

# Commonsense Water Billing

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**Abstract:** *Metering is clearly important in reducing water consumption and financing water supply systems. However, it must be recognized that metering can be imperfect, and common sense needs to be applied to avoid egregious charges. After successfully challenging a water bill, and subsequent posting of the result on the web, the author was contacted by others who were questionably billed and has otherwise learned of additional examples of obviously faulty water bills. Such examples and other reports are discussed herein, with the hope that some reduction in questionable billing can result. On the other hand, water theft can be an issue and an example of that is presented.*

**Keywords:** *Flow metering; Expert witness; Forensic engineering; Pipe flow; Water supply systems .*

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## I. Introduction

Metering is clearly important in reducing water consumption (e.g., Tanverakul and Juneseok, 2013 [1]) and financing water supply systems. However, it must be recognized that metering can be imperfect, and common sense needs to be applied to avoid egregious charges. After successfully challenging a water bill, and subsequent posting of the result on the web, the author has been contacted by others who were questionably billed and has otherwise learned of additional examples of obviously faulty water bills. Such examples are discussed herein, with the hope that some reduction in questionable billing can result.

## II. Initial Example

The writer was engaged by a forensic engineering firm regarding a water bill dispute involving an automobile dealership on Cape Cod. Unfortunately the owner of the dealership had to hire an engineer and a lawyer to win this case. The owner had a positive-displacement flow meter of the common nutating-disk type, consisting of a nutating primary element through which the flow traverses, and a secondary element which receives information from the primary element and converts it to a readout that may be locally displayed and/or telemetered to a passing vehicle or a central location.

In this particularly egregious example, in which the author served as an expert witness, the dealership was charged by the municipal water company for a nearly 50-fold increase in municipal water usage (and water-usage-based sewer bill) [2]. The author presented the following arguments: (1) with any reasonable street water pressure and any conjectured leak location in the dealership's piping, it would be impossible to hydraulically convey the claimed rate of flow through the system; (2) the author debunked the water company's "leaky-toilet" theory because even 2,500 gallons per day of additional water consumption caused by five perpetually leaking toilets would explain only a small fraction of the water bill; (3) the misreading by the water meter was readily explained. The absurdity of the water company's claims was recognized by the Appellate Tax Board, which found in favor of the author's client. That Board abated the water-usage charges such that the client was only required to pay 1/50<sup>th</sup> of the bill.

The following additional details are excerpted from the case docket [3]

"This is an appeal... from the refusal of the appellee to abate water-usage charges imposed on the appellant for the period reflected in the June 26, 2002 water bill...."

"**FINDINGS OF FACT AND REPORT...**The appellant presented the testimony of two witnesses to prove that the June 26, 2002 water bill was excessive and should be abated. The appellant's first witness was Peter Stagg, the president, treasurer, and general manager of Stagg Chevrolet, an automobile dealership....He testified that the

Subject Property first utilized town water in October 1985, having previously relied on well water. The water usage at the Property remained generally uniform until 1992 when the appellant received a bill for 4,828,000 gallons of water usage over a six-month period. After the water meter that recorded the water usage for that bill

was replaced and the Harwich Water Board had granted an abatement, the water usage at the Property returned to normal until June 2002. Then, once again, Stagg Chevrolet received a bill in the amount of \$9,083.45 for over 4,000,000 gallons of water usage at the Property. After that water meter was replaced, water-usage readings again returned to a more typical range of approximately 79,000 to 110,000 gallons per six-month period.

After filing for abatement, Mr. Stagg testified that he received a letter dated August 21, 2002 from the Harwich Water Board which enclosed a photocopy of a letter dated July 23, 2002 from Regan Supply & Testing Service (“Regan Testing Service”). The Regan Testing Service letter indicated that the water meter that had been recently removed from the Subject Property had been tested and was slightly under-estimating the amount of water being used. Following a subsequent hearing with the Harwich Water Board in September 2002, which resulted in another letter from the Harwich Water Board refusing the appellant’s request for abatement, Mr. Stagg retained the services of S. David Graber, an engineer, to evaluate the situation...

The appellant’s second and final witness was Mr. Graber, who is a registered engineer in Massachusetts and New York....In performing his evaluation, Mr. Graber reviewed the Property’s historical water-usage record; the measurements, schematics, and readings, including pressure data, supplied by Mr. Stagg; and the Neptune water meter test report from Regan Testing Service. Mr. Graber also reviewed information provided by the manufacturer of the water meter in question relating to pressure drops and information regarding the particular back-flow preventor on the appellant’s water system, which is located just downstream of the water meter to prevent the back-flow of contaminated water into the public water system.

....Mr. Graber theorized that the water meter in question incorrectly read the water usage at the Subject Property during the Period at Issue because the meter “jumped and dragged” an adjacent dial or dials along with it. This jump caused at least the seventh- or millionth-place digit of the meter’s mechanical-counting system to over-rotate and erroneously display a higher number in that place. Mr. Graber confirmed the possibility of just such a mechanical-counting-system failure with the manufacturer of this particular Neptune meter and model, which has not been manufactured since 1981. Mr. Graber further testified that the test of the subject water meter conducted by Regan Testing Service did not use a sufficient quantity of water to test for the mechanical-counting-system anomaly, which, in his view, caused the excessive water-usage reading.

In defense of the water-usage charge, the Harwich Water Board called two witnesses. Its first witness was...[the] Water Superintendent for Harwich....[He] testified that personnel from the Harwich Water Department investigated the appellant’s water pipes and system on four different occasions following the appellant’s receipt of the bill in question and failed to discover any leaks or problems. He further testified that, in his view, Regan Testing Service verified the accuracy of the water meter, which, if anything was under-estimating the water usage at the Subject Property for the Period at Issue. Accordingly, the Harwich Water Board refused the appellant’s request for abatement and stood by its June 26, 2002 water bill....

On the basis of all of the evidence, the Board found that Mr. Graber...presented well-reasoned and documented analyses and theories explaining why the subject water bill was excessive....Neither of the appellee’s witnesses was an engineer, and...[the Water Superintendent’s] speculation that an unattended hose had caused over four million gallons of excess water usage over four months fell far short of Mr. Graber’s credible explanation....

*OPINION*....In ruling that the subject water-usage charge was excessive and should be abated, the Board relied on the well-reasoned and documented explanations offered by Mr. Graber, a licensed engineer with advance degrees and significant experience in hydraulics. The Board’s own analysis of the water bills and usage documentation in evidence also supported abatement....[The Water Superintendents’] conjecture that an unattended hose had siphoned off over four million gallons of excess water over four months fell far short of Mr. Graber’s convincing theory....”

The decision of<sup>1</sup> the Appellate Tax Board was affirmed on appeal [3].

### III. Some Additional Examples Worked By The Author

The posting on the internet of the results of the Stagg case mentioned above resulted in additional requests for the author to investigate similar cases. A sampling of those is discussed here.

#### *Somerville, Massachusetts*

The writer served as a consultant to owners of a one-family town house in Somerville, Massachusetts. The writer prepared an affidavit in this case, which included the following. The water bill was normally on the order of \$150-\$200 for two-, three-, or four-month periods over five years, and they then received a four-month bill in 2007 for \$10,568 which was increasing at a 14% annual interest rate. That water bill was 35 times the long-term average for comparable periods. The water department suggested a toilet leak; the homeowners hired

a plumber to look for leaks and none were found. There were no exterior taps to blame (nor could toilet leakage under worst-possible conditions account for the quantity of water claimed according to the plumber and this writer agrees). The water department also confirmed that there was no leak, and in June 2007 replaced the water meter with a new one. The original meter was tested by the water department four times and was reported to be close to 100% accurate. A separate set of three tests gave similar results. A total of about 30 gallons was used for the first set of tests and a total of about 90 gallons for the second set. The question naturally arises as to how a meter which when tested exhibits a nearly 100% accuracy can in fact be inaccurate. The meter consists of two parts. The first is the primary portion of the meter (nutating disc), a positive displacement device which, as it ages, can develop leaks and if anything would measure less than the full quantity of water going through it. The other part of the meter is the secondary portion, which acts in a way similar to an odometer. It is connected magnetically and mechanically to the primary portion of the meter and, in essence, counts the number of revolutions of the primary device and converts that number to a useful measure of water volume. As this component ages, it can perform erratically, and jump as the dials turn, thus measuring more, and in some cases much more, than the actual quantity of water going through the meter. The author confirmed that older meters can malfunction in this manner ("number drag") with a technician at Neptune Company, manufacturer of the meter. A short-term test is generally incapable of determining the type of accuracy reported by the water department. The 120 gallons of total water metered during the city's two tests is less than one-hundredth of one percent of the amount of water metered during the period in question, not nearly enough to test the accuracy of the secondary device. The meter company indicated, based on the serial number, that the meter was about 21 years old at the time of the water bill in question. The Massachusetts Department of Environmental Protection issues permits that require repair, replacement, or recalibration of all individual service meters over ten years of age. During the period of the questionable bill, the homeowners would have had to use an average of 3.9 gallons per minute. The author was able to demonstrate that such a quantity could not flow without being very noticeable or causing considerable damage; the homeowners could testify that there was no such damage, and had a statement from their insurance company confirming that they had no water damage during the period in question. The author demonstrated that worst-case assumptions regarding fixture leakage could not possibly account for the amount of water usage claimed by Somerville. After the meter was replaced, the readings returned to normal. During testimony when asked to explain the questioned water usage the City's engineer claimed that there could have been an unnoticeable "pinhole leak", but could not explain how such a leak could account for the claimed quantity of water. That engineer further stated that if the homeowner agreed there had been leakage (which they did not) they would have received a 50% rebatement. Where's the logic? The case was settled by compromise between the homeowner and water department, the homeowner reasoning that the compromise would avoid further engineering and/or legal costs.

### ***Sewer Connection Incentive***

It is common in communities for some or all of the water customers to have individual wastewater disposal systems (e.g., septic tanks and leaching fields). Such customers are most often charged for water service only, although some communities charge those not on municipal sewers but with sewer betterments (for which they have been charged) for sewerage service anyway for the revenue and as an incentive for them to connect. The pros and cons of the latter practice are not addressed here, except to say that individual septic systems can be less polluting and usefully augment groundwater. Another situation that arises is discussed next with reference to a client of the author.

### ***Medfield, Massachusetts***

The author was contacted to serve as a consultant to the owner of a new car wash/gas station/convenience store complex in Medfield, Massachusetts regarding an unusually large combined water/sewer bill. The bill for a particular 6-month period was about 8 times the average of those for one period before the questionable bill and for four periods after that bill (for usage between December 21, 2011 and October 1, 2012). On investigating, the writer discovered that a faulty boot opening in a clean water tank was leaking and a pump prime line had been left on inadvertently during the high-billing period. The author's hydraulic calculations showed that all the lost water could go through the boot opening. Accordingly, the owner did not contest the water portion of the bill. The author advised the owner to read the Town's meter on at least a weekly basis.

However additional issues remained regarding inequity in sewage billing. Of immediate significance was that the boot through which water lost was above groundwater and none of that water would have flowed to the sewer system. The Town's practice was to base the sewer charge on a portion (75%) of the water charge. For the period in question, the sewage portion of the bill was approximately \$43,000. The Town was asked to take the reasonable approach of basing the sewage charge on 75% of the usual water usage based on periods before and after the malfunction. It was pointed out that if the sewage had gone into the sewer, the amount of sewage in

dispute would have resulted in an increase in flow to the Town's wastewater treatment plant of about 20 percent, which was not observed. Nevertheless, the Town took advantage of the situation and denied the request.

A more general issue concerned payment of sewer charges based on a fixed percentage of the water bill. In the case at hand, a sophisticated system recycles car wash water, wasting that when Total Dissolved Solids exceed a prescribed limit based on automatic conductivity metering to avoid water spotting of the vehicles. That wasted water is then replenished by clean water from the Town system. The total amount of clean water taken in makes up the water wasted as just described plus makes up for the water lost as evaporation and carry-out in the car-washing operation. The net result is that about one-fourth of the total water taken from the Town does not discharge to the sewer. That estimate is most likely on the low side, but without a sewage meter one can only estimate. It is also noted that the number of cars washed during the disputed billing period was less than the periods before and after. This all takes into account the fact that sanitary wastes from public and private facilities and a restaurant (totaling 4 low-flush toilets and 5 washbasins) were also discharged to the municipal sewer system.

With the author's assistance, the owner proposed to install a meter to measure the sewage going to the Town's system, to enable billing based on the metered amount (as is done elsewhere – see below). The Town denied that request. That seems unreasonable since the owner is being billed for services that are not actually received. This obviously creates a disincentive to reduce sewage discharge.

Wastewater metering devices and billing for separate water and sewer services are allowed by regulations of the Massachusetts Water Resources Authority (MWRA) [4], which applies to many of the communities in its large eastern- and central-Massachusetts service area (but not Medfield). Some non-MWRA Massachusetts communities also provide for such monitoring and billing. For example, the City of Attleboro, Massachusetts [5] provides that "Any user of the city's sewer system may install and maintain, at his own expense, an individual sewer meter or other measuring device acceptable to the Superintendent. Sewage so measured shall be charged for at the...[sewer use rate]." A car wash in Attleboro was cited by the Attleboro Superintendent that used so much water that it was well worth it to them to install their own sewage meter.

A problem that occurs that requires diligence on the part of water departments is water theft. While working on the Medfield case, the writer learned of a case in which a homeowner installed a well from which he asserted he would draw all his water. The homeowner then installed a bypass around his municipal water meter and proceeded to draw all of his water, including for watering his large lawn, from the municipal system. He was caught by an inspector.

Sewer bills are commonly based on a fraction or multiple of the metered water usage (75 percent in the case of Medfield). An issue that arises concerns requests for subtractive metering of water used for lawn watering to adjust the sewer bill for municipal water that is not returned to the sewer. Two residents who came before the Medfield water and sewer board argued heatedly for installation of a sewer meter to enable an exemption from sewer charges for water used in their outdoor sprinkler system; their request was denied [6] ("Sewer meters" are standard water meters that measure some water not returned to the sewer.) Such metering would be expensive and is not generally done in Massachusetts. Furthermore, Medfield concurs with the Massachusetts Department of Environmental Protection's implementation of policies that discourage outdoor water use in the interest of water conservation.

#### **IV. Some Other Examples**

Another batch of egregious examples was found in Brockton, Massachusetts [7,8]. One of the most notorious ones was that of a homeowner who was told he owed the City \$17,000. That particular homeowner had a dysfunctional outdoor meter (which the City acknowledged) and disputed the City's claim that they had entered his house to read a meter. Thousands of other residents had similar complaints, and the City acknowledged that there had used estimated billing rather than meter readings for six years.

In Randolph, Massachusetts [9] a homeowner's combined water and sewer bill (with the sewer portion based on a multiple of the water bill) jumped from \$349 to \$5,222.60 for a comparable period. The Town claimed the charge was legitimate, despite a plumber inspecting the property and, among other things, reporting the meter to be spinning and making "loud rapid clicking noises" when the water was turned off.

#### **V. Yet Another Example – Dayton, Ohio**

Cases in Dayton, Ohio are quoted from Tobias [10] below. Responses by the City speak for themselves in light of the above.

"Phillip Arszman assumed there had been a mistake when his 65-year-old disabled mother received a \$3,000 water bill last year. After many conversations with the city of Dayton, the frustrated homeowner doesn't feel any differently today. A city employee sent to the house replaced the meter but didn't look for leaks, he said. Arszman eventually decided to pay the bill to keep water running in the duplex he shares with his mother,

whose one-bedroom unit doesn't even have a washer/dryer hookup. 'It doesn't seem fair to me,' he said. 'But I guess I'm stuck with it.' Arszman is not alone. He's among more than a dozen people who called the Dayton Daily News to share their own water woes after reading an article last month about Marc and Judith Hamilton, a Dayton couple who received a \$2,400 water bill for a nine-month period. (The couple has since paid off the bill, thanks to donations.) Asked about the bills, city officials said they are a tiny minority of customers. They said outlandish bills are almost always caused by leaks, sometimes relatively undetectable that add up after going unnoticed for months when city meter-readers aren't able to physically read water meters.

... 'We do see bills that are large, and they normally result from a leak. A leaky toilet is usually the culprit,' said Cheryl Garrett, Dayton's finance director. Mike Nolden, the plumber who inspected the Hamiltons' home after they received their \$2,400 bill, said there's no way a leaky toilet could have caused that much water use. 'You would have to have every faucet in the house running 24 hours a day, seven days a week,' Nolden said. The callers' details varied, as did the amounts they owed. But all said there was no way their water bills could have been so high. 'I don't believe for a minute that much water went through the house ... it must have been a meter error,' said Gary Wagoner, of Kettering, who received his own \$2,400 bill last October for a house he had rented out to a family of three. The meter hadn't been physically read for almost a year by that point. Wagoner hasn't paid any of the bill out of principle, and is considering taking legal action.

Ryan Arnold, of Pinehurst Avenue, received a \$1,800 bill for his family of three after the city performed an actual read following estimates for several billing cycles. 'I was flabbergasted. I was like ain't no way,' Arnold said. Arnold didn't fight the bill and enrolled in a payment plan. 'I just kind of chalked it up to, this is what it is, and I went into a water payment to keep our water from being shut off,' Arnold said. Diane Welborne, Dayton's independent ombudsman, estimates that she takes between 60 and 80 calls a year from people with complaints about water bills. She said the vast majority of the time over the years, leaks — and not the meters — are to blame. 'Running toilets can really do severe damage to a person's water bill. Most people, and I can understand it because I'm a homeowner and a water customer too, most people can't believe it,' Welborne said. Dayton is making a change officials said that should help prevent some of the high bills. They are about 85 percent done replacing old water meters for the city's 57,000-plus customers with new electronic ones, city officials said. The old meters are nearly all past their 20-year lifespan [emphasis added], a point at which they can become prone to inaccuracy, Dayton sewer director Tammi Clements said.

But city spokesman Tom Biedenbarn in an email emphasized the old meters are accurate.... Joe Walsh, a Dayton attorney who has practiced here for nearly 50 years, said he has taken many calls over his career from people who want to challenge their bills in court. But he turns them down because they're not winning cases. 'There's no question about the fact that (water meters) can become faulty and generate erroneous data,' Walsh said. 'But how in the world are you going to prove all of that?' [N.B. The author has demonstrated that in the above.] The city does have an appeals process that in some instances has resulted in bill reductions, although homeowners who want to appeal must first make a 25 percent deposit on late bills, a 50 percent deposit if a shut-off notice has been generated, or a 100 percent deposit if the water has already been shut off.

... Three years ago, Bob Pack, of Stoddard Avenue, received a \$1,400 water bill for three months of water. He appealed and a year later the appeals board decided to knock off \$700, although he's not sure why. Pack, who is retired and lives alone, said his home didn't have any leaks. He wasn't thrilled about paying \$700, which is more than he typically uses in an entire year. 'But it's like they say, you can't fight City Hall or the water department. That's the only reason I took it because ... I didn't know what else I could do at the time,' Pack said. His water bills have since gone back to normal.

... The Dayton Daily News received calls from residents with water bills ranging between \$1,400 and \$3,000 following an article last month about a Dayton couple who received a \$2,400 water bill. City officials say these types of bills are uncommon and nearly always caused by undetected leaks."

## **VI. Summary and Conclusions**

Metering is important in reducing water consumption and financing water supply systems. However, it must be recognized that metering can be imperfect, and common sense needs to be applied to avoid egregious charges. After successfully challenging a water bill, and subsequent posting of the result on the web, the author was contacted by others who were questionably billed and has otherwise learned of additional examples of obviously faulty water bills. Such examples and other reports are discussed herein, with the hope that some

reduction in questionable billing can result. On the other hand, water theft can be an issue and an example of that is presented.

#### **References**

- [1] Tanverakul1, S. A., Juneseok, L. 2013. "Residential water demand analysis due to water meter installation in California." In ASCE 2013 World Environmental and Water Resources Congress. Cincinnati, Ohio: ASCE.
- [2] Stagg Chevrolet, Inc. v. Board Of Assessors Of The Town Of Harwich. 2006. Commonwealth Of Massachusetts Appellate Tax Board, Docket No. F266854, Promulgated: February 1, 2006. <https://www.mass.gov/files/documents/2016/07/wa/06p019.doc>
- [3] Stagg Chevrolet Inc. V. Board Of Water Commissioners Of Harwich. 2007. Appeals Court of Massachusetts, Suffolk. No. 06-P-522, Decided: January 30, 2007. <https://caselaw.findlaw.com/ma-court-of-appeals/1112101.html>.
- [4] Massachusetts Water Resources Authority (MwRA). 2009. "Sewer Use." 10.008(1) Monitoring Devices, August 7, 2009.
- [5] City of Attleboro, Massachusetts. 2012. "Revised Ordinances of the City of Attleboro." Section 16-18 Sewer Use Rates, July 17, 2012.
- [6] Domeshek, D. 2009. "Medfield Sewer Board denies Camden Place residents' bid to exempt sprinklers from fees." Wicked Local Medfield, November 12, 2009. <http://www.wickedlocal.com/medfield/news/x2087395590/Medfield-Sewer-Board-denies-C...>
- [7] Littlefield, A. 2010. "Man says water bill doesn't wash." Boston Globe, November 2, 2010.
- [8] Bolton, M. M.( 2011). "Lien mailing anger residents." Boston Globe, January 9, 2011.
- [9] Reardon, N. 2008. "Water bill is all wet, homeowner says." Patriot Ledger, October 20, 2008.
- [10] Tobias, A. J. 2012. "Thousand-dollar water bills blamed on leaks." Dayton Daily News, November 5, 2012. <https://www.daytondailynews.com/news/thousand-dollar-water-bills-blamed-leaks/RBx3D...>