Hazen and Sawyer
4000 Hollywood Boulevard, Suite 750N • Hollywood, FL 33021 • 954.987.0066

CITY OF HALLANDALE BEACH
FY 2018-2019-012 Continuing Professional Architectural and Engineering Services and Other Services
Discipline: Environmental Engineering Services

HAZEN AND SAWYER
WORK AUTHORIZATION No. E2021-001

Water Distribution System Master Plan
Scope of Services: May 3, 2021

*In accordance with Resolution No. 2020-054, RFP #FY 2018-2019-012 Continuing Professional Architectural and Engineering Services and Other Services, the following scope of services is provided by Hazen and Sawyer (*CONSULTANT*) as requested by the CITY.*

BACKGROUND

The City of Hallandale Beach (CITY) owns, operates and maintains a water supply, treatment and distribution infrastructure to supply drinking water to approximately 40,000 people within its water service area. The CITY's water service area consist primarily of residential and commercial customers.

The water distribution system includes approximately 75 miles of piping, along with valves, tanks, and pumps that convey water throughout the CITY. These critical assets provide adequate water supply to the CITY's customers for purposes of drinking, sanitation, fire protection and emergencies (e.g., hurricanes).

The CITY has requested Hazen and Sawyer (CONSULTANT) provide professional engineering services to develop a Water Distribution System Master Plan to evaluate the water distribution system capacity and identify a 20-year capital improvement plan.

The Water Distribution System Master Plan will include the updating and calibration of the existing water distribution system hydraulic model. The model will be used to identify capacity issues within the distribution network, to evaluate recommended improvements and address possible water quality concerns. The Water Distribution System Master Plan will also assess the costs for renewal and replacement of water piping based on age expected useful life.

SCOPE OF SERVICES

Task 1: Data Collection and Water Demand Forecast

1.1 Data Collection

The CITY will provide CONSULTANT with required data within the first four weeks of receipt of a Project Notice-to-Proceed. Data that are anticipated to be required include, but are not limited to, the following:

1. Agreements with other municipalities to supply water through interconnects.

2. A table that identifies the water distribution system interconnects with other utilities.
3. Document the location of all above ground pipeline water body crossings.
4. Document the location of all below ground pipeline water body crossings.
5. Geographical Information System (GIS) shape files or geodatabase of the water distribution system including the following information:
    a. pipe materials
    b. parcel boundaries
    c. service area boundaries
    d. valves
    e. storage tanks
    f. pump stations
    g. hydrants and hydrant laterals
    h. Pipe attributes must at minimum include the following:
        i. pipe diameter
        ii. material
        iii. year of installation
6. CITY will participate in a meeting with CONSULTANT to collect customer water billing records for the years 2016 to 2020. Data shall be broken down by account number, physical service address, account type (i.e., residential, commercial, fire and irrigation), account status and consumption.
7. CITY will participate in a meeting with CONSULTANT to collect data from the CITY SCADA system for the years 2016 to 2020, as follows:
    a. CITY's sewer pump station SCADA flow and pressure data (for development of water demand patterns)
    b. WTP high service pump station SCADA pressure and flow data
    c. WTP water storage tanks level data
    d. Water distribution system water tank level data
    e. Water distribution system SCADA pressure data
    f. Map of locations that the City SCADA system monitors water distribution system pressure
    g. Water treatment system monthly operating reports (MORs)
    h. South Florida Water Management District (SFWMD) Pumpage Reports
    i. Annual water balance summary reports in Microsoft Excel for 2016 to 2020 that the CITY submits to the SFWMD (the CITY might also know this report by the names "non-revenue water report" or "water loss report".

8. Identification of the locations of existing automatic flushing devices and frequent manual flushing hydrants via a street address or latitude/longitude.
9. For all automatic flushing devices, provide manufacturer name, model number, flow rate, operating duration, flushing start time, and flushing stop time.
10. Pump data for each pump at the North Miami Beach interconnect pump station, including the following for each pump:
    a. Make and model number
    b. Impeller diameter
    c. Pump curve
    d. Record Drawings
11. A list of GIS feature class indicating valves that are normally closed.
12. Maps identifying areas of known low pressure during high demand indicating known minimum pressures.
13. CONSULTANT shall conduct a meeting with the CITY's field operation staff to obtain information on the system's physical condition, pipe ages, and areas of concern such as areas exhibiting low pressures and issues with water quality. CONSULTANT shall prepare meeting minutes and distribute electronically.
14. CITY fire department hydrant flow test and inspection results
15. A workshop will be held with the CITY's GIS manager and the CITY's project manager to review the available GIS model the CITY has created of its infrastructure. During the workshop, the CITY will provide input on how it wants the projects identified in the master plan to be illustrated within the GIS model. The CITY's GIS model will be updated by CONSULTANT to illustrate projects identified in the master plan along with expected timeframe for project construction.
16. The CITY's laboratory will collect the following finished water quality (at the discharge of the high service pump station) parameters* once per day during the morning shift for seven consecutive days:
    a. pH
    b. Temperature (degree Celsius)
    c. Conductivity (µS/cm)
    d. Total Dissolved Solids (TDS) (mg/L)
    e. Calcium Ca2+ (mg/L as CaCO3)
    f. Total Alkalinity (mg/L as CaCO3)
    g. Total Chlorine (mg/L)
    h. Free Chlorine (mg/L)
    i. Monochloramine (mg/L)

* The CITY will retain an outside laboratory if needed for analyses it does not perform.

j. Free Ammonia (mg/L)

k. Nitrite (mg/L)

l. Nitrate (mg/L)

17. The CITY annually analyzes primary and secondary drinking water parameters at the finished water. Provide these data from 2015 to 2020.
18. Provide data collected for Disinfection By-Products Rule (DBPR) compliance from 2015 to 2020. Provide copies of all FDEP Reporting Format 62-550.822.
19. Provide a map that illustrates and describe the locations the CITY uses for DBPR compliance monitoring.
20. Provide a copy of the CITY's spreadsheet that it uses to calculate the Locational Running Annual Average (LRAA) under the DBPR.
21. Provide a copy of the CITY's Lead and Copper Rule (LCR) sampling plan that has been approved by the FDEP.
22. Provide a map that illustrates the locations that CITY samples for compliance with LCR for lead, copper, and water quality parameters (WQPs).
23. Provide LCR lead sampling results from 2000 to present in Excel spreadsheet format.
24. Provide LCR copper sampling results from 2000 to present in Excel spreadsheet format.
25. Provide LCR WQP sampling results from 2000 to present in Excel spreadsheet format.
26. Provide all data collected for Total Coliform Rule (TCR) compliance collected from 2015 to present.
27. Provide a copy of the CITY's TCR monitoring plan.
28. Provide a copy of the CITY's TCR monitoring standard operating procedures.
29. Provide a map that illustrates the locations that the CITY samples for TCR compliance.
30. Provide copies of the "Cross-Connection Control Program Annual Report" [Form 62-555.900(13)] submitted to FDEP annually from 2016 to present.
31. The CITY's laboratory will collect water samples entering and exiting the beach water storage tank and analyze the following parameters† once per day during the morning shift for seven consecutive days:
    a. Total Chlorine
    b. Free Chlorine
    c. Monochloramine
    d. Free Ammonia
    e. Nitrite
    f. Nitrate
    g. pH

† The CITY will retain an outside laboratory if needed for analyses it does not perform.

h. Temperature

1.2 Population Projections

CONSULTANT will evaluate the present population and future service area for the CITY's water service area. CONSULTANT will develop population forecasts for the planning horizons in the Years 2021, 2025, 2030, 2035, and 2040. Population forecast data will be obtained from Broward County Environmental Protection and Growth Management (BCEPGMD, which bases its analysis on University of Florida Bureau of Economic and Business Research (BEBR) population estimates). The data will be utilized as divided into Traffic Analysis Zones (TAZs) by BCEPGMD within the service area. CONSULTANT will meet with CITY to review population projections and confirm agreement prior to initiating demand forecasting.

1.3 Demand Forecast

Water demand on an average annual day and maximum day basis will be forecast through the year 2040 for the following:

- Raw water
- WTP production
- Concentrate production
- Water consumption (based on billing records)
- Water consumption forecast will be broken down by TAZ based on billing records
- Non-revenue water will be assessed. The difference between WTP production and billed consumption represents non-revenue water.

Task 2: Water Distribution System

2.1 Summary of Existing Water Distribution System

Key information for the existing water distribution system will be documented. Key information will include, but not be limited to:

- Storage tank capacities
- Water tank elevation
- Pump curves
- Miles of pipe, broken down by age and material
- Number and age distribution of isolation valves
- Number and age distribution of fire hydrants
- Number and age distribution air release valves
- Water body crossing locations

2.2 Update Existing Model

The CITY owns a water distribution system model that was developed in 2015 using Water CAD version V8i software by Bentley Solutions. The model will be updated as deemed appropriate with the current GIS data. The model will be developed as an extended period simulation (EPS). An EPS model will simulation flow rates and pressures changing throughout the system in response demand variations in time.

The 2015 model is based on piping six inches in diameter and greater. Pipes with diameters of four inches were only included if they represent critical loops in the network. Under this task the model will be updated to include all pipe sizes to enhance the accuracy of water age modeling.

2.2.1 City GIS Data

The CITY has been actively updating its GIS model of the CITY's infrastructure. CONSULTANT will obtain the CITY's GIS model and use it in the development of the water model. The GIS model will be reviewed and a master plan project will be included to update the GIS to achieve the City's goal of having a state-of-the-art GIS model of the City's infrastructure.

2.2.2 Spatially Distribute Water Demands Using Billing Records

Service area-wide water use will be spatially distributed to model network piping junctions in a manner consistent with the characteristics of the water billing data provided by the CITY. Water use will be allocated to each property parcel by applying GIS geocoding techniques using service addresses within the CITY's water billing records.

2.2.3 Pump Curves and Tank Data

CONSULTANT shall incorporate pump curves and operational controls to the model using manufacturer's performance curves and CITY's current operating strategy. CONSULTANT shall also configure storage tank dimensions and control elevations in the hydraulic model based on established data provided by CITY.

2.2.4 Diurnal Demand Curves

Diurnal demand patterns shall be developed based on available CITY data. If sufficient data is not available for the development of diurnal demands, then demand patterns from South Florida utilities with similar water consumption patterns shall be used to develop the required diurnal water demands. CONSULTANT shall assign diurnal demand patterns to model demand locations.

2.3 Field Data Collection for Model Calibration

CONSULTANT shall provide five Telog digital pressure recorders to be installed at pre-planned locations to monitor diurnal variations in water pressure at key locations throughout the CITY's service area. It is anticipated that a total of fourteen (14) locations within the service area will be monitored. Designated locations will be monitored in two groups, each group being monitored for a total period of eight (8) consecutive days. CITY staff (with CONSULTANT assistance) will install and relocate the recorders in accordance with the location and sampling schedule provided by the CONSULTANT. The CITY will also provide the high service pump flow and discharge pressure data corresponding to the field pressure data collection time periods. The data collected will be used for hydraulic model calibration and verification purposes.

2.4 Calibration

Calibration involves the iterative process of comparing model output with field measurements and SCADA records, adjusting model input parameters, and making pipe connection corrections so that the discrepancies between the model results and the field data meet the desired calibration criteria. The model parameters such as Hazen-Williams C-factors, minor losses and diurnal curves will be adjusted until its predictions agree reasonably well with the measurements. Major discrepancies will be investigated and further resolved as needed.

2.5 Model Simulations

2.5.1 General Network Performance

The calibrated hydraulic model shall be used to evaluate the CITY's water distribution network performance under current and future maximum day flow (MDF) demand conditions. The following scenarios shall be developed:

- Current Year System Performance
- Year 2030 System Performance without Short Term Improvements
- Year 2030 System Performance with Short Term Improvements
- Year 2040 System Performance without Long Term Improvements
- Year 2040 System Performance with Long Term Improvements

CONSULTANT shall identify general network performance deficiencies and will identify improvements that would eliminate or reduce their hydraulic impacts.

2.5.2 Fire Flow Availability

CONSULTANT shall apply two methods of distribution system fire flow evaluation, as indicated below.

2.5.2.1 System Wide Fire Hydrant Flow Simulation

The fire hydrant flow simulation function embedded in WaterCAD will be used to sequentially test available fire flow at each fire hydrant. Hydrants that can provide a minimum of 500 gallons-per-minute (gpm) at 25 pounds-per-square-inch (psi) residual system pressure will be deemed acceptable. Any fire hydrants below this criterion will be identified. Improvements to increase fire flow above this criterion will be identified.

2.5.2.2 Fire Flow Analysis for Selected Sites

The model will be updated to simulate fire flows at five sites analyzed in 2015 the model as indicated in the table below.

Site	Fire Flow (gpm)‡
Hallandale Beach High School	3,500
Gulfstream Park	3,500
Multi-family residential complex at SW 11th Ave and SW 8th St	2,500
Seaside Retirement Resort at 2091 S. Ocean Drive	3,500
Multi-family residential complex at NE 10th Street and Parkview Dr.	3,500

The analysis will be performed under steady-state MDF demand conditions under the following scenarios:

- Current Year System Performance
- Year 2030 System Performance without Short Term Improvements
- Year 2030 System Performance with Short Term Improvements
- Year 2040 System Performance without Long Term Improvements
- Year 2040 System Performance with Long Term Improvements

If residual system pressure drops below 20-psi then a deficiency will be noted. Improvements will be identified that would eliminate or reduce noted deficiencies.

2.5.3 Storage Evaluation

2.5.3.1 Assess Compliance with Minimum Storage Volume Requirements

CONSULTANT shall evaluate the water volume requirements of the distribution system with respect to three primary functions in the distribution system: equalization, fire protection and emergency supply. Compliance with the storage requirement of Rule 62-555, Florida Administrative Code (FAC) shall be documented.

2.5.3.2 Assess Addition of New Ground Storage Tank off-site

The model will be used to assess the need for improving pressure (and fire suppression capacity) in the distribution system by construction of an off-site tank. The model will be used to assess potential locations.

2.5.3.3 Assess Replacement of the Existing 2-MG Water Tank at the WTP

- The CITY indicated that the existing the 2-million-gallon (MG) water tank at the WTP may be nearing the end of its useful life; the CITY may want to consider replacing it in a different location.
- The model will be run to assess the optimal location (at the WTP or in the distribution system) of a replacement tank for the existing 2-MG tank.
- If the WTP is selected as the optimal location, the site planning process for Utilities/DPW should be considered. This study may recommend that the 2-MG tank should be installed

‡ Fire flows are based on Insurance Services Office, Inc. (ISO) document titled "*Guide for Determination of Needed Fire Flow*".

adjacent to the membrane building (where parking is now) and the parking for Utilities personnel relocated to where the existing 2-MG tank is presently located.

2.5.3.4 Beach Tank Filling Rate Assessment

The CITY staff reported that the elevated storage tank at the beach draws down rapidly and fills slowly. The model will be used to assess beach tank filling rate relative to standard industry practice. If the tank fills slower than standard industry practice, then infrastructure improvements will be assessed.

2.5.4 Network Redundancy

The occurrence of redundant paths between water treatment facilities and customers greatly increases the reliability of the distribution system. Three scenarios simulating a break in a large water main (e.g., failure of a water main crossing the Intracoastal Waterway) shall be modeled. These extended period simulations (EPS) will document the impacts of pipe breaks on minimum pressures across the distribution system under MDF conditions. In cases where localized minimum pressures drop below an acceptable threshold, new piping will be proposed and tested that would provide effective redundant paths for water delivery to affected areas.

2.5.5 Water Age Modeling

2.5.5.1 Map Water Age for Existing Operations

The EPS model will assess water age in distribution system under existing operating conditions. Results will be presented as a color-coded map of water age predictions. The map shall be color-coded to highlight areas with excessive water age.

2.5.5.2 Storage Tank Water Age

Storing water in tanks increases residence time in the distribution system, thus degrading water quality. Water age will be modeled; excessive water age in the storage tanks will be identified.

2.5.5.3 Evaluate Methods of Reducing Water Age

The model will used to assess methods of reducing water age in the distribution system and storage. Low-cost operational changes will be assessed along with higher cost capital improvements to reduce water age. The addition of automatic flushing devices shall be assessed.

2.6 Demand Driven Improvement Needs

Based on the model findings, demand driven improvement needs will be master planned. The timeframe that the improvements are needed will be determined.

2.7 Water Distribution Piping Renewal and Replacement

The age and condition of buried piping are key attributes to assessing water distribution system piping renewal and replacement needs. The assessment of the condition of buried piping is challenging and expensive. Hence, this master plan will not include physical inspections. Rather, the master plan will be limited to quantifying pipe replacement needs based on the age of the pipe, expected useful life of piping, the pipe material and institutional knowledge of pipe condition based on interviews with the CITY's senior staff.

A color-coded map illustrating the age of the piping in the City's network shall be prepared in the CITY's GIS model along with graphics included in the master plan report. Where geospatial data on pipe failures over time is available, it shall be included in this map. This map shall be the basis for identifying areas in the system with the highest likelihood of pipe failures for targeted replacement.

2.8 Distribution System Regulatory Improvement Needs

Document compliance with existing regulations and identify improvements needs based on review of existing water quality data, collection of new water quality data and review of future regulations.

2.8.1 Review Existing Water Quality Data

Review existing distribution system water quality data, including:

- Disinfection By-Products Rule Data
- Lead and Copper Rule Data
- Total Coliform Rule Data
- Distribution system nitrification data (if collected)

Document compliance with existing regulations. Based on the findings, recommend operational and infrastructure improvements.

2.8.2 Review Water Storage Tank Water Quality Data

Water quality data will be collected by the CITY (as described in Task 1) for water entering and exiting the beach water storage tank. CONSULTANT will process these data to assess if nitrification is occurring within the water tank. Based on the findings, recommend operational and infrastructure improvements.

2.8.3 Future Regulations

Master plan projects needed for compliance with draft Environmental Protection Agency (EPA) regulations (e.g., Lead and Copper Rule Revisions).

Task 3: Master Plan Report

3.1 Opinion of Probable Project Costs

Opinion of probable project costs (OPPCs) will be prepared to Class 5 as defined by the Advancement of Cost Engineering (AACE) International Recommended Practice No. 18R-97. The expected accuracy range for this type of estimate is 50-percent below to 100-percent above the actual cost.

3.2 Master Plan Project Organization

Recommended projects and their associated costs will be compiled. Projects will be categorized by improvement type, as follows:

- capacity improvements,
- regulatory improvements, and

- renewal and replacement improvements.

Each project will be assigned a unique project identification number to facilitate management.

3.3 Capital Improvements Program (CIP) and Prioritization

A preliminary 20-year CIP cost schedule shall be developed. A workshop shall be held with the CITY to review the preliminary 20-year CIP cost schedule and discuss project prioritization and funding limitations. During the workshop, the CIP cost schedule shall be adjusted based on the CITY's input on project prioritization to create a finalized CIP.

The CITY uses a CIP spreadsheet to document its projects for budgeting. CONSULTANT will use the CITY's spreadsheet to create the master plan CIP. The CITY's spreadsheet will be adapted to facilitate escalating project costs to the mid-point year of construction.

3.4 Master Plan Report

The findings of all prior tasks shall be assembled into an overall Water Distribution System Master Plan Draft Report. The Water Distribution System Master Plan Draft Report shall be submitted to CITY (in digital Adobe PDF format) staff for review and comments. A review meeting shall be held with the CITY staff within two weeks of submission to discuss CITY comments. The CITY's comments shall be addressed to create the Water Distribution System Master Plan Final Report. Three hard copies along with an Adobe PDF format digital copy of the Water Distribution System Master Plan Final Report will be submitted.

Projects that are identified in this Master Plan shall be incorporated into the CITY's GIS model. Additionally, graphics will be prepared using the CITY's GIS model to illustrate the proposed projects in the Master Plan report.

3.5 Presentation Preparation

A PowerPoint show shall be prepared that summarizes the master plan. The style and content of the presentation shall be prepared assuming that the CITY commission and the public are the audience.

3.6 Presentation to Commission

CONSULTANT shall participate in a presentation of the PowerPoint show created in task 3.5.

ASSUMPTIONS

The following assumptions were made in preparation of the above scope:

1. CITY will retain a financial consultant to develop a ten-year financial forecast to evaluate funding of the prioritized capital program and estimate the impact on existing and planned utility rates.
2. The CITY will provide information on currently planned water distribution projects. The list will indicate the estimated scheduled start and finish dates for planning, design, permitting and construction. The information will include a map showing the location of the planned distribution system improvement projects.

3. Corridors for proposed water distribution system piping recommended in this Master Plan will be of a conceptual "schematic" nature. No detailed legal descriptions, surveys, corridor analyses, or easement identification will be developed in the Master Plan.
4. The work performed under this Master Plan effort will not preclude CONSULTANT from providing engineering services to design and oversee construction of projects identified in this Master Plan under future work authorizations.
5. The CITY Water Treatment Plant (WTP) includes two treatment technologies: 1) lime softening and 2) membrane softening. The water from both treatment technologies is blended, stabilized, and disinfected prior to pumping into the distribution system as "finished water". The CITY has decided to implement 100% membrane treatment. Treatment master planning is not included in this Master Plan.

SCHEDULE OF COMPLETION

The anticipated duration for the major work tasks is summarized in the table that follows. The Master Plan will be delivered within 300 days of receipt of notice to proceed.

Task	Description	Approximate Duration (days)
1	Water Demand Forecast	60 (includes days for data collection)
2	Water Distribution System	300
3	Master Plan Report	300
	Total Calendar Days for Completion	300

COMPENSATION

Compensation shall be made to CONSULTANT not to exceed the total of $421,760. CONSULTANT shall bill the CITY on a monthly percent complete by task basis as indicated in the table below.

Task	Description	Fee By Task (to be billed by Percent Complete)
1	Water Demand Forecast	$33,080
2	Water Distribution System	$285,556
3	Master Plan Report	$103,124
	Total (not to exceed)	**$421,760**

AUTHORIZATION - HAZEN AND SAWYER

Accepted:	Janeen M. Wietgrefe, P.E. Associate Vice President	Date: May 3, 2021