MEMO

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COPY TO : **Kevin Girard, P.Eng, MBA, Director, Infrastructure Services**

FROM : **MIchelle Scott, P.Eng., Project Engineer**

DATE : **May 15, 2024**

SUBJECT : **Essex HLP Testing and Model Update**

1. Introduction and Background

A water model of the Harrow-Colchester South Water Supply System (HCSWSS) was developed in InfoWater Pro software by C3 Water Inc. (now CIMA+). A summary of the model inputs and results is provided in the report titled “Harrow-Colchester South Water Supply System Model Build TM” (October 2023).

At the time of the model build, pump curves were not available for the three (3) high-lift pumps (HLPs) at the Harrow-Colchester South Water Treatment Plant (WTP). Therefore, only pump design points from the WTP Operations Manual were input into the model. Design points provided in the Operations Manual are summarized in Table 1 below.

Table 1 HLP Design Points (Operational Manual)

Pump ID	Flow (L/s)	Head (m)
HLP1	26.5	54.90
HLP2	68.2	57.90
HLP3	113.7	60.98

When pump curves are not available, the model estimates a pump curve based on the design point which may not be an accurate representation of actual pump performance.

To improve the accuracy of the model, performance testing was completed for each HLP. The testing procedure and results as well as the updated model results are presented in this memo.

2. Pump Testing

Testing was completed on each of the HLPs at the WTP on February 29, 2024. The purpose of the test was to determine the relationship between flow and head for each HLP and develop pump curves that can be used in the water model.

2.1 Test Procedure

To collect a range of performance data at each of the pumps, three operational conditions were created:

1. High flow/ low head:
    a. The Essex tower was drained overnight to a level of 4.9m to create a low head condition.
2. Normal operations:
    a. The Essex tower was re-filled to a typical operating level.
3. Low flow/ high head:
    a. The butterfly valve on the discharge header of each pump was throttled to create a high head condition at the pump.

Under each operational condition, each HLP was run individually for a period of approximately 15 minutes. It is noted that HLP3 was not run under “normal operations” conditions as this pump is typically only intended to run when the Essex tower level is below 4m.

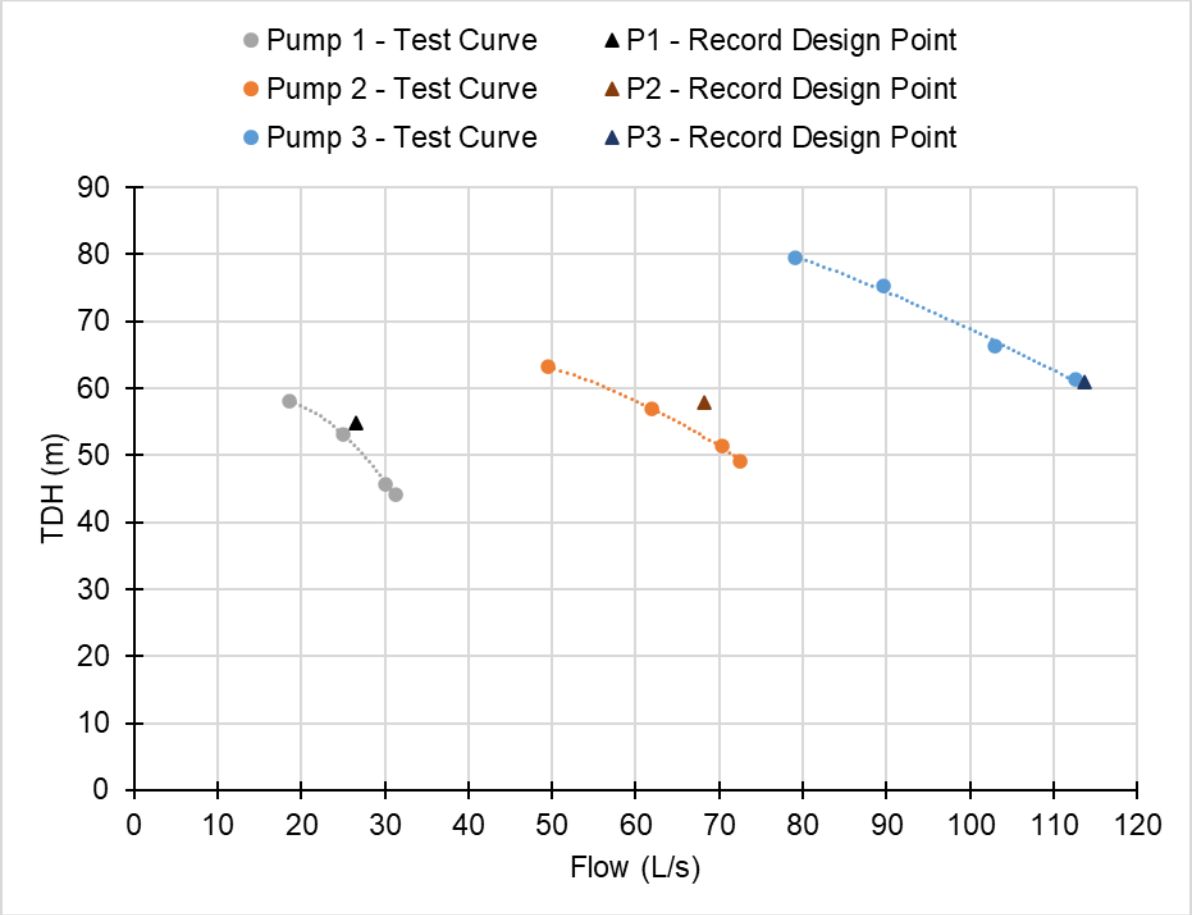
Flow data was collected from the WTP discharge flow meter via the live SCADA screen. The head was determined by taking the difference between the reservoir level and the pump discharge pressure. The reservoir level data was collected from the level transmitter via the live SCADA screen. Discharge pressure data was collected from manual pressure gauge located between the pump and butterfly valve for each HLP (see Figure 1). The difference in elevation between the reservoir and the pressure gauge was accounted for when calculating the pump head. Frictional losses were calculated using first principles to account for piping and appurtenances between the reservoir and the pressure gauge.

Figure 1 HLP1 Discharge Header

2.2 Test Results

The HLP curves that were developed from the testing are shown in Figure 2 below. For HLP1 and HLP2, the test curve was found to be lower than the original design point provided by the manufacturer. This is expected as pump performance typically decreases over time. The HLP3 test curve was found to closely align with the record design point, likely because HLP3 is used for emergencies and is not operated on a regular basis. The maximum HLP3 flow rate during the pump test was about 112 L/s which is slightly lower than the design flow of 114 L/s. It is expected that this pump would operate at a higher flow rate during an emergency condition such as a fire flow or watermain break which would result in lower head conditions in the system than what was experienced during the pump test.

Figure 2 Test Pump Curves



3. Model Update

The HCSWSS water model was updated to incorporate the test curves for the WTP HLPs. The model validation that was presented in the 2023 Model Build Report was revisited.

Figure 3 shows the WTP discharge flow on March 17, 2021. This date was found to be representative of a typical average demand day (ADD). The model results were compared to SCADA data. With the original model pumps, when HLP1 was running, the model flow was approximately 3 L/s higher than the recorded SCADA flow. With the updated pump curves, the HLP1 flow was found to align with SCADA very closely. When HLP2 was running, the model flow was found to be approximately 5 L/s lower than SCADA with the updated pump curve.

Figure 3 WTP Discharge Flow – ADD (HLP 1&2 Operation)

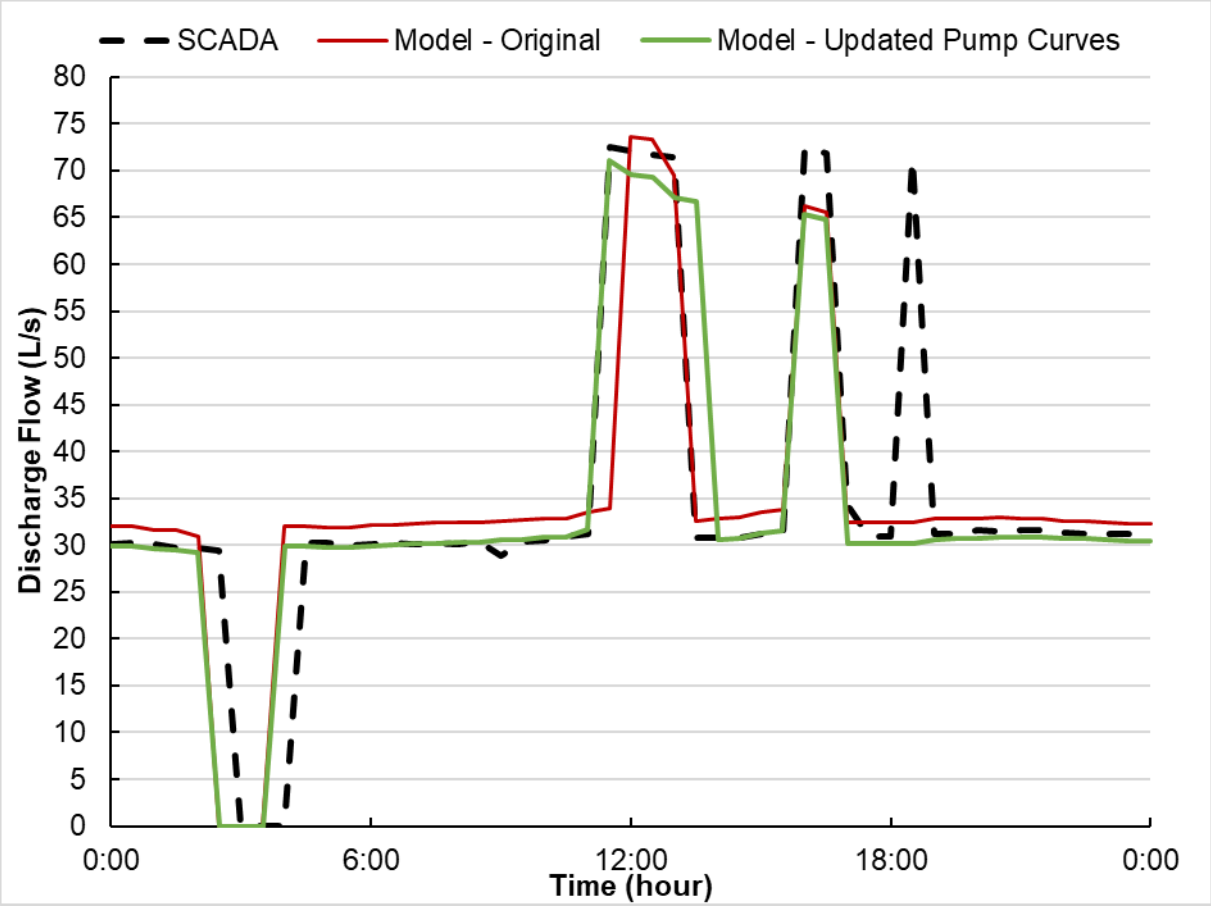
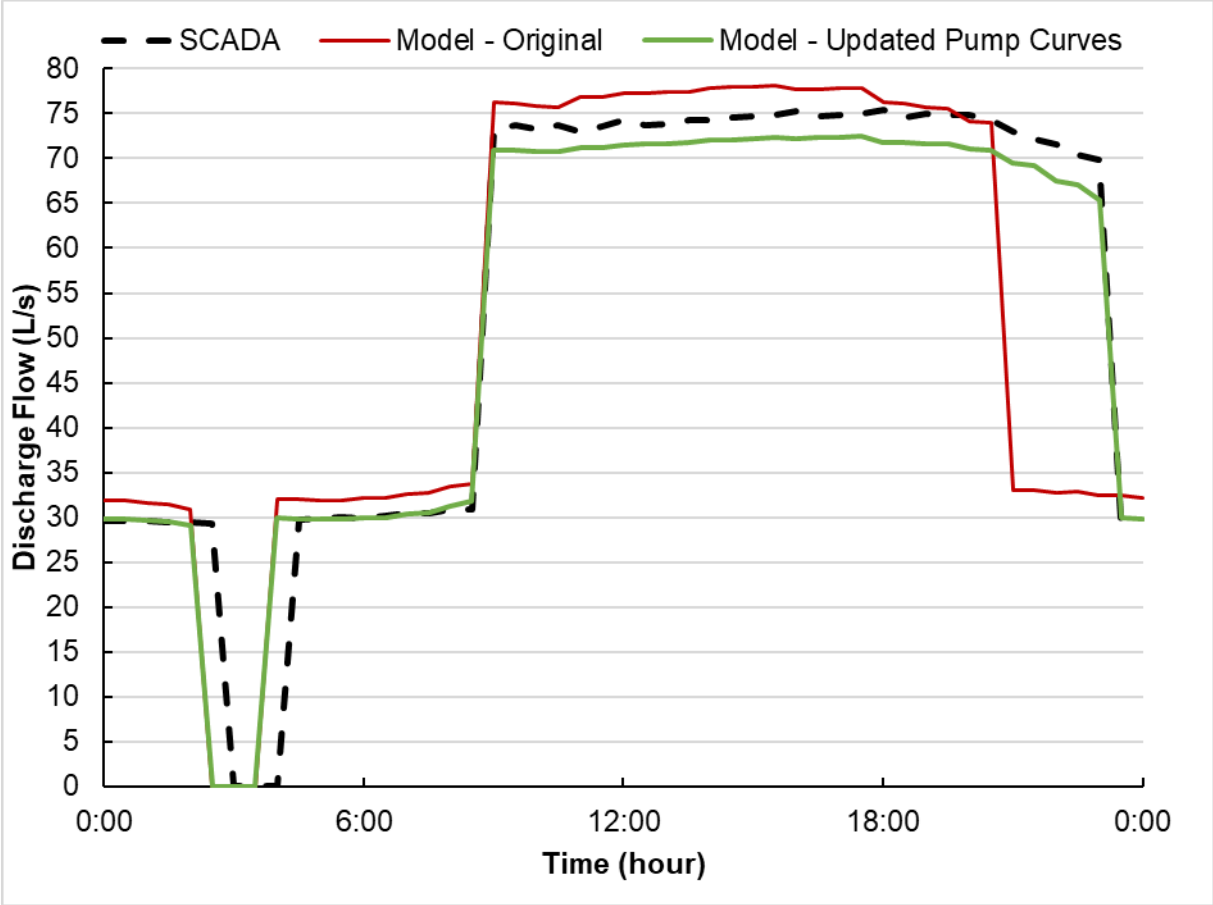


Figure 4 shows the WTP discharge flow on May 22, 2021. This date was found to be representative of a typical maximum demand day (MDD). The model results were compared to SCADA data. Similar to ADD, with the original model pumps, when HLP1 was running, the model flow was approximately 3 L/s higher than the recorded SCADA flow. With the updated pump curves, the HLP1 flow was found to align with SCADA very closely. When HLP2 was running, the model flow was found to be approximately 3 L/s lower than SCADA with the updated pump curve. A potential cause for the difference between SCADA and the model at higher flows could be pipe C-factors in the distribution system. At this time, the model distribution system has not been calibrated and pipe C-factors are based on literature values. Frictional losses between the WTP and the tower may be overestimated in the model, causing HLP2 to run at a slightly higher head and lower flow. Overall, the updated model results were found to align well with SCADA are well within industry standards for accuracy.

Figure 4 WTP Discharge Flow – MDD (HLP 1&2 Operation)



4. Conclusions

Testing of the Harrow-Colchester South WTP HLPs allowed for a better understanding of the pump curves. The water model was updated to incorporate the HLP test curves and the results are now found to closely match available SCADA data, particularly for HLP1.