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September 19, 2014

Mr. Richard M. Carnevale, P.E.
Director of Public Works
Town of North Reading
235 North Street,
North Reading, MA 01864-1298

Re: Water Meter & AMR Evaluation

Dear Mr. Carnevale:

Weston & Sampson Engineers is pleased to provide this evaluation report for water meter replacement and automatic meter reading (AMR) system implementation. The purpose of this report is to provide a general feature and functionality comparison for mobile and fixed network AMR systems, provide budgetary program pricing and payback period, and communicate key design, procurement, and implementation issues which the Town of North Reading ("the Town") will need to manage.

In summary, to improve meter reading and billing efficiency, equity in billing, and quality of customer service, Weston & Sampson recommends the following:

1. Replace all meters of service life greater than 15-years. This includes approximately (4,000) 5/8-inch meters and (25) 3/4-inch meters.
2. Replace the existing water meter reading system either a mobile (drive-by) automatic meter reading system or a fixed network automatic meter reading system. Each system has an advantageous payback period. A mobile AMR system will deliver the baseline benefits of advanced metering systems, including operational efficiency, enabled monthly billing, and reliable read acquisition, all while keeping cost down and maintaining simplicity of system operation and maintenance. A fixed network system would enable advanced functionality, such as on-demand meter readings for customer move-in/move-out, acquisition of interval data for customer complaint review, water ban enforcement, and customer-side leak detection, but it requires significant organizational commitment to implement and operate.
3. Procure equipment utilizing a request for proposal (RFP) where the Town may award to the most advantageous proposer.
4. Install meters & RF modules with a water meter installation contractor. The Town would utilize an invitation for bid (IFB) for construction services to secure a contractor. This option would allow a one-year implementation program, and reduce demand on Town staff.

## 1.0 Background

Town records indicate that the system includes 4,866 active water meters sized from 5/8-inch to 2-inches. All residential water meters and reading devices in the system are owned and

maintained by the Town. Commercial meters are purchased and maintained by the customer. Town water meters are positive displacement type meters manufactured by Neptune. Some 1 ½ and 2-inch meters may be turbine or compound type meters. Ninety-five percent (95%) of the metered accounts are residential, approximately five percent (5%) are commercial and industrial, and less than one percent (<1%) are municipal. Table 1 provides a summary of water meters by size. Table 2 provides a summary of the age of water meters, according to Town billing system records.

**Table 1: Active Water Meter Inventory by Size**

| Meter Size | Meter Quantity | Percentage |
|---|---|---|
| 5/8 | 4,186 | 86% |
| 3/4 | 625 | 13% |
| 1 | 26 | <1% |
| 1 1/2 | 11 | <1% |
| 2 | 18 | <1% |
| Total | 4,866 | |

**Table 2: Water Meter Inventory by Age**

| Age (Yrs) | Number of Meters | Percentage |
|---|---|---|
| ≥21 | 3,358 | 69% |
| 16-20 | 661 | 14% |
| 11-15 | 326 | 7% |
| 6-10 | 318 | 6% |
| 0-5 | 203 | 4% |
| Total | 4,866 | |

Existing metering assets are strictly utilized for water billing purposes. The Town does not provide sewerage services to customers, nor does it anticipate utilizing their water metering assets for sewer billing in the foreseeable future. Town water rules & regulations require meter pits for large diameter services of significant length.

The DPW has one staff member trained in administration of the meter reading, among other job responsibilities. The existing water meter reading process requires the reader drive approximately 8,000 miles driven per year. At IRS standard mileage rates of $0.56 per mile, this amounts to $4,480 per year. Most water meters in the Town are wired to Neptune touchpads, mounted to the exterior of the building. This system requires the reader to physically touch the pad to obtain a reading. Wiring from the meter to the touchpad includes three-wire induction coupling. In addition to the touchpad system, small quantities of Neptune R900 walk-by mobile AMR modules have been deployed. The cost for maintenance and license for the existing meter reading hardware and software is approximately $5,000 per year.

The Town has a three tier increasing block water rate structure. Current water and sewer rates are attached in Appendix A. The Town does not abate water leaks identified on the customer premise.

## 2.0 Automatic Meter Reading

Automatic Meter Reading (AMR) systems allow a community to automatically retrieve meter readings through radio transmissions without having to enter the customer's home or facility or access their property. The two general categories of AMR systems widely used today are mobile and fixed-network. The basic components of an AMR system, either mobile or fixed-network, include the data transmitter (RF module) that is connected to the water meter and the data collection units (collector) which collect, store, and transmit the meter readings to the network control computer (NCC). The term Advanced Metering Infrastructure (AMI) is used to describe fixed network AMR systems enabled with two-way communications and functionality beyond meter reading for billing, such as acquisition of interval reads and event flags such as leak and tamper identification.

RF modules can be integrally mounted on a water meter register or remotely mounted on the interior or exterior of the building and connected to the water meter register with wires. All AMR systems offer tamper-resistance features that notify the meter reader when the register or RF module has been tampered with. Batteries power the RF modules. Most manufacturers provide a full warranty of 10 years and prorated warranty for years 11 to 20. RF modules often are capable of meter reads at intervals as small as 1-hour.

### 2.1 Mobile AMR Systems

For a mobile system, the data collection unit is typically a laptop computer with a mobile transceiver. Handheld units are generally used for backup and final reads. With a mobile reading system, a meter reader drives by a customer's home or business to acquire meter readings. The transceiver receives the reading and the mobile computer records and stores the meter reading. Operators are able to view reads and event flags as they come in. When the readings are ready to be transferred to the billing software, they are uploaded from the portable computer to another computer that will handle the data and billing.

Mobile AMR systems allow for improved meter reading efficiency and improved read data consistency. Reading for billing may be performed much more quickly with drive-by reading, and automated collection reduces the opportunity for manual entry errors. Key operational benefits enabled by mobile AMR systems include:

- Reduced number of estimated bills.
- Reduced administrative time and errors entering meter read data.
- Meter readers do not have to enter the property in order to obtain meter readings.
- More efficient meter reading operations.
- Allow the Town to transition to monthly billing. More frequent meter readings and bills will allow customers to better budget themselves and improve cash flow for the Town.

Mobile systems are generally less expensive to implement than fixed network systems. Mobile RF modules range from zero (0%) to twenty (20%) percent cheaper than fixed network RF modules, depending on manufacturer. Mobile data collection systems expense includes only a mobile transceiver and laptop, as compared to fixed network's collector siting and installation, accommodation for power & communications, and maintenance/leasing fees. A budgetary estimate for a mobile AMR system is included in the "Project Costs and Payback Period" section of this report.

If the Town prefers a mobile system, but wants the ability to upgrade to a fixed network system in the future, several vendors offer "hybrid" systems. RF modules in such a system, upon signal from a fixed network collector, change from mobile to fixed network operational mode. These RF modules are typically priced in-line with fixed network modules. Drawbacks to hybrid systems include greater upfront expense for hybrid modules, and additional expense at the time of transition including software replacement and purchase and installation of collectors.

**2.2 Fixed Network Advanced Metering Infrastructure (AMI)**

With fixed network systems, meter reads are transmitted to fixed data collection units located at points of high elevation in the service area, such as utility poles, buildings, or water storage tanks. To avoid the additional cost of renting space on utility poles, data collection units should be located on buildings or structures owned by the Town. Many of the manufacturers have solar powered data collectors, which can eliminate the need for an external power source. The data collectors send the meter reading data back to the utility network control computer (NCC), either via radio signals, cell phone technology, modem, fiber optics, or WiFi network.

Fixed-network AMI collects more data, more frequently, than mobile AMR systems. They also can include 2-way communications with the RF module. Mobile systems transmit data to the utility when meter reading routes are driven, typically for billing purposes, while fixed-network systems typically transmit data to the utility one to six times per day. Additional benefits enabled by AMI include:

- Eliminate truck rolls for all manner of reading operations, including off-cycle readings such customer changes and home closings.
- New customer service offerings including efficient customer-side leak detection and proactive customer notification. Fixed networks allow for leaks to be flagged in days, instead of months, thereby preventing additional property damage, municipal water loss, and customer charges.
- Detect meter tampering and stuck meters through zero usage flags and tamper alarms.
- Detect reverse flow events to identify backwards meters and backflow events.
- Remote troubleshooting, programming, and firmware upgrading with two-way communications.
- Reduce customer inquiry call duration by providing better analytical tools and granular usage history. Information lets customer service representatives be better informed and helps customers understand their usage better.
- Enable resource conservation and resource management initiatives, including conservation-oriented rate programs, water-ban enforcement, and customer specific education programs, if desired.
- Provide infrastructure for new distribution system technologies, including distribution system leak detection, pressure monitoring, and remote shutoff, if desired.
- Audit unaccounted-for water with time-synchronized comparison of consumption on master meters and revenue meters.

Proactive customer service enabled by AMI can provide real benefits to the municipality and the customer. An example is observed in a Massachusetts community which detected a water leak inside a customer's home. The municipality's staff noticed very high usage and called the customer to notify them of the usage. The customer did not answer the phone call, so the Police Department was notified. The Police Department was dispatched to the customer's home and noticed a large leak in the basement. They were able to identify that the customer

was on vacation, so they shut the water service off, preventing further damage to the customer's property and water loss.

Fixed-network systems are generally more costly than drive-by mobile read systems due to upfront capital costs associated with the network of fixed data collection units. In the past, line of sight issues created problems in some communities using fixed-network systems, requiring the installation of additional data collection units or repeaters to acquire adequate coverage. However, the increased application and capability of fixed-network systems has reduced the quantity and cost of data collection units required. Another item to be aware of is that fixed network systems do require significant support by local IT staff to implement and maintain. It benefits a project to engage IT early in the planning process and keep them involved through implementation and ongoing system maintenance. A budgetary estimate for purchase of fixed network AMI equipment, including installation of collectors and configuration of network control hardware and software, is included in the "Project Costs and Payback Period" section of this report.

## 3.0 Water Meter Accuracy, Testing, and Revenue Loss

### 3.1 Meter Testing and Calibration

As with any mechanical device, water meters are subject to wear and over time begin to lose their accuracy. When meters start to lose their accuracy it is generally not in favor of the utility, most often the water meter under registers water flow, which results in lower readings and higher unaccounted-for water and therefore some rate payers subsidizing other rate payers. The factors that affect water meter accuracy include water quality, rate of flow, and chemical buildup or abrasive material carried by the water. The only way to determine if a meter is registering flow accurately is to test it. However, many utilities do not regularly test water meters, especially small meters, because the labor is costly and the process is time consuming (i.e. the cost of meter testing may approach the cost of meter replacement). Instead of budgeting to test small meters, utilities typically budget to replace meters when they reach a specified age.

The Department of Environmental Protection's (DEP) *Guidelines and Policies for Public Water Systems* states that the normal life expectancy of water meters ranges from 7 to 15 years. A study in the Journal of the AWWA concluded that the economical optimal time to replace ½-inch positive displacement water meters is 15 years.[1] Both AWWA and DEP recommend that meters be systematically checked for accuracy.

Slight meter inaccuracies can result in a large revenue loss, especially in the larger meters. It is good practice to test the large meters in accordance with AWWA recommended frequency to ensure that they are maintaining their accuracy. If the results of the meter testing indicate that the meters are not within the accuracy range then the meter should be replaced or refurbished. The AWWA recommended testing frequency for water meters is shown in the Table 3.

**Table 3: AWWA Recommended Testing Frequency**

| Meter Size (inches) | Type | Frequency (Years) |
|---|---|---|
| 5/8 | Positive Displacement | 10 |

[1] Michael D. Yee, "Economic Analysis for Replacing Residential Meters", Journal AWWA, July 1999, Vol. 91, #7, pp. 72-77

| | | |
|---|---|---|
| 3/4 | Positive Displacement | 8 |
| 1 | Positive Displacement | 6 |
| 1 ½ - 2 | Positive Displacement | 4 |
| 2 | Compound/turbine/fire | 4 |

The inaccuracies from an improperly functioning meter, or incorrectly sized meter, can be result in substantial lost registration. Because larger water metered customers generally consume more water than smaller meters, a small degree of inaccuracy in the larger meters could result in significant revenue losses for the Town. In addition to meters under registering, meters that are not appropriately sized for their applications can result in significant revenue loss. The AWWA M22 Sizing Water Service Lines and Meters Manual provides sample forms that can be utilized to determine the appropriate meter size.

### 3.2 Meter Accuracy and Revenue Loss

The study in the Journal of the AWWA cited on the last page used statistical sampling to determine ½-inch water meter accuracy based on the age and material of the meters in Alameda County Water District in Fremont, California. The meter accuracy degradation profiles presented therein indicate registration reduction for small residential meters with plastic measuring elements at 0.3 to 0.5 percent per year the meter has been in service.

Estimated annual revenue loss from unrecorded consumption due to under-registering meters is presented in Table 4. The model uses an annual meter accuracy reduction of 0.30%, per the cited AWWA study. The number and age of existing meters was per information provided by the DPW. Average consumption per meter was calculated based on total volume of annual billed consumption asserted in the Town's 2013 Annual Statistical Report.

**Table 4: Estimated Annual Revenue Loss from Unrecorded Consumption**

| Age | Quantity | Est. % Accuracy | Unrecorded Consumption Per Meter (Gallons) | Unrecorded Consumption Subtotal (Gallons) | Revenue Loss per Meter | Revenue Loss Subtotal |
|---|---|---|---|---|---|---|
| 1 | 45 | 99.70% | 225 | 10,106 | $2.46 | $111 |
| 2 | 38 | 99.40% | 450 | 17,094 | $4.93 | $188 |
| 3 | 38 | 99.10% | 676 | 25,680 | $7.41 | $282 |
| 4 | 41 | 98.81% | 902 | 36,999 | $9.90 | $406 |
| 5 | 41 | 98.51% | 1,130 | 46,318 | $12.39 | $508 |
| 6 | 71 | 98.21% | 1,358 | 96,397 | $14.89 | $1,057 |
| 7 | 75 | 97.92% | 1,586 | 118,978 | $17.40 | $1,305 |
| 8 | 56 | 97.63% | 1,816 | 101,681 | $19.92 | $1,115 |
| 9 | 63 | 97.33% | 2,046 | 128,884 | $22.44 | $1,414 |
| 10 | 53 | 97.04% | 2,277 | 120,656 | $24.97 | $1,324 |
| 11 | 74 | 96.75% | 2,508 | 185,589 | $27.51 | $2,036 |
| 12 | 83 | 96.46% | 2,740 | 227,428 | $30.06 | $2,495 |
| 13 | 58 | 96.17% | 2,973 | 172,430 | $32.61 | $1,892 |
| 14 | 42 | 95.88% | 3,206 | 134,671 | $35.17 | $1,477 |
| 15 | 69 | 95.59% | 3,441 | 237,408 | $37.74 | $2,604 |
| 16 | 266 | 95.31% | 3,676 | 977,719 | $40.32 | $10,726 |
| 17 | 67 | 95.02% | 3,911 | 262,056 | $42.91 | $2,875 |
| 18 | 105 | 94.74% | 4,148 | 435,502 | $45.50 | $4,777 |
| 19 | 109 | 94.45% | 4,385 | 477,933 | $48.10 | $5,243 |
| 20 | 114 | 94.17% | 4,622 | 526,963 | $50.71 | $5,781 |
| 21 | 128 | 93.89% | 4,861 | 622,205 | $53.32 | $6,826 |
| 22 | 669 | 93.60% | 5,100 | 3,412,030 | $55.95 | $37,430 |
| 23 | 2,489 | 93.32% | 5,340 | 13,291,577 | $58.58 | $145,809 |
| 24 | 72 | 93.04% | 5,581 | 401,816 | $61.22 | $4,408 |
| Total | 4,866 | | | 22,068,120 | | $242,087 |

The model suggests that approximately 22 million gallons of consumption, or 6% of the Town's total registered consumption, may be unrecorded due to under-registering meters. This results in approximately $242,087 in annual unbilled water revenue, of which $223,874 is attributable to meters older than 15-years in-service, assuming an average water rate on margin of $10.97 per thousand gallons (tier 2 rate). For reference, the 2013 Annual Statistical Report asserts unaccounted for water at 17%. A meter replacement program would eliminate unregistered flow and revenue loss associated with the oldest meters in the system.

## 4.0 Project Management and Implementation

### 4.1 Procurement

There are a few alternatives that can be used to procure meters and AMR. While some communities have used solely a criteria based proposal process, the two most widely used alternatives are public bidding or a combination of proposal and public bidding. A public bid for the purchase of the AMR system and water meters would specify the requirements for the water meters and AMR system and would require the Town choose the lowest responsive bidder that can provide a system that meets the specifications. A proposal/public bid would allow the Town to use its discretion in selecting a system based on pre-determined criteria, not necessarily based on lowest price. Typically in a request for proposal (RFP), the Town would request that the strongest candidates provide a presentation of their system.

Separating the purchase of equipment from installation is one way to minimize contractor markups and reduce overall project costs. However, it also eliminates the ability to have one party responsible for a complete and operational system. This is generally handled by ensuring that there is language in both the equipment supply and installation contracts that clearly identifies the responsibilities of the supply contractor and the installation contractor. The supply contractor is usually responsible for training the installation contractor on the proper installation of the equipment. If meter readings cannot be obtained because the equipment is faulty, then the supply contractor is responsible for supplying new equipment. If the meter cannot be read because of an improper installation, then the installation contractor is responsible for correcting the issue. Another disadvantage of separate equipment purchase and installation contracts is that administration of the program requires more time due to an increased level of coordination between the equipment supplier and installer.

The preferred implementation option discussed with the Town is a two-step purchase and installation option. The first contract will include the supply of AMR system and all water meters, registers, and RF modules. The Town would have the option to award to the most advantageous system per technical proposal, price, and qualifications. The second contract would be bid for installation of water meters, registers and RF modules. The contract would be awarded to the lowest responsive bidder. The supply contract should be set up as a two year contract. The water meters and reading equipment would be purchased in year one, and implementation services, maintenance, and support agreements would be included for each subsequent year.

### 4.2 Implementation and Strategies

There are several potential issues that may occur during a water meter replacement and meter reading system upgrade program. While it is impossible to predict every issue that may occur during purchasing and construction, those issues most likely to occur and methods to mitigate their impact on the project are presented in this section of the report.

*4.2.1 Public Outreach*

Public support for water meter replacement and AMR implementation is essential. Since the customers will pay for the project it will be imperative for the Town to actively involve the community from the onset of the project. A public education/outreach campaign should be developed to address two distinct bodies: governing authorities who will approve the project funding/financing and secondly all the customers.

The public outreach program for the governing authorities would include the following:

- Project Financials
  - Cost of the program
  - Program financing/funding options
  - Operation & Maintenance cost savings of program
  - Revenue recovery
- Schedule
  - Financing and funding timeline
  - Procurement
  - System Installation and deployment
- Customer/Rate Payer Impact (discussed further in customer outreach program)

A public education/outreach program should be developed to inform the customers of the following:

- Why old water meters need to be replaced
- The benefits of a water meter replacement and meter reading system upgrade including:
  - Fair and equitable water bills
  - Better budgeting through more frequent billing (if the Town chooses)
  - Improved customer service
- How the program will impact them and what they can do to make the program go smoother
  - Up to one hour may be needed for the water meter replacement, with typical installations taking 20 minutes.
  - Meters need to be accessible
  - Plumbing issues will have to be addressed by the customer prior to the installation of the water meter
  - New RF modules should be installed on the exterior of buildings. Homes will need to be entered to complete the meter replacement and RF module installation.
- Commercial and Industrial users should be informed that meter replacement and repairs would be scheduled at a time to minimize the impact to their operations.
- Ensure the public that the data transmitted by the automatic meter reading system is protected and that no private information is transmitted.
- Address concerns that the public may have regarding the health effects of the AMR system which operates using radio frequency.

The program should seek to involve and inform the public as this will build trust with the customers. Strategies for involving/informing customers in the design phase of the project might include strategies like:

- Hosting public meetings
- Inviting Public Comment/Questions
- Development of a website related to the program – allow for customers to post questions
- Creating a meter demo with the selected AMR system at a location that has lot of foot traffic (Library, Town Hall)

As the program transitions from design/procurement to implementation the message to the customers changes from general impression information to notification of the actual installation process. This should include multiple types of media/format prior to start and during the meter installation, so that customers are well informed and not surprised when the installer shows up.

There are many methods that the Town can use to disseminate information to their customers including:

- Bill stuffers
- Direct mailings
- Phone calls (reverse 911 system or equivalent)
- Public space advertising
- Public Access television
- Newspaper story
- Information centers at Town Hall, DPW, library, schools and other public spaces
- Public service announcements; radio/television/internet/audio-visual presentations.
- Web page
- Social Networking – Twitter, Facebook, LinkedIn, YouTube

During the installation phase, customers should be notified by mailings that installations will be happening in their area and they will be asked to schedule an appointment with the Town. Appointments will be necessary entry to the property is required. Involving the customers at the beginning of the project will send an important message that the Town is taking this project very seriously and that the customer's willing participation is expected and appreciated.

*4.2.2 Lock-outs*

Lockouts occur when either the customer refuses to schedule an appointment or the customer does not show up for an established appointment. While active public outreach prior to and during the program will result in a high meter installation rate, it cannot be expected that the Town will have a 100% success rate through standard customer notification discussed previously. It should be estimated that two percent of the customers will not respond to the request for home entry. The Town should take steps early in the project to develop a policy for customers do not cooperate. Such a policy may include a large fee/charge assessed to the customer's water/sewer bill after all reasonable attempts have been made to contact the customer. If the fee does not result in a corrective action by the customer, the Town should be prepared to shut off the customer's service. Other communities have found that a large fee generally results in the customer's cooperation and very few have had to resort to turning off a customer's water. Customers who do not respond to the installation contractor's attempt to contact them should be notified by a certified mailing of the actions the Town will take if they do not schedule an appointment on their own.

*4.2.3 Plumbing Problems*

Another potential issue encountered during a meter change out program is that the customer's plumbing does not allow for an "easy" meter installation. If the piping materials are in poor condition and the installation contractor is not comfortable that they can install the meter under the current conditions, the installer notifies the Town of the conditions that were observed. These conditions will not be known until the installer is at the customer's property. Most communities require that customers modify their plumbing prior to the meter being replaced, at the customer's expense. The Town's existing policies include language which will help ensure

customers implement plumbing improvements in a timely manner so that meter replacement can be completed.

*4.2.4 Final Bills & Operation 2-Systems in Parallel*

Operating two reading systems in parallel during transition is challenging for a utility for several reasons. First, the meter reading data must be entered into the appropriate reading program depending on whether the meter has been replaced or not. Second, the final bill on the old meter may be higher than the customer is used to, especially if they have been receiving estimated bills because of problems gaining access to the property. Our recommendation is that once the old meter is removed a final bill be issued based on the final reading of the old meter, even if the bill is off schedule. It is also recommend that the Town hold the meter for up to six months in case a final reading is disputed.

*4.2.5 Resolve Read Issues Before Meter Modernization Project*

The metering project will be more successful if any existing meter reading issues are resolved before the project begins. A key issue is acquiring actual reads at long-term estimated accounts. Customers receiving high bills due to old issues can turn public perception of the project and impact the overall customer responsiveness to the program. It is recommended that the Town initiate a program to acquire indoor register reads for all accounts estimated prior to the start of the meter replacement program.

*4.2.6 Ordinance Review/Update*

The Town should their Water Rules and Regulations to ensure that language is included that allows the Water Department to access the meters and meter reading equipment for maintenance and deters tampering with meter equipment.

*4.2.7 AMR and the Billing System*

A new AMR system would be required to interface with the existing billing system. The Town's existing reading system components could be discontinued from service. In the Town's request for proposals from vendors, the Town should require that the AMR vendor provide references for communities where they interface with the Town's billing system. The AMR vendor should be required to provide all labor and expense required to configure the transfer file for communication of meter readings, event flags, and account data between the systems. A list of acceptable meter reading system interface file formats should be named in the specification. The name and contact information for billing system's representative should be provided in the proposal documents so that proposers understand the scope of work required before costs are submitted.

Meter replacement and AMR deployment programs require extensive updating of customer account records and handling of meter in/out readings. Some billing systems offer meter replacement applications which automate data upload and forgo manual entry. Such systems reduce the opportunity for costly errors and expedite clerical handling. The Town should review with their billing system vendor the availability of a bulk meter replacement module for their use.

*4.2.8 Meter Compatibility & Functionality*

The system should be required to be compatible with any portion of existing meters which the Town intends to retain. Additionally, the resolution, or scale of smallest value transmitted, is important. A resolution of 10 gallons or less is preferred in AMR applications, to enable features such as leak detection and representative interval consumption graphing.

*4.2.9 Data Collector Site Configuration*

Fixed network data collectors and repeaters may be hosted on buildings, water towers, utility poles, or any other elevated sites. Each available AMI system communicates differently, so the number, spacing, and height requirements of data collectors for each system will vary. Typically, repeaters will be required every one to five square miles, depending on the system. Consistent across all AMI systems, those DCUs will require a communication medium to relay reads to the NCC and power supply.

DCU communication mediums include radio signal, cell phone technology, fiber optics, or WiFi network. The easiest option to implement is often cellular (GPRS) technology. These systems do not require extension of communication medium to the proposed site, and generally provide reliable service once configured. The drawbacks include that the units must be sited in a location with adequate coverage, and service is subject to monthly fees per unit. A typical monthly service charge is estimated at $40 per unit per month, or $480 per year per site, with actual costs varying by carrier. Alternatively, if available, fiber optic is a reliable and robust option that may not include service fees based on arrangements with the service provider. It is recommended that the DPW consult with their IT and electrical personnel to review requirements around use of Town fiber and power at municipal facilities. A thorough review of town bylaws around antenna location and height restrictions should be performed before soliciting proposals for fixed network infrastructure requiring such equipment.

*4.2.10 Installation by Contractor or In-House Staff*

The Town has the option to hire a contractor to deploy the meter and AMR system, or to perform the work with in-house operations staff.

In-house installation would eliminate the need to pay Massachusetts prevailing wage for meter installers ($75 per hour), and grant the Town more control and flexibility to implement the program in the manner and schedule they prefer. Another benefit is that it fosters organizational acceptance of the new system and keeps jobs in the community. This option would require staff augmentation with part-time or seasonal help. If a seasonal employee was fully-dedicated to meter replacement and RF module deployment for 9-months of the year, 40-hours a week, they might service approximately 1,500 accounts per year, and complete the system installation in approximately three-years. In addition to dedicated installers, the installation program would require additional resources to help with project management, appointment scheduling, coordination, and data handling. Per discussion with the Town, additional resources to support in-house installation may be problematic.

Contract installation services would expedite project completion (complete the project in one-year) and would ensure adequate resources are turned toward the effort. The organizations that perform these services have project management systems that facilitate customer outreach, project documentation, and project control. Contract installation would require public bidding of the contract and award to the lowest responsive responsible bidder. Strong installation contract documents would be required to obligate quality work, appropriate communication with customers, and return of data in a manner acceptable to the Town. A budgetary estimate for contract installation services is included in the “Project Costs and Payback Period” section of this report.

*4.2.11 Town Involvement during Implementation*

The oversight of the implementation of new water meters and AMR system will require significant effort from the Town. To ensure that the project moves smoothly the Town should

have one contact person for the project that has a thorough understanding of the Town's system and can make decisions on the Town's behalf, a dedicated Project Manager. This Project Manager will answer questions and provide information to the Supply and Installation Contractor, if applicable, and the Engineer as necessary. The Project Manager would act as the liaison between the various Town departments to keep them informed on the project status and obtain information that may be needed.

## 5.0 Project Costs and Payback Period

Budgetary estimates for water meters and a mobile AMR system, water meters and fixed-network AMI, and contract meter & RF module installation services are included in Tables 5, 6, and 7, respectively. The costs presented in this letter report are per 2014 pricing.

**Table 5: Estimate for Mobile AMR System & Water Meters**

| Item Description | Qty | Unit $ | Total |
|---|---|---|---|
| Radio Frequency Module | 4,866 | $82 | $399,012 |
| Mobile Collector & Software | L.S. | $30,000 | $30,000 |
| Handheld Units | 1 | $7,000 | $7,000 |
| Training & Support (3-yr) | L.S. | $10,000 | $10,000 |
| 5/8-Inch Water Meter | 4,000 | $92 | $368,000 |
| 3/4-Inch Water Meter | 25 | $135 | $3,375 |
| | | Subtotal: | $817,387 |
| | | Engineering & Construction Administration: | $78,000 |
| | | Construction Contingency (10%): | $81,739 |
| | | Total: | $977,126 |

**Table 6: Estimate for Fixed Network AMI System & Water Meters**

| Item Description | Qty | Unit $ | Total |
|---|---|---|---|
| Radio Frequency Module | 4,866 | $95 | $462,270 |
| Fixed Network Data Collectors[(1)] | 13 | $10,000 | $130,000 |
| Data Collector Installation | 13 | $4,000 | $52,000 |
| Network Control Hardware & Software | L.S. | $20,000 | $20,000 |
| Handheld Units | 1 | $7,000 | $7,000 |
| Training & Support (3-yr) | L.S. | $20,000 | $20,000 |
| 5/8-Inch Water Meter | 4,000 | $92 | $368,000 |
| 3/4-Inch Water Meter | 25 | $135 | $3,375 |
| | | Subtotal: | $1,062,645 |
| | | Engineering & Construction Administration: | $78,000 |
| | | Construction Contingency (10%): | $106,265 |
| | | Total: | $1,246,910 |

[(1)]Estimated Quantity; actual number of units required vary vendor-to-vendor.

**Table 7: Contract Installation of Meters and RF Modules**

| Item Description | Qty | Unit $ | Total |
|---|---|---|---|
| Installation of 5/8-Inch Water Meter and RF Module | 4,000 | $106 | $424,000 |
| Installation of 3/4-Inch Water Meter and RF Module | 25 | $106 | $2,650 |
| Installation of RF Module Only | 841 | $80 | $67,280 |
| | | Subtotal: | $493,930 |
| | | Engineering & Construction Administration: | $20,000 |
| | | Construction Contingency (10%): | $49,393 |
| | | Total: | $563,323 |

The project payback for water meters with mobile AMR and water meters with fixed-network AMI, with or without contract installation services, is presented in Table 8. The option with the fastest payback period, of 6.0 years, is a mobile AMR system with water meter replacement by Town staff. Additional monetary benefits not included in the calculation include reduced administrative labor through abatement reduction and facilitated billing, and opportunity for improved operational cash flow through transition to monthly billing. While payback period is not applicable to the "No Change" option, it does result in approximately $233,000 per year in existing reading system expense and unregistered revenue loss, relative the mobile AMR system plus meter replacement option.

**Table 8: Summary of Project Payback Period**

| Presented Improvements Options | Upfront Expense ($) | Payback Period (Yrs) |
|---|---|---|
| No Change to Metering Practice | $0 | NA |
| Option 1 - Mobile AMR & Meters Installed by Town | $977,126 | 6.0 |
| Option 2 - Fixed Network AMI & Meters Installed by Town | $1,246,910 | 7.4 |
| Option 3 - Mobile AMR & Meters Installed by Contractor | $1,540,449 | 6.8 |
| Option 4 - Fixed Network AMI & Meters Installed by Contractor | $1,810,233 | 8.2 |

The payback period calculation, including itemized expenses and revenues, is detailed in Appendix B. Modeled payback periods should be considered to begin at the start of installation. A summary of contributing expenses and assumptions are listed below.

- Installation by Town staff includes an allowance of $40,000 for staff augmentation, per year, for three years. Installation by a contractor includes no augmentation of Town staff, and assumes completion in one-year.
- Meter reading system maintenance expenses are per Weston & Sampson estimates, and information provided by the DPW, and include system maintenance fees, service fees, and licensing fees.
- Water and sewer revenue loss due to under-registering meters is per calculation in Section 3.2 of this report, and includes only contributing meters greater than 15-years in service.
- An inflation escalation factor of 2.7% was included where applicable, per US Bureau of Labor & Statistics CPI database for All Urban Customers.

## 6.0 Conclusions and Recommendations

The DEP's *Guidelines and Policies for Public Water Systems* state the normal life expectancy of water meters range from seven to fifteen years. AWWA recommends replacing small meters, 2-inches and smaller, every 15 years. Eighty-three percent (83%) of Town meters are greater than 15-years old. The age of existing meters suggests that they may under-register by 6% in aggregate, and result in $242,000 of unbilled water revenue annually. If the meters are not repaired or replaced, the amount of unbilled water will increase over time.

To improve meter reading and billing efficiency, equity in billing, and quality of customer service, Weston & Sampson recommends the following:

1. Replace all meters of service life greater than 15-years. This includes approximately (4,000) 5/8-inch meters and (25) 3/4-inch meters.
2. Replace the existing water meter reading system either a mobile (drive-by) automatic meter reading system or a fixed network automatic meter reading system. Each system has an advantageous payback period and features advantageous to the Town. A mobile AMR system will deliver the baseline benefits of advanced metering systems, including operational efficiency, enabled monthly billing, and reliable read acquisition, all while keeping cost down and maintaining simplicity of system operation and maintenance. A fixed network system would enable advanced functionality, such as on-demand meter readings for customer move-in/move-out, acquisition of interval data for customer complaint review, water ban enforcement, and customer-side leak detection, but it requires significant organizational commitment to implement and operate.
3. Procure equipment utilizing a request for proposal (RFP) where the Town may award to the most advantageous proposer.
4. Install meters & RF modules with a water meter installation contractor. The Town would utilize an invitation for bid (IFB) for construction services to secure a contractor. This option would allow a one-year implementation program, and reduce demand on Town staff.
5. Plan for success through deliberate public education/outreach, an effective procurement process, and sufficient allocation of office, field, and project management resources during implementation. Engage sufficient internal or external resources to support these efforts.
6. Resolve foreseeable billing issues, including long-time estimated reads, prior to the start of the meter replacement program.
7. Initiate discussions with the billing system provider to determine if a bulk meter replacement module is available. The system would improve accuracy, and ease, of data entry associated with meter replacement and AMR system deployment.

The RFP published by the Town would solicit a two year agreement with vendors for meters & an AMR system, allowing purchase of equipment and services as needed throughout implementation. If the Town intends to install the meters and AMR modules with their own forces, W&S recommend augmenting staff with at least one additional seasonal or part time employee. Budgetary cost for supply of a mobile (drive-by) AMR system plus water meters sufficient to replace those older than 15-years, is $977,126. Budgetary cost for supply of fixed network AMI plus water meters sufficient to replace those older than 15-years, is $1,246,910. Staff augmentation to support installation by Town forces might be estimated at $40,000 per year, for approximately three years, or $120,000. Installation by a contractor over a one-year period is estimated to cost $563,323. The project payback for a mobile AMR system is 6.0 to 6.8 years, depending on installation method. The project payback for fixed network AMI is 7.4 to 8.2

years, depending on installation method. Supply costs include ten percent (10%) contingency and engineering design, procurement, and construction administration services.

If you have any questions concerning this report please contact me at (978) 532-1900.

Very truly yours,

WESTON & SAMPSON

Bruce W. Adams, PE
Vice President

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# APPENDIX A

Water and Sewer Rates and Service Fees

# APPENDIX B

Project Payback Period Model