



## TATA & HOWARD

June 13, 2016

Mr. Robert Tozeski, Water Superintendent  
Town of Shrewsbury  
Water and Sewer Department  
100 Maple Street  
Shrewsbury, MA 01545

Subject: Review of Master Meter Recording and Billing System  
T&H No. 3593

Dear Mr. Tozeski,

On June 1, 2016, Tata & Howard, Inc. (T&H) met with the Town of Shrewsbury and Matt Palardy of R.E. Erickson (REE) to review the method of master water meter recording and accounting. In short, the process involves an operator manually taking daily readings for each of the wells, and writing the readings on a pre-printed form. This hand-written data is then entered manually into an Excel spreadsheet, printed, and then kept in the Water Department Office on a monthly basis.

As documented in our letter to you on June 1<sup>st</sup>, T&H assisted REE on February 1<sup>st</sup> of this year, in verifying the calibration of each well flow meter by comparing respective hydrant flows to the meter and SCADA readings. In general, all meters appeared to read correctly. During the site visit on June 1<sup>st</sup>, T&H and REE confirmed the following:

1. The SCADA records minimum, maximum, and average daily flows for each well and the hours of operation. The average flow reading, which is not tied to the flow totalizer, was multiplied by the hours of operation manually so as to yield a daily pumpage total. The SCADA system performs flow totalization at each by summing the flow readings every 1/10 of a second. This computer generated method of flow totalization was compared to the manual calculation, and was found to be relatively the same.
2. All wells except for the Sewell well, are combined and enter the treatment facility. The combined flow entering the facility is monitored by a venturi meter in the underground vault beneath the air stripper towers. The totalized flow for this meter was compared to the sum of the individual flows for the Home Farm and Lambert wells, and found to be relatively the same.
3. Water pumped to the treatment facility passes through the air strippers and enters a clearwell from which the water is pumped to the distribution system. Since there is no true "storage" of water in the facility, the amount of water that enters the facility must exit the facility. A second venturi meter in the vault monitors all flow pumped to the distribution system. The total flow recorded by this meter closely matched the combined flow entering the facility.

Based on the above analyses, T&H believes that the master meters and their recordings are virtually accurate.

As stated, the daily totals for each well are written on a standard form, and then manually entered into an Excel spreadsheet. While there is the possibility of error in the data entry, it is improbable that the errors would amount to an approximate 400 million gallons per year overage as compared to customer meter readings, for multiple years. The one possible constant for error is the equation utilized to sum the daily readings to provide a monthly total. This was checked on the Excel spreadsheet and found to be correct.

Printouts of the monthly well flow total reports are given to the Water Department Office, where they are tabulated at the end of the year.

Based on the above operations review, T&H believes that it is highly unlikely that any differences between the annual well pump totals and the customer meter reading totals is attributed to metering inaccuracies at the wells/water treatment facility.

On June 2<sup>nd</sup>, T&H met with the Water Department to review their billing operations. The Town is in the process of converting all of the approximately 11,360 meters to radio transmitters, but there remain approximately 700 units which still rely on operations personnel to walk up to the home to access the remote reader. All readings are automatically recorded onto a hand-held device, which is then downloaded to the computer at the Water Department Office. The newer, radio transmitter-equipped meters report in gallons down to the single digit, while the older units transmit their data in 100's or 1,000's of gallons, dependent on meter size.

Many of the readings download directly without the need for adjustment, whereas some of the meter readings must be adjusted for proper location of the decimal point due to meter/transmitter calibration. An example was one direct download reading on the order of 0943 having to be scaled to yield a reading of 9,430 gallons.

A printout of all the meter readings is reviewed for any obvious anomalies (i.e.: unusually high or low usage totals) before bills are sent out, and as many as possible are investigated. While some anomalies may go unnoticed, it is unlikely that the few meters that may slip by would amount to an under-registration of 400 million gallons per year. All readings and billings are reported in gallons, so there is no math error in the conversion of gallons to cubic feet of water. In addition, the number of billings mailed out is compared to the total number of services in use to assure that some meter data is not being lost.

From our review of the data collection and billing operations, T&H can find no obvious accounting errors that could amount to the 400 million gallon shortfall as compared to the well pumpage totals.

What is of interest is that the approximate 400 million gallon unaccounted-for total has been noted every year for a number of years, which indicates that something consistent is occurring. If the flow/usage data is correct, which it is believed to be, then the only explanation is a major leak or some other form of constant discharge that has not been detected to date. However, numerous leak detection studies have failed to uncover any discharges that resulted in any notable reduction in the approximate 1.2 MGD daily loss. Another possibility is a faulty pump check which would allow water to flow back into a well or clearwell undetected. However, this would be limited to occurring only at the Sewell well since:

1. Any faulty check valves on either the Home Farm or Lambert wells would result in the combined raw and finished water meters at the treatment facility yielding a flow less than the sum of the operating wells, which is not the case.
2. A faulty check valve on any high lift pump at the treatment facility would yield a discrepancy between the combined raw water and finished water flow readings, which is not occurring, with the excess water being discharged via the overflow.

The Town has indicated that the check valves have been inspected, and static well levels were monitored for any indication of higher than normal water levels in the well, which would be indicative of flow reversal.

As a result of our investigations, T&H offers the following recommendations in attempting to determine the loss of water:

1. The Town is divided into 4 pressure zones, three of which are served by booster pump stations with flow meters. However, meter readings currently cross pressure zone boundaries, resulting in the inability to compare pressure zone usage versus the quantity of water being pumped into the respective zone. It is recommended that each service meter be linked to its respective pressure zones so that the usage within a zone can be compared the respective booster station pumpage records. This would allow for narrowing the location of any large supply/consumption anomalies to a given pressure zone.
2. It is our understanding that the Town has retained the services of the same leak detection company in recent years, and is about to obtain quotes for the next round of leak detection. T&H recommends that the Town utilize the services of a different company in that:
  - a. The exact same testing methods and protocols are not followed, yielding the same results.
  - b. The testing company may have encountered unusual circumstances in other cities/towns which may lend knowledge to alternate testing protocols/methods that may assist in locating any leaks not detected previously.
3. Any abandoned water mains that are still tied into the distribution system and segregated solely by a closed valve, should be leak inspected in that the valve may not be fully closed or is leaking by, and allowing water to escape from any cracks or abandoned water services on that main.
4. All known blow-offs, bleeder lines, and abandoned water services should be inspected. It is of interest to note that an open ended 1.5 inch diameter water service at a system pressure of 90 PSI can discharge up to 620 gallons per minute.

Mr. Robert Tozeski  
Water Superintendent

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Should you have any questions, please do not hesitate to contact our office.

Sincerely,

TATA & HOWARD, INC.

A handwritten signature in black ink that reads "Paul B. Howard". The signature is written in a cursive style with a large, sweeping initial "P".

Paul B. Howard, P.E.  
Senior Vice President



June 1, 2016

Mr. Robert Tozeski, Water Superintendent  
Town of Shrewsbury  
Water and Sewer Department  
100 Maple Street  
Shrewsbury, MA 01545

Subject: Master Meter Calibration Flow Tests  
Job No. 3593

Dear Mr. Tozeski,

On February 1, 2016, Tata & Howard, Inc. assisted the Town of Shrewsbury with performing flow tests to check the accuracy and calibrate the magnetic flow meters and the corresponding SCADA reading for the Home Farm, Lambert, and Sewell Wells. R.E. Erickson tested and calibrated the meters, while Tata & Howard performed the hydrant flow tests to determine the actual flow from each well. Attached is a summary table of the results from the flow tests.

Should you have any questions, please do not hesitate to contact our office.

Sincerely,

TATA & HOWARD, INC.

Paul B. Howard, P.E.  
Senior Vice President

Attachment

Well Name	Test Time	Hydrant Reading	Mag Meter Reading	SCADA Reading	Notes
1 Home Farm Well 6-1	9:10am	910-920 gpm	910-912 gpm	912 gpm	Flows appear to match Gate valve could not be shut completely and water was entering the system instead of going out of the hydrant
2 Home Farm Well 6-3 (Test 1)	9:35am	380 gpm	380 gpm	380 gpm	Gate valve could not be shut completely and water was entering the system instead of going out of the hydrant
3 Home Farm Well 6-3 (Test 2)	9:53am	540-580 gpm	696 gpm	704 gpm	Gate valve could not be shut completely and water was entering the system instead of going out of the hydrant
4 Home Farm Well 6-4	10:22am	680-700 gpm	688 gpm	689 gpm	Flows appear to match Parko valve at well caused surging because of lack of backpressure.
5 Sewell Well No. 4	10:55am	500-700 gpm	530-650 gpm	600 gpm	Hydrant was shut down and well was pumped to distribution system. Mag Meter and SCADA readings were within 1%.
6 Lambert Well 6-2	11:50am	530 gpm	536 gpm	536 gpm	Flows appear to match Used flow tube and pitot gauge. First reading was 16 psi. Cleaned out pitot blade and gauge; second reading was 18 psi. Third reading was 22 psi. None of these readings match 310 gpm, however, visual inspection of flow appears to match Mag Meter and SCADA reading.
7 Lambert Well 6-3	12:10pm	177 gpm	310 gpm	310 gpm	