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February 7, 2022

Mr. John Scenna
Superintendent
Lynnfield Center Water District
83 Phillips Road
Lynnfield, MA 01940

Subject: Hydraulic Modeling Evaluation for Proposed Tie-In at 109 Lowell Street

Dear Mr. Scenna:

In accordance with Task Order 1.4 of the FY22 Master Services Agreement, CDM Smith is pleased to submit this evaluation of the hydraulic impacts associated with the proposed water main tie-in at 109 Lowell Street in the Lynnfield Center Water District (LCWD, the District).

This letter report describes the work performed to assess the distribution system's performance at a proposed development at 109 Lowell Street in Lynnfield. A model analysis was performed to evaluate delivery pressures and fire protection results and to determine if any piping improvements are necessary prior to the development connecting to the LCWD.

Hydraulic Model Calibration

The hydraulic modeling analysis was conducted using the most recent version of the LCWD distribution system model, Innovyze InfoWater Version 12.4 that was last updated in July 2020.

Hydrant flow tests were performed at 109 Lowell Street to calibrate the model in the vicinity of the proposed development. Calibration is the process of simulating each field hydrant flow test in the computer model. Then, by comparing field test results against modeled results, and making adjustments to the model variables, the computed system response can be adjusted to closely match the actual field data. The greatest variable in the calibration of the model is the assumed Hazen-Williams C-value of the mains that is sometimes influenced by valves that may be closed or partially closed. The C-values of these mains are adjusted during calibration until the model simulates the approximate head losses (pressure drops) and flow rates in the distribution system that were recorded during the hydrant flow tests.

Hydrant Flow Tests

One hydrant flow test was conducted at 109 Lowell Street by Hayes Engineering, Inc. personnel on November 30, 2021. The test utilized a single 2.5-inch hydrant outlet. Hydrant flow test data is summarized in **Table 1** below and the test location is shown in **Figure 1.**

Table 1 – Hydrant Flow Test Field Data

Hydrant Flow Test	November 30, 2021
Flow Hydrant	
ID	HYD 632
Location	End of Mohawk Lane
Model	Dresser 500
Flow Rate (GPM)	920
Pressure Hydrant	
ID	HYD 570
Location	130 Lowell Street
Model	Kennedy K81D
Static Pressure (PSI)	45
Residual Pressure (PSI)	43

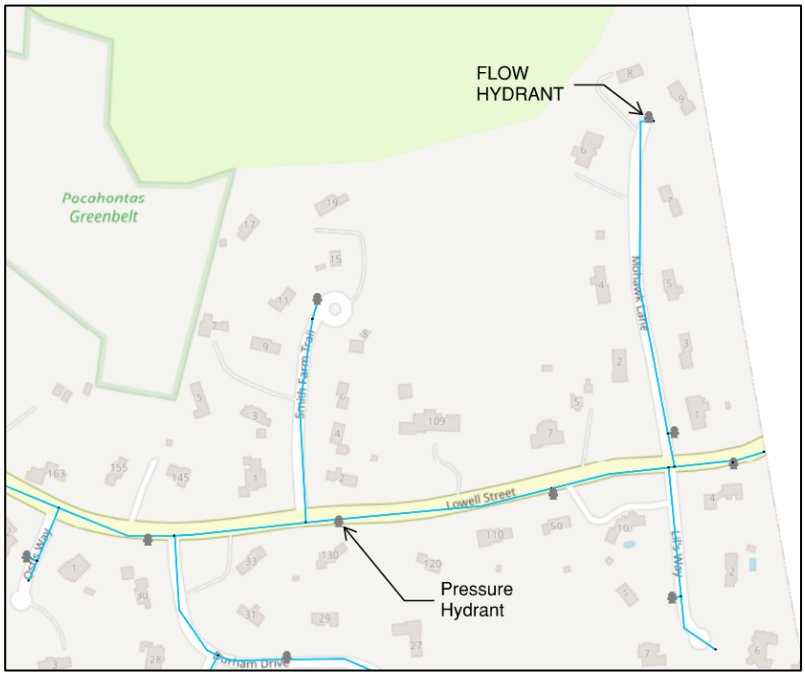

Figure 1 – Hydrant Flow Test Locations

Calibration Conditions

An assumed system demand of 0.65 million gallons per day (MGD) on the day of the flow test was simulated based on historical November water consumption data.

Calibration Results

Calibration was performed by comparing the field measured static and residual pressures and observed hydrant flow at the hydrant flow test location with the corresponding data from the

computer model simulations. C-values of the pipes and open/closed conditions of the valves were adjusted to achieve calibration to the hydrant field flow test. A model is generally considered calibrated when the field residual pressure drops (i.e., the difference between static pressure and residual pressure or "deltas") were at least 10 psi and when simulated on the computer model, were within 10 percent of the actual field residual pressure drops. In areas such as this one where a total of 10 psi pressure drop was not achieved in the field, it is very difficult to calibrate the model to match within these margins. Generally, an agreement of approximately 5 psi between simulated pressure drop and field pressure drop is considered very good. The flow test conducted had a pressure drop of less than 10 psi and could not be calibrated within the 10 percent criteria. However, it was within the 5 psi criteria and thus, considered calibrated. **Table 2** provides a summary of the hydrant flow calibration results.

Table 2 - Flow Test Calibration Results

Hydrant Test ID	Date	Location	Field Flow (gpm)	Field Pressure Drop "delta" (psi)	Modeled Pressure Drop "delta" (psi)	Difference between Field and Modeled Pressure Drop (psi)
1	November 30, 2021	109 Lowell Street	920	2	4.73	2.73

Alternatives Development and Modeling

CDM Smith used the calibrated distribution system hydraulic model to perform an evaluation of post-development conditions at the proposed development at 109 Lowell Street. Model runs (simulations) were conducted using the predicted maximum day demand (MDD) for the LCWD, which is 1.5 MGD. Two scenarios were evaluated in the model in addition to the existing conditions for reference.

In Scenario 1, a new 8-inch cement lined ductile iron (CLDI) dead end pipe on the proposed Vallis Way was added to the model as shown in **Figures 3 and 6.** For Scenario 2, a new 8-inch CDLI pipe was added to the model extending from the proposed Vallis Way main to the existing main on Smith Farm Trail creating a loop as shown in **Figures 4 and 7**. For Scenarios 1 and 2, a demand of 10 gallons per minute (gpm) was applied to the node at the end of the proposed dead end on Vallis Way. The demand estimate was provided by LCWD.

Available Fire Flow

Available fire flow is evaluated in the computer model under post development conditions to determine whether fire protection provided from the distribution system is adequate. The Insurance Services Office (ISO) establishes fire protection guidelines pertaining to needed fire flow based on the type of structure and neighboring building spacing, among other criteria. Generally, available fire flow requirements in residential areas range from 500 to 1,000 gpm but specific requirements for this development should be confirmed with the fire department. The results of the fire flow model run for existing conditions as well as Scenarios 1 and 2 are shown in **Figures 2, 3 and 4**, respectively.

Simulated available fire flow under both proposed post development conditions exceeds 1,000 gpm throughout the neighborhood except for locations that do not exceed 1,000 gpm under existing conditions.

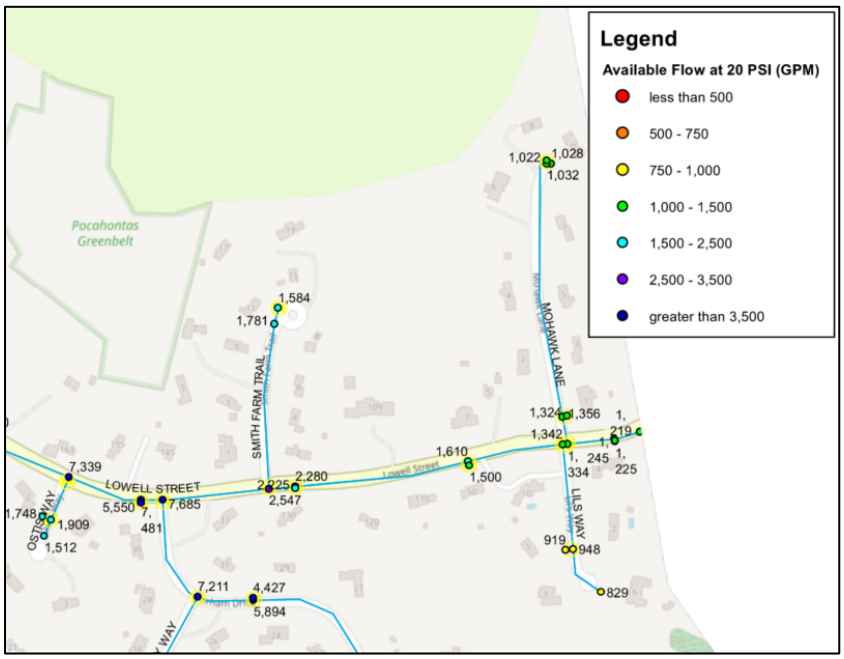

Figure 2 – Existing Conditions Simulated Fire Flow at 20 PSI

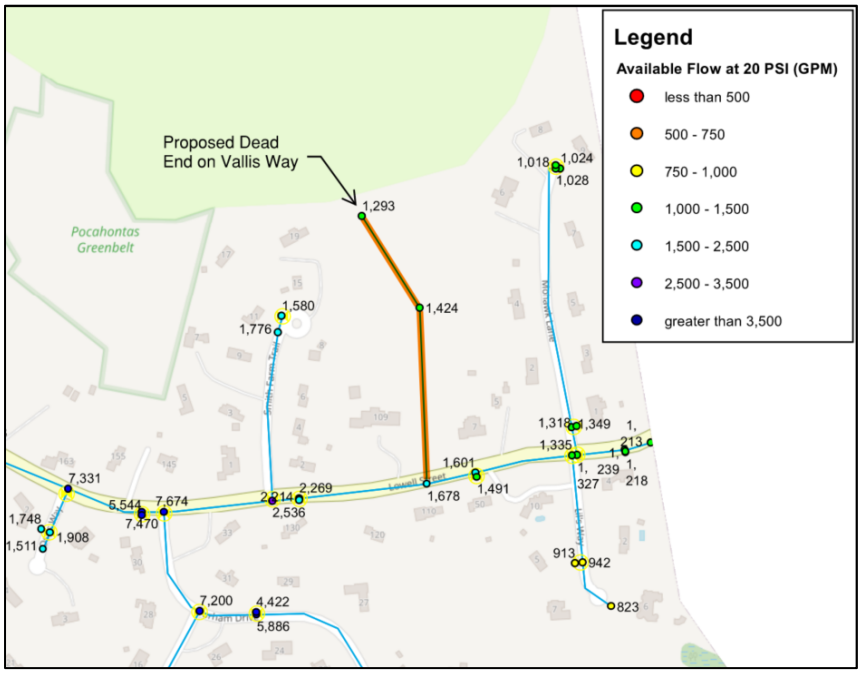

Figure 3 – Scenario 1 (Dead End) Simulated Fire Flow at 20 PSI

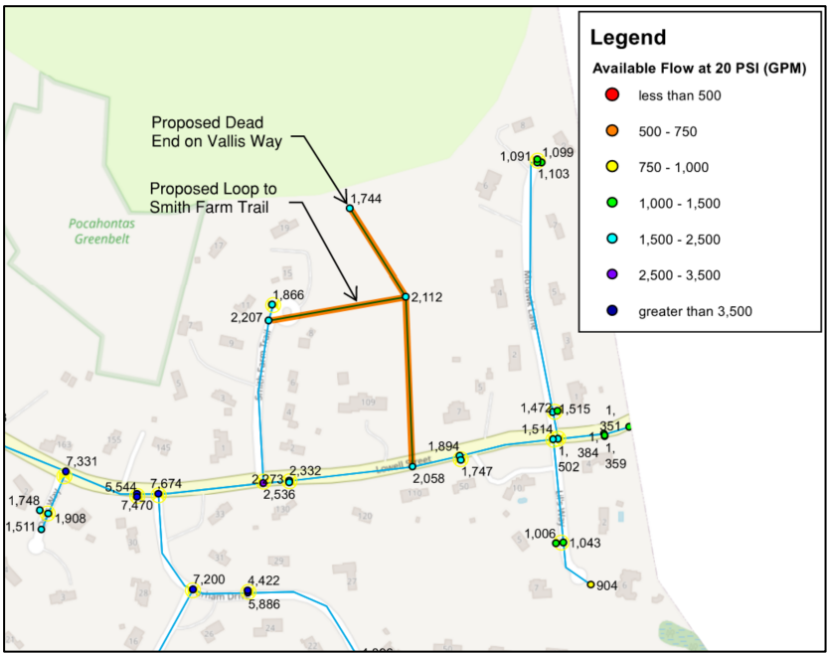

Figure 4 – Scenario 2 (Loop) Simulated Fire Flow at 20 PSI

Delivery Pressure

The Massachusetts Department of Environmental Protection (MassDEP) provides guidance for public water system design, including a minimum recommended normal working pressure in the distribution system of 35 psi. The results of the delivery pressure model runs for existing conditions as well as Scenarios 1 and 2 are shown in **Figures 5, 6 and 7**, respectively. The simulated working pressure evaluated under maximum day demands with the proposed development connected to LCWD's water system, exceeds MassDEP minimum recommended normal working pressure for both scenarios.

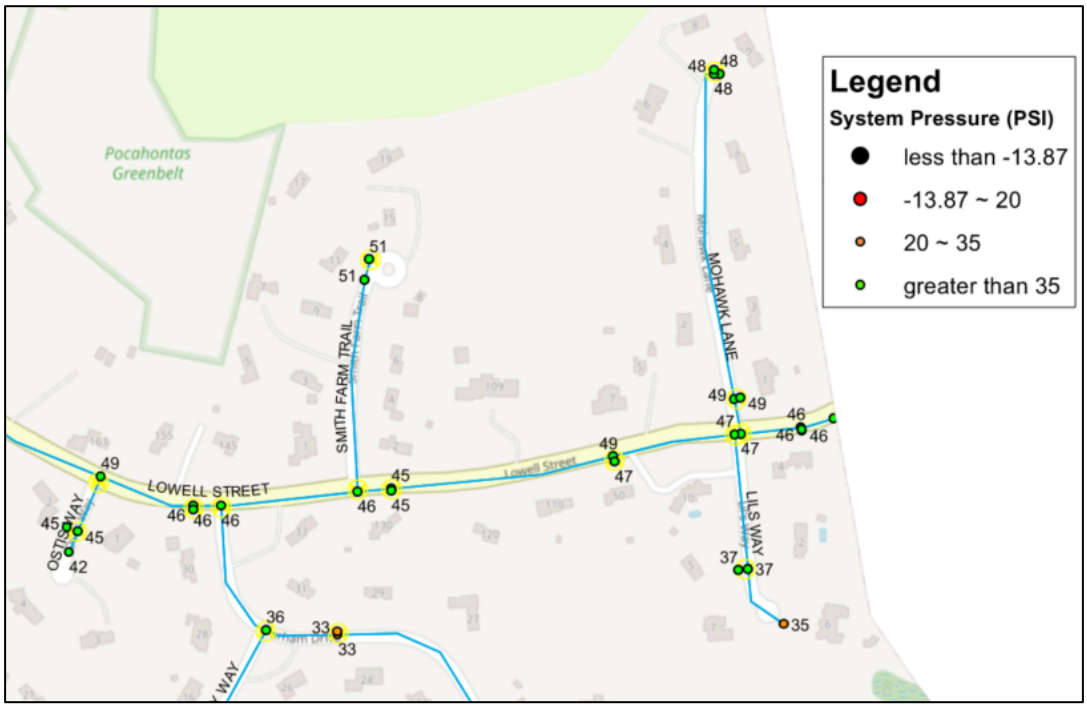

Figure 5 – Existing Conditions Simulated Delivery Pressure

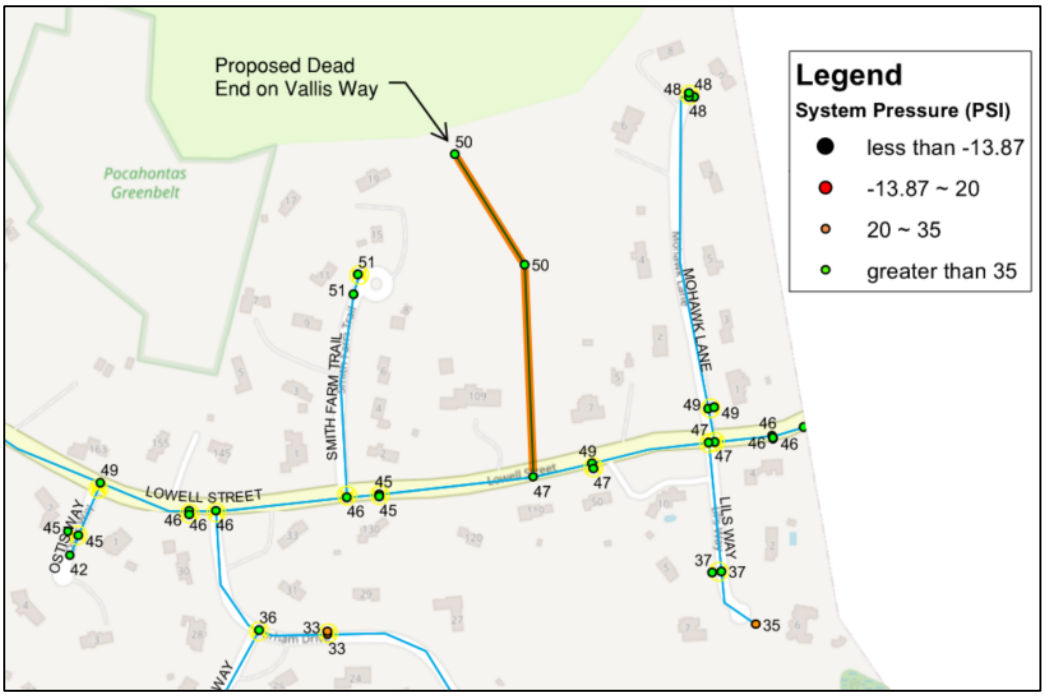

Figure 6 – Scenario 1 (Dead End) Simulated Delivery Pressure

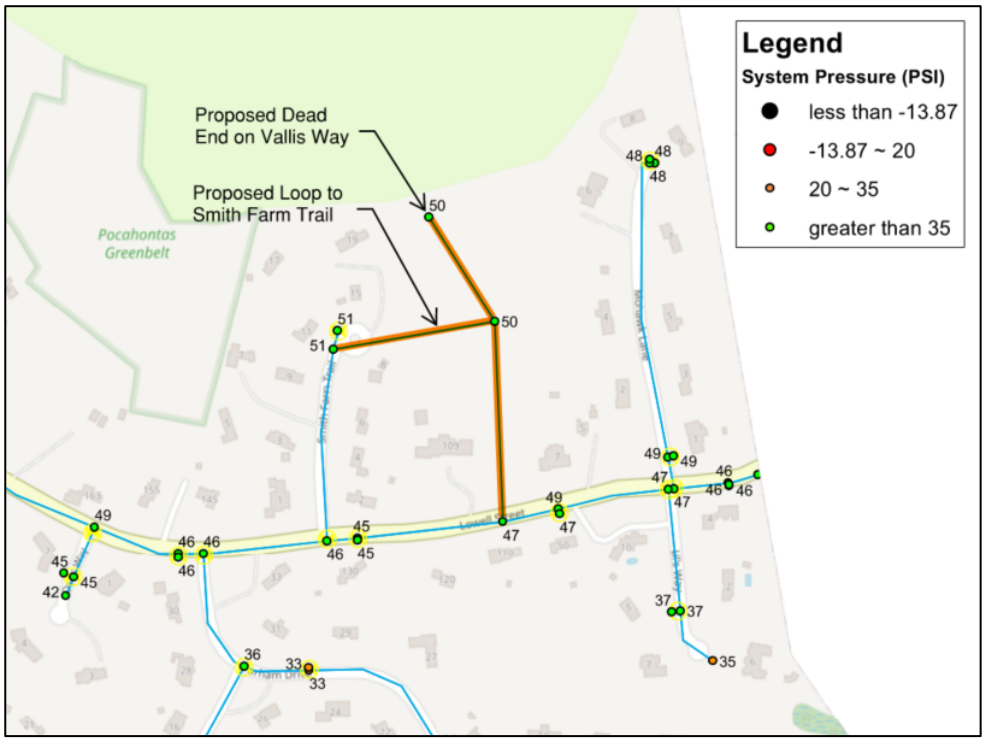

Figure 7 – Scenario 2 (Loop) Simulated Delivery Pressure

Conclusions and Recommendations

The results of the model evaluations indicate that the fire flow and delivery pressure at the proposed site ***likely exceed ISO and MassDEP requirements*** for both Scenarios 1 and 2.

For Scenario 1, a new 8-in CLDI main is proposed extending from the existing main on Lowell Street to the end of the proposed Vallis Way development. This scenario yielded pressures in the low 50s psi and fire flows in excess of 1,200 gpm at 20 psi. For Scenario 2, a second 8-in CLDI main is proposed to connect Smith Farm Trail to the new 8-in CLDI main proposed in Scenario 1. This scenario yielded similar pressures (low 50's psi) and fire flows in excess of 1,700 gpm at 20 psi. Scenario 2 yields greater fire flow protection than Scenario 1 as well as the added benefits of redundancy, looping and increased water quality.

Sincerely,

Anne Malenfant

Anne Malenfant, P.E., PMP
Environmental Engineer
CDM Smith Inc.

cc: Colleen Heath and Hannah Sullivan, CDM Smith