Ruekert • Mielke
W233 N2080 Ridgeview Parkway, Waukesha, WI 53188-1020 262-542-5733

May 10, 2024

Mr. Mike Gitter, P. E.
Water Utility Director
Racine Water Utility
City Hall Annex - Room 227
800 Center Street
Racine, Wisconsin 53403

Re: Racine Hydraulic Water Distribution System Model Update

Dear Mr. Gitter:

Due to various updates, developments, and changes in water demands within the Racine Water Utility service area, we recommend that a comprehensive model update be performed. The Wisconsin Department of Natural Resources (WDNR) requires that all municipalities have a current model system plan in place in 2025.

This proposal is an update to the proposal from August of 2021. We have reconsidered our approach for this project. Given the WDNR requirements, we feel a more comprehensive and detailed approach is warranted. This proposal has the following changes from the original 2021 version.

- Supervisory Control and Data Acquisition (SCADA) will be used in conjunction with the model development for improved accuracy.
- Detailed analysis of peak day and diurnal demands.
- Validation of the model with operational and SCADA data.
- Additional field testing with hydraulic grade line tests.
- Greater involvement from a subconsultant for quality assurance.

These updates are explained in a subsequent part of this proposal. The changes will result in greater project cost compared to the August 2021 proposal. In addition, it is estimated that our standard rates have increased approximately 18% since the original proposal.

The reliability of the hydraulic model is dependent on the accuracy of the infrastructure and water demands used to create the model, as well as the accuracy of the model calibration. With extensive improvements to the water system in the past six years, it is in the Utility's best interest to perform a comprehensive review and update of the model. This is important so the Utility is able to provide prospective developers with preliminary modeled flow and pressure data. Additionally, it is our recommendation to perform a model calibration at this time. Extended period simulations will be done with three different scenarios for planning purposes.

The increased model calibration and extended period simulation efforts would provide more accurately sized proposed future regional water mains compared to previous modeling efforts. By more accurately sizing the proposed future regional mains it may reduce the main sizes and oversizing costs of the regional facilities.

This proposal outlines our approach to updating and improving the model as follows:

Task 1: Model Components Update

This task is necessary for use of the model for assessing general water system questions.

Task 2: Steady State Validation and Calibration

This task is necessary to ensure proper function of the model for use in planning efforts and fire flow simulations.

Task 3: Extended Period Simulation Update and Scenario Evaluation

This task will allow the model to be used for planning efforts for zone analysis.

A detailed scope of services for each task is provided below.

Task 1 – Model Components Update

The following Scope of Services summarizes the work items involved with Task 1.

Scope of Services:

1. Review current GIS data for water main and facilities constructed after the creation of the model in 2018.
2. Adjust water main and facility locations in model to reflect current GIS data.
3. Import all system hydrants into model with appropriate hydrant labels.
4. Review changes in operating conditions of the water treatment plant, pump stations, and elevated storage tanks since model creation, including but not limited to:
   a. Louis Sorenson elevated storage tank filling/draining conditions.
   b. Backflow interzone systems at Braun Road and Highway 20 pumping stations.
   c. Emmertsen and Newman PRV modifications.
   d. Add updated Perry Ave, Braun Rd, Summit Ave. and Hwy 20 booster station information.
   e. Pump curves in the model will be checked against information from the Utility.
5. Meet with operations staff to document the typical current operating conditions of the water treatment plant, pump stations, and elevated storage tanks.
6. Review zone designations of structures in model and update, if necessary.
7. Adjust model to reflect accurate zone designations of structures, if necessary.
8. Assign/update elevation.
9. Re-allocate node demands in the model using 12 months of recent customer billing data and meter locations provided by the Owner. Node demands will be adjusted to account for non-revenue water using Water Treatment Plant (WTP) records provided by the Utility. Ruekert & Mielke, Inc. (R/M) will update flushing rates at nodes representing flushers (if applicable) using information provided by the Utility.

   We will review up to ten years of historical water production records to determine an overall Maximum Day multiplier for the City's system. We will also determine a Maximum Day multiplier for each pressure zone. The Maximum Day demand will be calculated using production records to calculate a peaking factor that will be applied to the average diurnal pattern for all customers. This peaking factor will be used in the model in subsequent tasks. R/M will meet with Utility operations staff so that the model of the system simulates operating procedures. We will use Public Service Commission reports and past R/M reports as supporting data for the Maximum Day multiplier determination.

10. R/M will calculate composite hourly diurnal demand pattern over a 24-hour period using SCADA records of flow from the water plant and booster pump stations together with calculated flows in and out of storage based on hourly changes in recorded tank levels. To the extent adequate data are available and show a substantial difference between zones, separate diurnal demand patterns will be developed for each pressure zone. These diurnal demand patterns will be used directly in the model to vary demands when running extended period simulations (EPS). Engineer will also work with Owner's staff to develop diurnal demand patterns for up to the top ten largest wholesale or retail customers if adequate information is available. Patterns by use type (i.e. residential, commercial, etc.) will not be developed as part of this scope.
11. Import all system isolation valves into the model with appropriate valve labels.

Proposed Project Timeline

R/M will complete Task 1 by July 31, 2024, assuming the project is awarded to R/M by the end of May and that we have the operational review meeting by mid-June.

Task 2 – Steady State Validation and Calibration

Model calibration typically consists of fire flow tests. This micro-calibration approach works well for small distribution systems, but not for larger systems. We propose a three-step alternative approach which includes model validation, field hydraulic grade line (HGL) checks and fire flow tests.

Scope of Services

1. The macro calibration of the model will be validated by comparing the model predictions to appropriate SCADA data (as shown in Figure 1). This is referred to as the validation process. The macro calibrations are the most important components of the distribution system (i.e., pump stations, storage facilities, and wholesale connection points). This ensures that the model accurately simulates tank performance and system operations and is important to ensure the model can accurately predict water age. This step in the calibration process uses extended period simulations to check diurnal demand patterns, pump curves and pump controls.

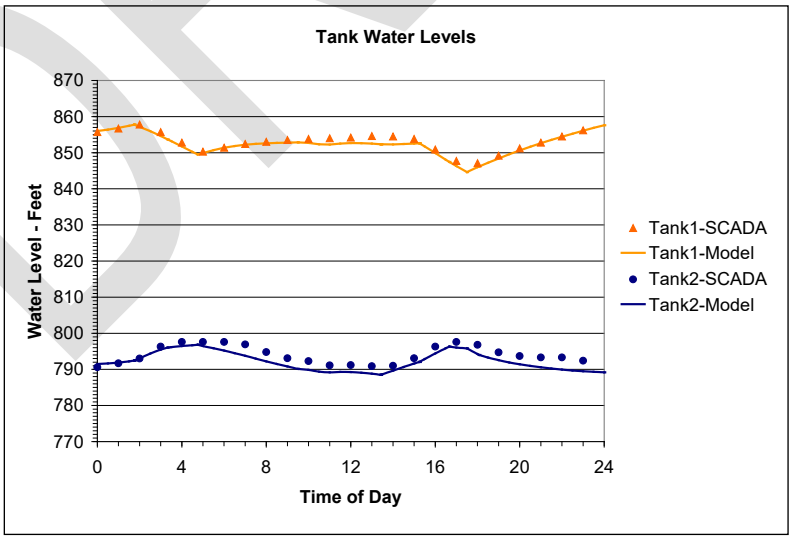

Figure 1: Model calibration data using tank levels recorded by SCADA

2. We will use the results of the model validation to plan additional field testing to support the calibration. The field tests include:
   a. Up to three HGL tests that measure flows and pressures along selected paths of transmission mains connecting the water plant or booster pump stations to storage reservoirs/tanks. R/M will provide equipment to measure flows and pressures where Utility water treatment plant or booster pump station flow meters are not sufficient. Measured pressures will be converted to hydraulic grade lines (HGLs) by adding gauge elevations (based on GIS ground surface elevation data and field-measured height from ground surface to gauge), in order to plot HGLs against distance from sources. These tests show the accumulation of head loss at known flows, providing information to verify pipe roughness, detect restrictions (e.g., closed or throttled valves), and calibrate the model. This approach also provides accurate information for checking the operating points for the pumps at the water treatment plant and pump stations, an important step because errors at supply sources propagate throughout the system.
   b. We propose checking localized calibration by conducting up to 12 fire flow tests. We will work with Utility staff to identify problem areas. Our approach is to verify that the model simulates existing problems before modeling improvement alternatives in subsequent projects.

3. Appropriate adjustments will be made to the model based on the field test results and SCADA data. R/M will calibrate the model by comparing the model predictions to appropriate SCADA data and field test results and adjusting the model. We will further calibrate and check micro calibration of the model in high-priority areas, such as areas with known deficient fire flow capacity or other problem areas where improvements may be needed. The static pressure measurement for each hydrant flow test will be compared to the predicted static pressure to check elevations and tank water levels in the model, and the measured flow from each hydrant flow test will be simulated in the model. Predicted residual pressures will be compared to the measured residual pressures from these fire hydrant flow tests, and reasonable model adjustments will be applied to obtain agreement.

   Major discrepancies discovered during calibration that cannot be resolved with reasonable, defensible model adjustments will be reviewed with the Utility to develop a plan for further investigations. R/M will meet with the Utility staff to review model calibration and discuss findings in a meeting. Potential needs for additional field data and improvements to the existing system will be discussed.

4. Add water model data to GIS. This will consist of actual fire flow rate and residual pressures from the 12 fire flow tests.

Proposed Project Timeline

R/M will complete Task 2 by September 30, 2024, assuming that all necessary flow and pressure test field test are done in late July/early August.

<u>Task 3 – Extended Period Simulation and Scenario Evaluation</u>

The following Scope of Services summarizes the tasks involved with Task 3.

Scope of Services

1. Using the calibrated model, R/M will develop four 24-hour extended period (EPS) simulations, which can be used in the future to conduct modeling analyses. The scenarios that will be developed are:
   - Current Conditions (2024), Max Day Demand.

- Year 2025 Conditions, Max Day Demand. This will include the completion of the new 42-inch transmission main through the City.
- Year 2035 Conditions, Max Day Demand. This will include the year 2025 conditions, and projected 2035 land use.

2. For each scenario, we will provide areas of high velocities, areas of low pressures, and other relevant information. The scenario results will be documented in a letter report.

Proposed Project Timeline

R/M will complete Task 3 by November 30, 2024, assuming Task 2 is completed on schedule.

Proposed Compensation

R/M proposes to undertake this work on a time and materials basis using our standard rates. The estimated cost for performing Task 1 - Task 3 is $89,879. The estimated cost per task is shown below:

Task 1:	$27,336
Task 2:	$38,931
Task 3:	$23,612

We will not exceed this amount without prior authorization from the Utility. If additional HGL testing is required those will be done for an estimated fee of $3,700 per test. If additional fire flow tests are required, those will be done for an estimated fee of $600 per test.

Items listed in the Excluded from the Scope of Services section are not included in these estimates.

Excluded

Excluded from the Task 1, Task 2, and Task 3 Scope of Services:

1. Planning scenarios other than those listed in this proposal.
2. Linking of as-built data to GIS.
3. Field testing other than that listed in this proposal.

Subconsultants

R/M proposes to partner with Hazen and Sawyer (Hazen) in this project. Hazen will provide peer-review and assistance services for model component updates, model validation and calibration services, field testing result interpretation, and scenario planning.

Acceptance

The above-described professional services will be provided to you in accordance with the attached three-page **R/M Standard Terms & Conditions (Consulting)** dated January 1, 2024, which are made part of this updated agreement by reference. Please indicate your acceptance of this agreement by having the appropriate authorized official(s) affix their signature(s) where indicated and return one fully executed copy to our office.

We look forward to working with the Utility on this project. Please feel free to call with any questions related to this proposal.

Respectfully,

RUEKERT & MIELKE, INC.

David W. Arnott, P.E. (WI, IL)
Team Leader/Senior Project Manager
darnott@ruekert-mielke.com

DWA:sjs
Enclosure

cc: Chad Regalia, P.E., Racine Water Utility
Shane B. Davis, P.E., Ruekert & Mielke, Inc.
Brennen E. Fischer, P.E., CFM, Ruekert & Mielke, Inc.

RACINE HYDRAULIC WATER DISTRIBUTION SYSTEM MODEL UPDATE
Between Racine Water & Wastewater Utility
and
Ruekert & Mielke, Inc.
Dated May 10, 2024

CLIENT:	CONSULTANT:
Racine Water & Wastewater Utility	Ruekert & Mielke, Inc.
Signature: _____	Signature: _____ Steven C. Wurster, P.E.
Title: _____	Title: Senior Vice President/COO
Date: _____	Date: May 10, 2024
Designated Representative:	Designated Representative:
Name: _____	Name: David W. Arnott, P.E.
Title: _____	Title: Team Leader/Senior Project Manager
Phone Number: _____	Phone Number: (262) 953-3080