

**ADVANCED METERING INFRASTRUCTURE (AMI) WATER METER SYSTEM**

**PART 1: GENERAL**

**1.01 SCOPE OF WORK**

- A. This section covers the furnishing and installation of a complete AMI water meter system as specified herein.
  
- B. Line item quantities of the proposed system are as follows and shall be used to assist in the formulation of the cost proposal. This list is approximate and not intended to be exhaustive. The cost proposal shall include all itemized costs of AMI system supply, installation, implementation, software, support services, and all other costs as applicable for a complete and functional AMI system, including costs for required and/or recommended items not included in the below list. Proposers shall assume that meters will be a direct replacement of existing meters in existing locations/setters without significant reworking of services required.

ITEM NO.	DESCRIPTION	QUANTITY
1	5/8" x 3/4" AMI Meter (Materials Only)	1800
2	5/8" x 3/4" AMI Meter w/ Leak Detection (Materials Only)	20
3	5/8" x 3/4" AMI Meter w/ Cellular (Materials Only)	20
4	5/8" x 3/4" Meter Install Charge	1,840
5	1" AMI Meter (Materials Only)	60
6	1" AMI Meter w/ Leak Detection (Materials Only)	5
7	1" AMI Meter w/ Cellular (Materials Only)	5
8	1" Meter Install Charge	70
9	2" AMI Meter (Materials Only)	100
10	2" Meter Install Charge	100
11	3" AMI Meter (Materials Only)	2
12	3" Meter Install Charge	2
13	4" AMI Meter (Materials Only)	6
14	4" Meter Install Charge	6
15	6" AMI Meter (Materials Only)	2
16	6" Meter Install Charge	2
17	8" AMI Meter (Materials Only)	2
18	8" Meter Install Charge	2
19	External Antenna (Materials Only)	100
20	External Antenna Install Charge	100
21	Meter Transmitting Unit (MTU) (Materials Only)	20
22	MTU Install Charge	20
23	AMI Collector Set (Installed)	2
24	AMR Collector for Vehicle Use (Installed)	1
25	AMR Collector for In-Person Use	1

## 1.02 QUALITY ASSURANCE

- A. The equipment shall be manufactured by a reputable company with at least ten (10) years of experience in the manufacture of water meters and AMI systems.
- B. All materials and equipment supplied under this Section shall be new, of good quality, and in good condition.

## 1.03 SUBMITTALS

- A. Conformance to Specifications: The material and performance specifications described herein are intended to establish a desired standard of quality. The inability to meet all requirements does not constitute an automatic rejection of a proposal. **Proposer shall submit a list of all deviations from this specification as part of his Proposal.**
- B. Shop Drawings: The Proposer shall submit three (3) sets of shop drawings and wiring diagrams for the major equipment to be installed such as meters, registers, radio units, collectors, and mobile read units. A description of proposed software and guarantee of compatibility with Owner's existing billing software shall also be provided.
- C. Operation and Maintenance Manuals: Prior to acceptance of the equipment, three (3) complete sets of operation and maintenance manuals for the complete system shall be supplied to the Owner by the Proposer.

## 1.04 DELIVERY, STORAGE AND HANDLING

- A. All equipment shall be delivered, stored and handled in strict accordance with the manufacturer's recommendations.

## 1.05 WARRANTY

- A. All complete meter units, including meters, registers, radio units, mobile read units, and software shall be warranted by the Proposer against all defects in materials and workmanship for a period of one (1) year from the date of final acceptance. The Proposer shall be obligated to replace all parts and accessory construction proved defective within the one-year period at no cost to the Owner. Individual component warranties from the material providers as specified herein shall also be applicable.

## PART 2: PRODUCTS

### 2.01 METERS

- A. Acoustic Leak Detection
  - 1. The meter manufacturer shall offer the option for meters to have the capability to monitor and record acoustic noise to enable leak detection on residential meter sizes up to 1 inch. The acoustic leak detection sensor and electronics shall be integral to the meter, requiring no external hardware or wired connections.

2. The acoustic data shall be captured regardless of reading method (AMR or AMI).
3. The acoustic functionality may be activated immediately at time of purchase or offered as an upgrade without requiring a field visit or reprogramming of the meter or affecting the warranty or battery life.
4. The design of the acoustic leak detection feature shall minimize the impact of sensitivity to acoustic noise generated across different pipe materials including metal and plastic pipes. Proposal shall describe how the proposed solution fulfills this requirement.
5. The Proposer shall provide information on expected life cycle and replacement costs associated with acoustic leak detection to assist with return-on-investment calculations.

B. Meter Construction

1. All water meters shall use solid state measuring technology with no moving parts to ensure accuracy over the lifetime of the meter.
2. The meter shall be resistant to wear and impurities in the water.
3. All sensors and electronics shall be designed so that they are fully protected against internal and external penetration of fluid.
4. The meters shall be hermetically and vacuum-sealed to prevent humidity from entering the electronics and avoid condensation between the glass and display.

C. Materials

1. Meters shall be made available in both composite and metal bodied housings that incorporate design features that help prevent cross-threading during installation.
2. For composite bodied meters the meter housing and measuring tube shall be constructed of lead-free thermoplastic polyphenylene sulfide (PPS) reinforced with fiberglass. The composite meters shall offer exceptional mechanical strength, high temperature resistance, chemical resistances, electrical insulation, and flame resistance.

D. Battery

1. The battery shall be warrantied to last **twenty (20) years**.
2. The meter shall provide a low battery warning on the display in accordance with AWWA C715 operating guidelines and transmitted as an alert to the AMI system.
3. The Proposer shall provide life expectancy information including a fifteen-year total cost of ownership calculation.

E. Measurement

1. Maximum permissible error shall fall in accordance to AWWA C715-18 operating guidelines  $\pm 1.5\%$  in normal flow range and  $\pm 3\%$  for low flow ranges,  $\pm 5\%$  for extended low flow ranges.
2. Starting flows on 5/8" meters shall start measuring as low as 0.015 GPM and 0.01 GPM on residential meter leak detection option.
3. Water meters shall have the ability to measure, log, and transmit the temperature of the water and ambient temperature.

F. Flow Validation: All meters shall have the ability to log a total of historic volumes by flow rates to validate flows as a tool for right sizing and realization of how much low flow was captured at various flow rates.

G. Approvals, Certifications, Standards, and Ratings

1. The meter shall be approved according to Drinking Water Standards in multiple countries and certified to NSF/ANSI 61.
2. The meter shall fully comply with AWWA C715-18 guidelines.
3. The meter shall be IP68 type tested and able to operate fully submerged
4. The manufacturing and testing process shall only use materials approved for drinking water. Meters shall be disinfected before dispatch and hygienically controlled.
5. All radio communications shall comply with relevant FCC rules, including Part 15. Meters shall have been tested by FCC to ensure that they meet requirements regarding EMC emissions and FCC ID shall be laser printed or permanently engraved on each meter.

H. Verification and Calibration: All meters shall be verified and calibrated by an ISO 17025 accredited laboratory during production.

I. RF Communications Module

1. The meter and RF communication module shall be one single integrated unit hermetically sealed for easy installation reducing labor cost and time. The meter shall be IP68 rated, and submersible suited for installation in flooded meter pits, vaults and basement installations.
2. The meter shall be capable of two communication modes operating within an unlicensed frequency in the 902-928 MHz band for mobile drive-by operation and support a licensed frequency within the 450-470 MHz band to provide wide ranging radio coverage and propagation.

J. Data Logging

1. The meter shall store data logs in the EEPROM, easily retrievable via mobile app and Bluetooth.
2. Data logs shall provide 460 days of daily readings, 100 days of hourly readings and the last 50 info codes such as leak, burst, dry, reverse, tamper, overflow and battery capacity.
3. Logged hourly and daily usage data shall be available on the mobile device or on the headend system.

K. Data Options

1. To support configuration changes to leak, burst, temperature thresholds and transmission intervals the meter shall allow reprogramming over the air. Firmware updates shall be permissible over RF without having to gain physical access to the meter and allow deployment in groups.
2. Standard data communication intervals shall be every three hours (eight times per day) delivering hourly values.
3. The meter shall be capable of delivering near real time events such as:
  - a. Leak: Continuous flow for the past 24 hours based on a configurable limit of greater than 0.1%, 0.25%, 0.5%, 1.0% and 2.0% of maximum flow for meter size.
  - b. Burst: Indicating 30 minutes of flow based on a configurable limit of 5.0%, 10.0% or 20.0% of maximum flow.
  - c. Dry: Indication of air in the pipe, no fluid or a frozen meter.
  - d. Reverse Flow: Indicating water is running in the opposite direction of normal flow. Reverse flow shall be logged in a separate internal register.
  - e. Tamper: Indication that electronics or meter has been compromised.
  - f. Overflow: Indicating flow exceeded the rated maximum flow rate for the meter size.

L. Display

1. The meter shall include an easily readable LCD display including nine-digit resolution, unit of measure, billable digits for reference, all active alarm codes (leak, burst, dry, reverse, tamper, low battery) radio off, visual flow indicator and flow rate.
2. Display resolution shall be configurable upon order and may be changed after shipment.

3. Display resolution shall have no effect on digits provided for billing however billing digits are referenced on the display.
  4. Meter serial number shall be barcoded and numerically visible on the register face, as well as meter size, FCC identification, NSF compliance, production year, and maximum operating pressure.
  5. The option for a laser printed customized label such as company logo to indicate what utility owns the meter.
- M. Security
1. Data sent from the meter to the collector or receiving device shall always be encrypted.
  2. Only authorized devices shall be able to decrypt messages from the meter.
- N. Operation: The meter shall be able to operate accurately under a maximum pressure of 250 PSI for meter sizes 5/8" x 3/4" and 1" and 300 PSI for meter sizes above 1".
- O. Check Valve: Each 5/8" x 3/4" water meter shall be supplied and installed with a spring-loaded check valve on the discharge end to prevent backflow into the distribution system.

## 2.02 DATA COLLECTORS

- A. Configuration: Data collectors shall consist of a base box and top box to maximize performance based on link budget. The bottom base box provides the network backhaul communication method whether cellular modem or ethernet and supplies power to the top box. The base box shall allow up to four top box connections for maximum performance if the collector site installation requires.
- B. Built-In Network Intelligence: The AMI system shall automatically monitor and adjust the output power of the meter to allow the optimal radio performance of the system and extend battery life on the meter. The system shall select the optimal collector to read the meter, but in the event the collector is taken out of operation, other collectors shall provide redundancy.
- C. Data Storage: The collector shall support up to 5,000 meters and be able to store 10 days of hourly data.
- D. Communication: Collector communication backhaul options shall include either cellular modem or ethernet network.
- E. Security: The data collector shall follow TLS 1.2 protocol with AES 256-bit encryption to the head end system.
- F. Physical: Collector shall be rugged, high enclosure class with built-in lightning protection.
- G. Operation: Collector shall operate within -22°-158° F. Power input 110-230 VAC 50/60 Hz. Power output 24 VDC/10A.

## 2.03 NETWORK

- A. The network shall allow for redundancy without the need for repeaters. The network shall allow a fallback method of meter reading in the event the meter is not able to transmit successfully to the collector.
- B. The network shall automatically perform required updates such as firmware for the collector infrastructure without user intervention.
- C. The system network design shall achieve a daily reading performance between 98.5 to 99%.
- D. The AMI system shall be self-healing by automatically monitoring reading performance and adjust power output of meter transmissions. This ensures that meters with stronger signal strength can transmit at lower power and meters that have weaker signal strength transmit at higher power to improve reading performance across the entire system.

## 2.04 AMI SYSTEM SOFTWARE

- A. The host software shall be an intuitive easy to use solution. It shall include online help describing all menus and feature sets with step-by-step tutorials. The software shall be a cloud-based solution, alleviating the need for server platform investment and maintenance, providing optimal performance and scalability.
- B. Data Storage: To address billing disputes while maintaining optimal system performance, historical reading data shall be kept up to thirteen months for hourly data, five years for daily data, and ten years for monthly data.
- C. Billing Systems Integration: The software interface to and from Owner's billing software shall be flexible supporting with single record fixed width or delimited (CSV) file formats that can be customized to easily integrate to the billing system.
- D. Features
  - 1. The software shall have search capabilities to search all or specific fields such as address, meter serial number, account number, customer name, etc. The software shall be able to filter on meter rollovers and final readings. The software shall provide hourly readings, bar graph chart visualization of average flow per hour to easily identify trends, and anomalies and hourly, daily, monthly, yearly consumption over a user defined date range.
  - 2. The software shall be able to prioritize between high and normal priority codes and be able to schedule the frequency and time when the notifications are delivered or be able to send notifications when they are detected.
  - 3. The software shall allow the creation of meter groups automatically through imports or manually.
  - 4. Allow user to perform meter exchanges, so that historical data may be referenced under the account with associated meter data history.

5. The software shall have consumption reporting capabilities by group and custom date range with filters higher or lower than configurable thresholds.
6. The software shall provide meter data set comparisons by a defined date range.
7. The software shall allow import and display of custom fields which also may be exported back to the CIS.
8. The software shall allow the reading to be displayed and exported as read from the meter, or in US gal, ft<sup>3</sup>, m<sup>3</sup>, l, Imp gal (Us Gallons, cubic feet, cubic meters, liters and Imperial gallons)

E. Hybrid System – Mobile Drive-By Reading and Cellular Reading

1. The AMI software shall include the ability to read meters via mobile drive by and cellular without installing additional PC software or add on module components. The mobile application shall support Android devices (smart phones or tablets). Data may be synchronized from the mobile app and host software at any time via Wi-Fi or cellular network without the loss of captured data.
2. In addition, if readings were missed by the fixed network system, it shall allow a data log of the meter to be sent back to the head end system so that it may be viewed in the software.

F. Mapping Visualization: The software shall have the ability to import GIS coordinates or be able to geocode by address, city and zip code via Google Maps. The meter may be viewed graphically in the host software and in the mobile application when in the field.

G. Scheduled Jobs: User defined custom data imports and exports shall have the ability to be scheduled as automatic jobs to an FTP/FTPS/SFTP server or email.

H. Performance Reporting: The software shall provide performance analytics to recognize data collection success of all meters or meter groups on user defined parameters such as daily or hourly reads as a percentage or number to monitor the health of the system.

I. Data Security and Integrity

1. Data shall be stored in an ISO27001 certified environment in compliance with GDPR legislation including firewalls, antimalware systems and encryption for data protection. Meter encryption keys are assigned to the utility end-user to prevent unauthorized access to meter reading data. Data sent to the host software shall use TLS 1.2 protocol with AES 256-bit encryption.
2. The import of meter data shall prevent human data entry errors, prevent duplication of meter serial numbers, and distinguish between meters with integrated or separate endpoints.
3. The system shall allow the utility to assign their own roles and permissions to users and have various levels of users, (Administrators, Super User, and User).



## 2.04 WATER SYSTEM ANALYTICS SOFTWARE

### A. Acoustic Leak Detection Analysis

1. The software shall support the collection of acoustic noise data from integrated acoustic smart meters and automatically prioritize them based on custom defined levels. Shall allow for advanced filtering to provide quick identification of critical meters to investigate.
2. The software shall be intuitive, user friendly and accessed via a web or mobile browser such as Google Chrome, Microsoft Edge, Internet Explorer and supported on mobile platforms (iOS, Android and Windows.)
3. The software shall graph acoustic noise trends over time and allow the user to select the desired date range.
4. The software shall visually display meters color coded by noise level geographically in map view and allow customization of which meters are displayed or hidden.
5. The software shall allow for tracking meters of interest, comments, editing, categorization and resolution once the noise levels are investigated in the field.
6. The software shall provide auto-generated reports configurable by custom noise level and number of days.
7. The software shall allow for meters to be ignored.
8. The software shall provide a list view of meters with corresponding data including latest acoustic noise value, maximum value, average value, customer side meter alarms such as leaks, and bursts and latest reading date.
9. The software shall have the ability to correlate active alarms to determine if the leak may be before or after the meter.
10. The software shall provide integration of distribution pipe layer network to know where meters are in relation to distribution main lines and utility service lines.
11. The software shall be able to export data in CSV and PDF formats.

### B. District Metering Analysis

1. The software shall allow a geographical map view with color coded districts to easily visualize which zones are normal versus exceeding the custom water loss limit set for the district.
2. The software shall have a list view with meta data for different districts.
3. The software shall display graphical representation of consumed water, supplied water and water loss selectable by user.

4. The software shall have KPI reporting based on water loss during the last 24 hours, week and month. The software shall have an intuitive drawing tool to create districts.
5. The software shall provide integration of distribution pipe layer network to know where meters are in relation to distribution main lines and utility service lines.
6. The software shall allow the manual inputs for compensated water used such as pipe flushing.
7. The software shall have an alarm system to indicate if a water balance is moving in a wrong direction.
8. The software shall have advanced algorithms to monitor and estimate water balances. The software shall be able to calculate missing consumption data through extrapolation.
9. The software shall be able to integrate with third party district meters from other systems, such as a SCADA.
10. The software shall be able to analyze the correct configuration threshold for larger meters. The software shall be able to show the data performance on district levels.

## **PART 3: EXECUTION**

### **3.01 INSTALLATION**

- A. All equipment, hardware, and software shall be installed in accordance with the manufacturer's recommendations.
- B. Meters
  1. All meter install locations shall be collected with high resolution GPS (3-foot minimum horizontal accuracy) along with all pertinent information including but not limited to service address, meter size, meter/radio identification numbers, and all other collectible attributes determined during project kickoff meeting(s). This data shall be transmitted to the Town in shapefile and .xlsx file formats, at minimum. Proposed methodology for this data collection should be discussed in the proposal.
  2. The meter may be installed at any angle and position with no minimum straight pipe to meet applicable AWWA accuracy standards. The meter shall allow an external antenna to be mounted when required.
  3. When the meter is installed, the use of a mobile application shall confirm that the meters signal is being received by one or more data collectors and verify the signal strength to determine whether the installation is good before leaving the installation site.
  4. All accessories necessary for the proper installation of meters to existing setters and pipe configurations (spools, reducers, adapters, etc. for lay length and otherwise) shall be supplied and installed by the Proposer at no additional cost to the Owner.

- C. Data Collectors: The collector shall be plug and play without requiring programming of the base box alleviating the necessity of IT resources. All firmware upgrades shall be performed automatically over the network without the need for user intervention.

### **3.02 QUALITY CONTROL AND FIELD TESTING**

- A. Quality Control: The manufacturer shall furnish the services of a qualified technical representative for a minimum of two (2) days to inspect the installation and provide start-up, field testing and operator training services.
- B. Field Testing: The Proposer and the manufacturer's representative shall demonstrate to the Owner that the equipment operates as designed and specified.

### **3.03 SPARE PARTS/SUPPORT**

- A. The meter system supplier shall provide hardware/software support for a period of one (1) year after installation, acceptance, and start-up of AMI system at no additional cost to the Owner.

**END OF SECTION**