Percentage of Absolute Pressure Differential between Actual and Model Conditions Before Model Parameter Adjustment

Absolute Pressure Differential Model vs. Actual	Comber Transmission Inlet	County Rd.14 Station Inlet	County Rd. 18 Station Inlet	Leamington North Gate Station Inlet
Percent Differential	0.12%	0.97%	1.03%	1.01%

The results are depicted in figure 2 to 5 below.

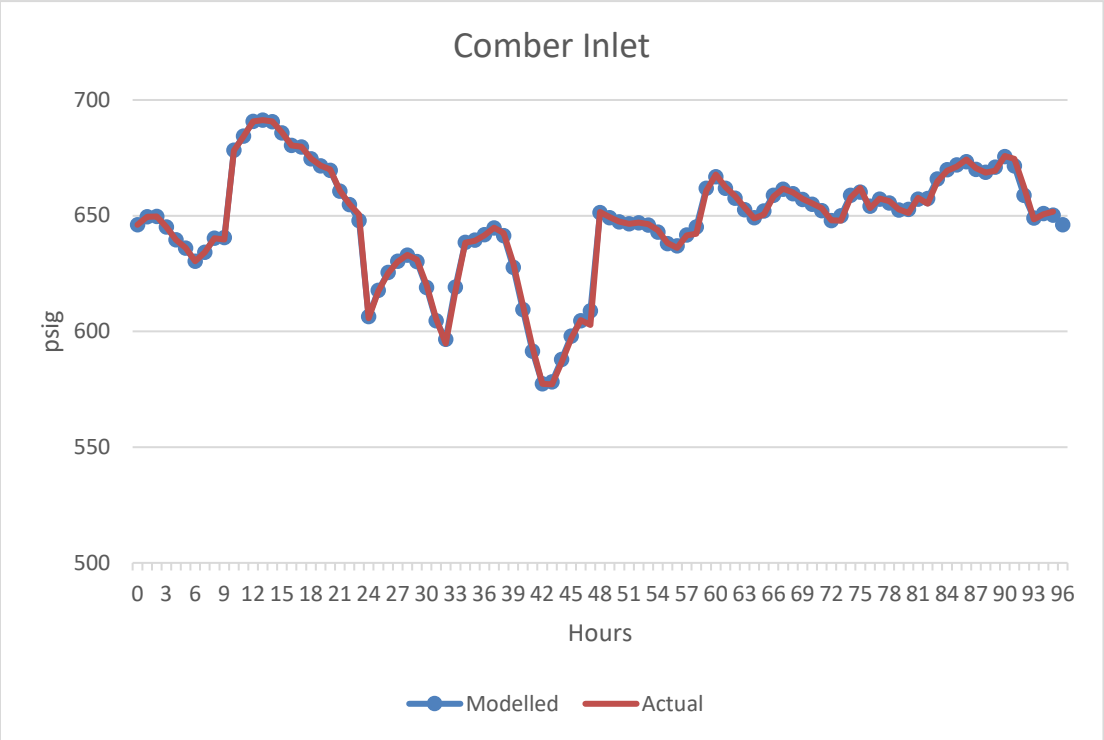

Figure 2: Comber Transmission Station Inlet Pressure Model and Actual

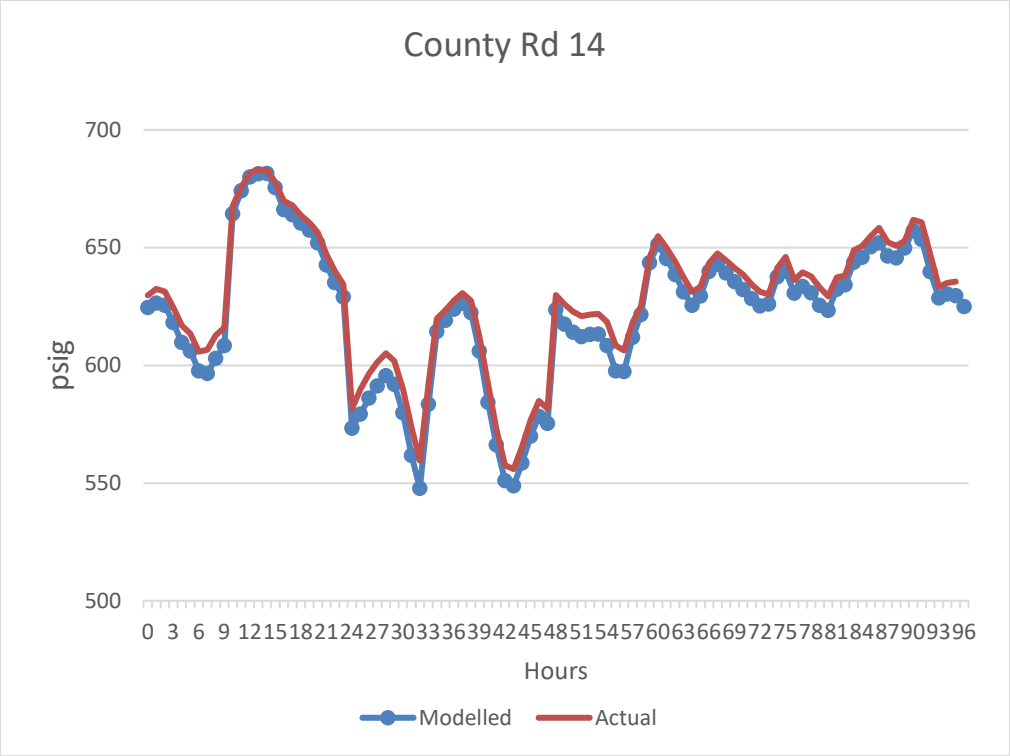

Figure 3: County Rd. 14 Station Inlet Pressure Model and Actual

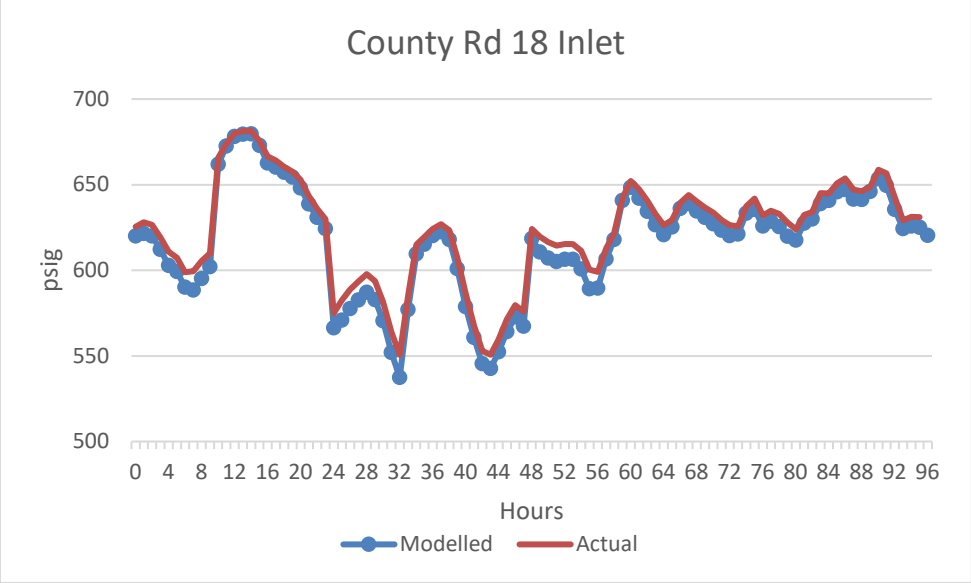

Figure 4: County Rd. 18 Station Inlet Pressure Model and Actual

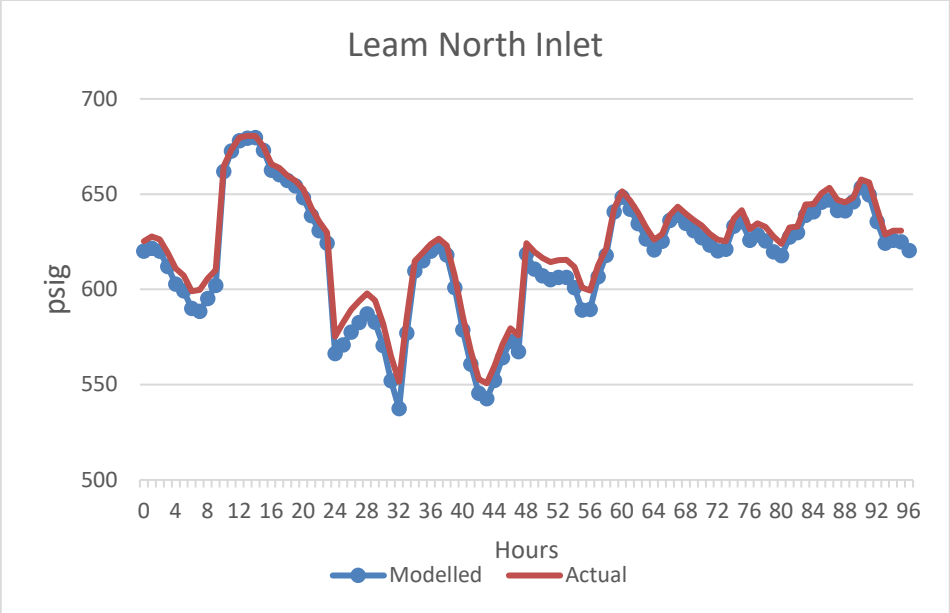

Figure 5: Leamington North Gate Station Inlet Pressure Model and Actual

Results and Impact

No adjustments were required to the model parameters based on the results as the pressure differential between modelled and actual were within 2% tolerance.