



American Water Works  
Association



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# **DRBC Workshop**

## **Water System Audits and Water Loss Control**

Bordentown, NJ

April 13, 2011

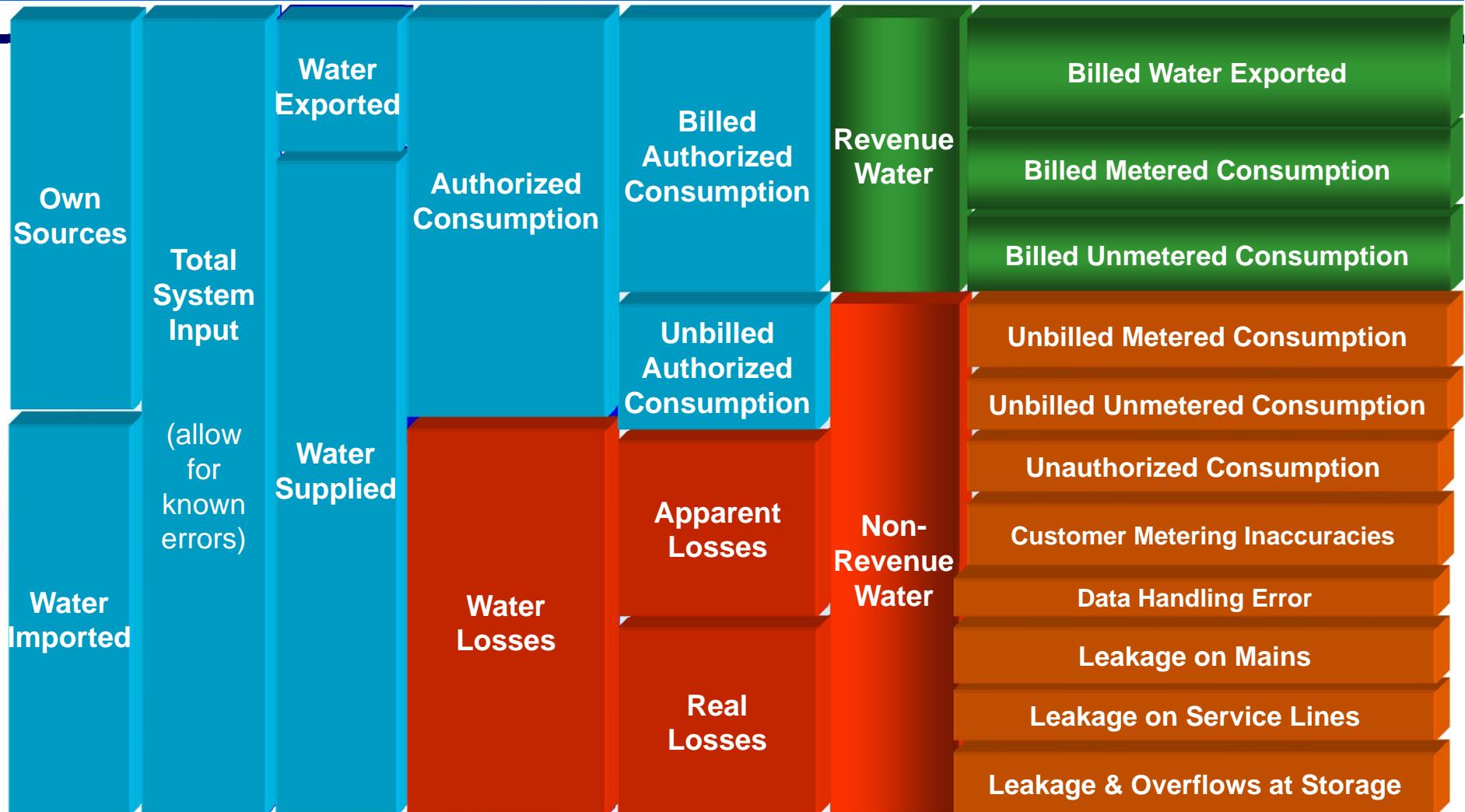
### **Module 3 Session 2**

## ***Controlling Apparent Losses: Recouping Revenue***

**George Kunkel P.E.**

Philadelphia Water Department

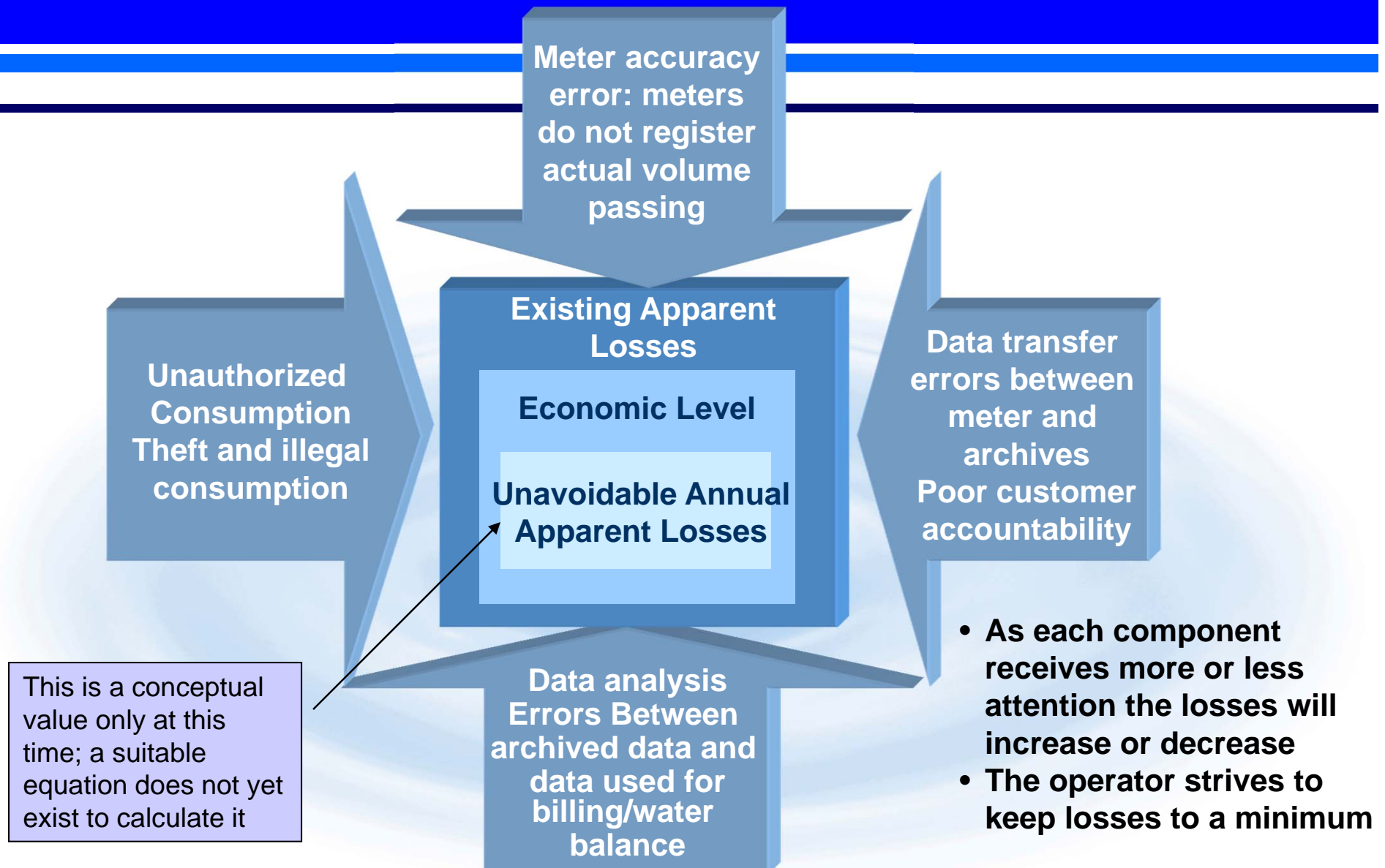
# IWA/AWWA Water Balance



# *Impacts of Apparent Losses*


- ◆ *Aggregate customer consumption volume is understated*
  - *Water supply planning suffers from inaccurate consumption data for customer populations*
  - *Analysis of conservation savings and other customer targeted impacts is hindered*
- ◆ *A portion of billings are understated or omitted, causing revenue loss*
  - *Paying customers effectively subsidize those who under-pay or don't pay at all for water service*
  - *High apparent losses exacerbate the need to increase water rates*

# Four Components of Managing Apparent Losses

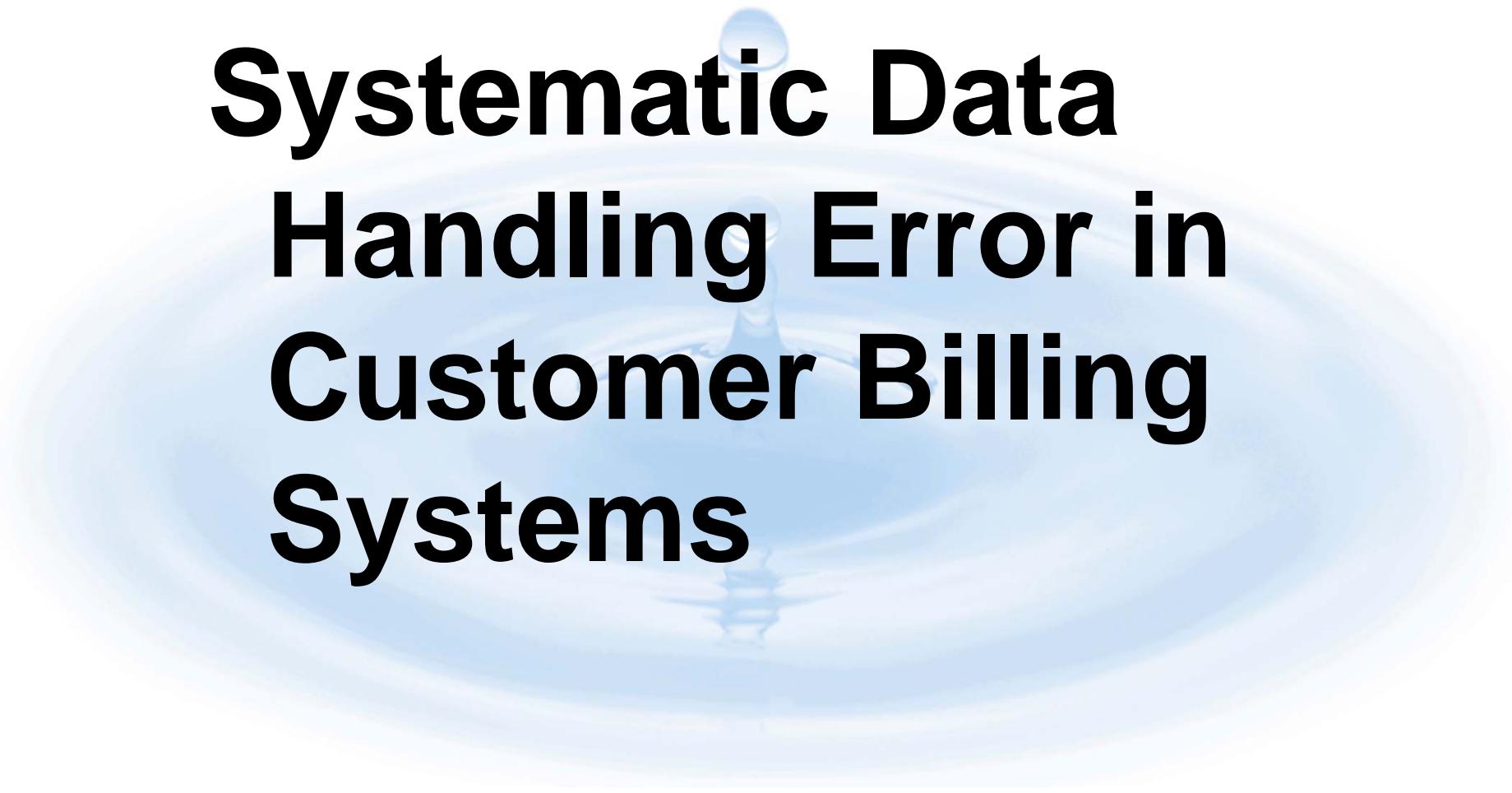



# Philadelphia's Water Audit Summary

July 1, 2009 - June 30, 2010 in Million Gallons Per Day (mgd)

A large, faint graphic of a water drop falling into a pool of water, creating ripples, is centered in the background of the table.

|                               |              |    |                  |
|-------------------------------|--------------|----|------------------|
| Water into Supply -           | 244.4        |    |                  |
| Customer Billed Consumption - | <u>167.8</u> |    |                  |
| Non-revenue Water             | 76.6         |    |                  |
| Unbilled Auth. Consumption    | 2.0          | \$ | 778,000          |
| Apparent Losses               | 17.0         | \$ | 30,034,000       |
| Real Losses                   | 59.6         | \$ | <u>5,869,000</u> |
| Non-revenue Water Cost:       |              | \$ | 36,681,000       |



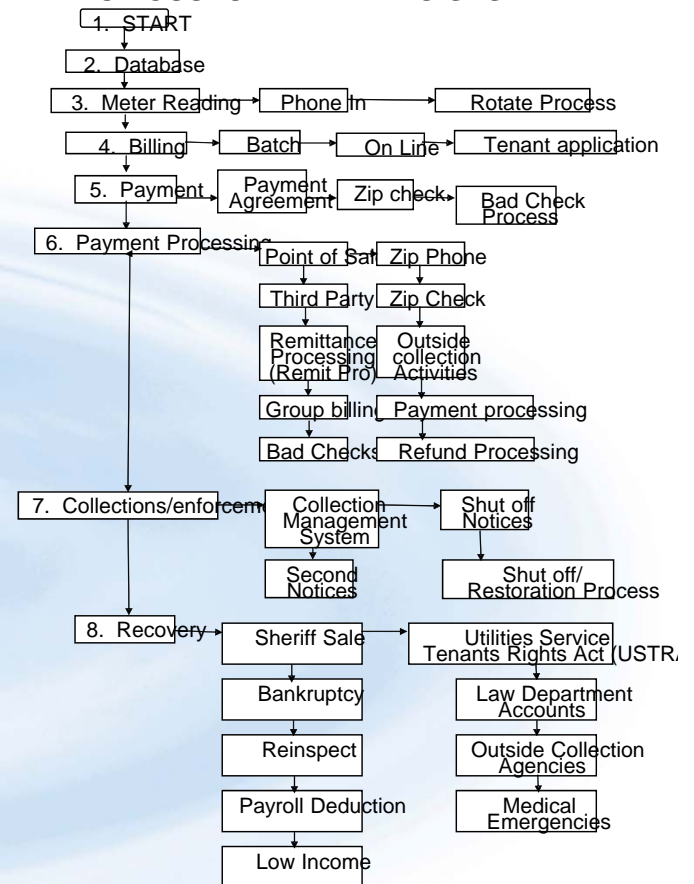
# **Systematic Data Handling Error in Customer Billing Systems**

# Assembling Water Audit Data

## Apparent Losses: systematic data handling error

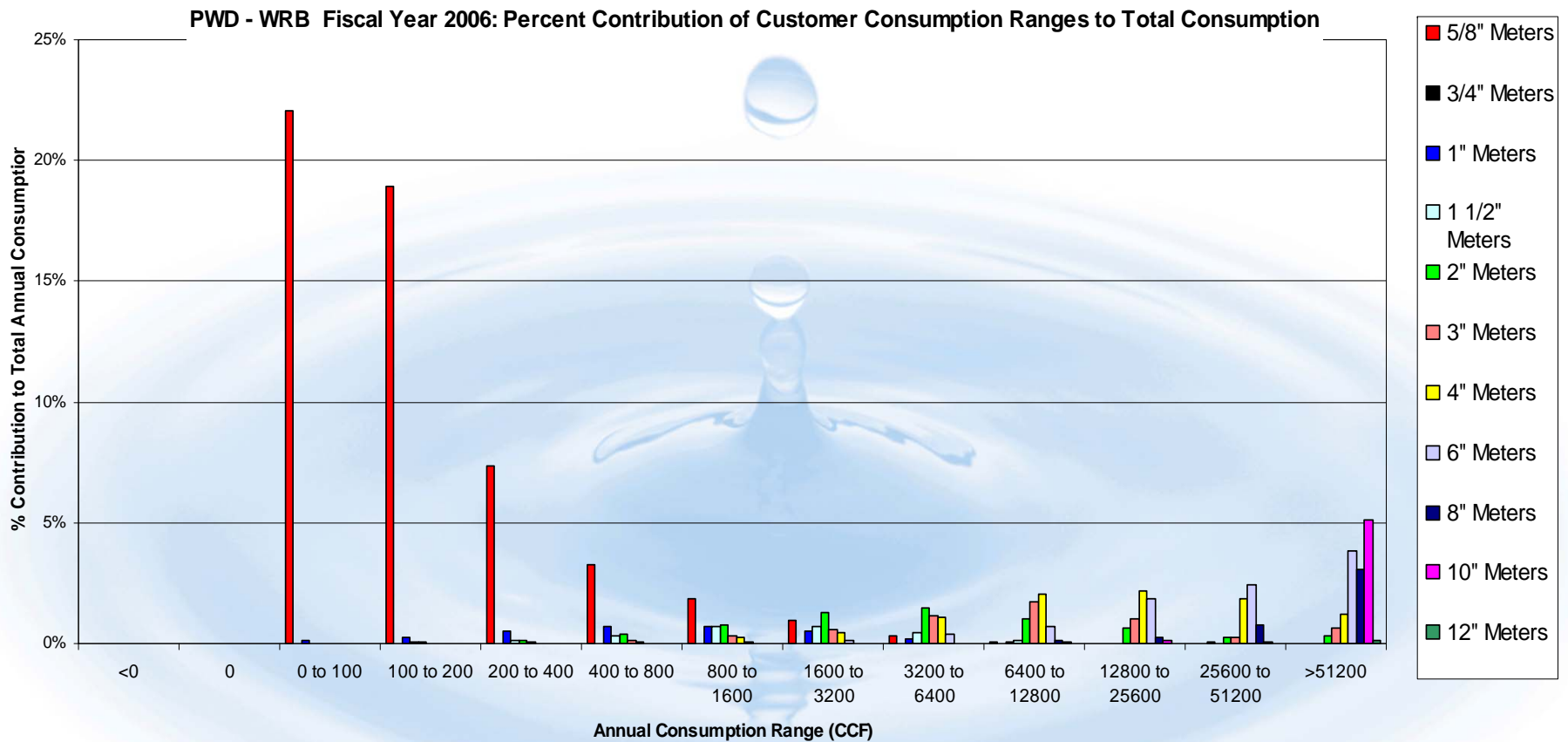
- Category of apparent loss was identified by AWWA WLC Committee
  - Includes all forms of data transfer, handling and archiving error in billing
- The “dark horse” of loss auditing
  - Can be subtle and tedious
  - Can often be readily corrected by programming or procedures improvements
- Review of billing system data is a good starting point in the assessment of apparent losses – **find out what goes on in the billing system! Start with a flow-charting process**

### OVERVIEW OF CUSTOMER BILLING SYSTEM





# Data Mining Analysis can be used to track billing trends





## *Data Analysis Error: Identify the effects of Billing Adjustments*

### ◆ Philadelphia: Customer Metered Consumption Vs. Customer Billed Consumption

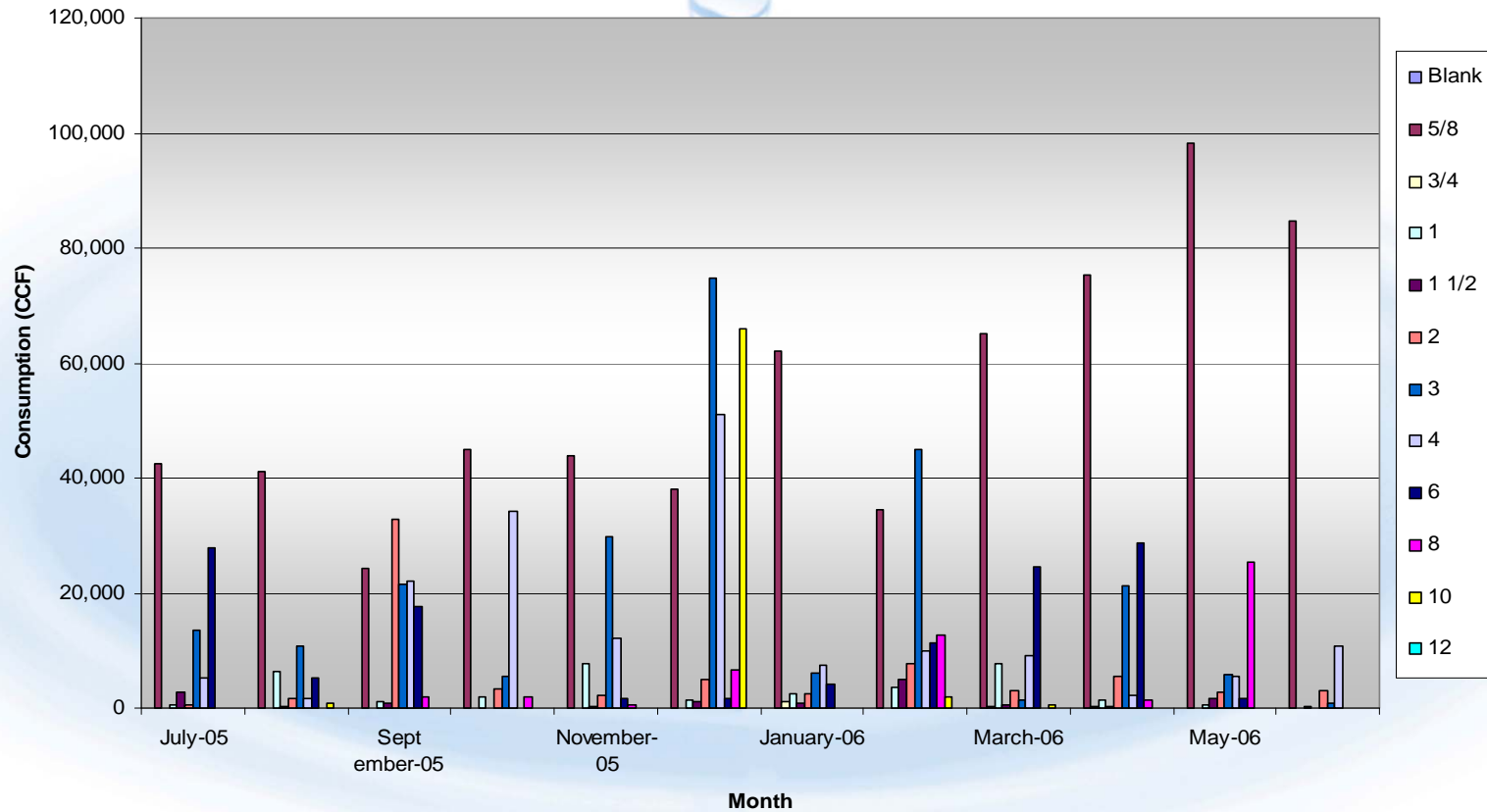
- A sampling of Customer Billed Usage: 8-inch meters

| <u>Month</u>    | <u># of Accounts</u> | <u>Usage (100 cubic feet)</u> |
|-----------------|----------------------|-------------------------------|
| July 1999       | 71                   | 177,312                       |
| <b>Aug 1999</b> | <b>70</b>            | <b>-134,825</b>               |
| Sept 1999       | 69                   | 246,923                       |
| Oct 1999        | 68                   | 178,278                       |

- ◆ It's important to find out what the Billing System does to Metered Data

# Data Handling Error: "Negative" Consumption Philadelphia's Data Mining Analysis

PWD - WRB  
Negative Monthly Consumption for Meter Size  
Fiscal Year 2006



# Data Handling Error: Policy Idiosyncrasies

- ◆ *Philadelphia has roughly 472,000 Billed Accounts*
- ◆ *But - - Philadelphia also has roughly 50,000 Non-Billed Accounts!*
- ◆ *Non-billed Accounts: Typically a temporary status, yet accounts can remain indefinitely if not monitored closely*
- ◆ *Eight categories of NB's include unoccupied properties, non-payment shutoffs, other*
- ◆ *Invalid NB Accounts: a primary target of Philadelphia's Revenue Protection Program*
- ◆ *New Stormwater billing program makes all accounts "billed", but policy needs to catch up*



# **Customer Metering Inaccuracies**

# *Impacts to Customer Meter Accuracy*

- ◆ Many reasons for Meters Error:
  - Wear over time, excess volume/abrasive water
  - Incorrect installation/poor maintenance
  - Incorrect sizing
  - Incorrect meter type for the application
  - Environmental problems such as freezing or over heating
- ◆ Good installation, selection, sizing, testing and replacement will resolve these issues





***Managing Meters – establish a maintenance and inspection program to detect malfunctioning meters***



Inaccurate, malfunctioning or  
vandalized meters

# Tracking Customer Meter Accuracy

- ◆ *Develop meter population demographics*
  - *Compile an inventory of meters based upon size, type, manufacturer, model, location (indoors or in outdoor meter pits)*
  - *Select a sample of billing accounts with various meters; look at billed consumption pattern – is the right meter in place?*
- ◆ *Conduct meter accuracy testing on samples of various meter types*
  - *Test randomly selected meters of different types*
  - *Test selected “high consumption” residential meters to determine lifetime accuracy threshold*
- ◆ *Large meter right-sizing: meters 1-inch and larger*
  - *Many existing meters are the wrong size/type*
  - *Consider data-logging meters to determine the customer consumption profile*
  - *Stay abreast of new types of meters: single jet meters and solid state meters are evolving to compete with the traditional turbine and compound meters*



Small meter test bench



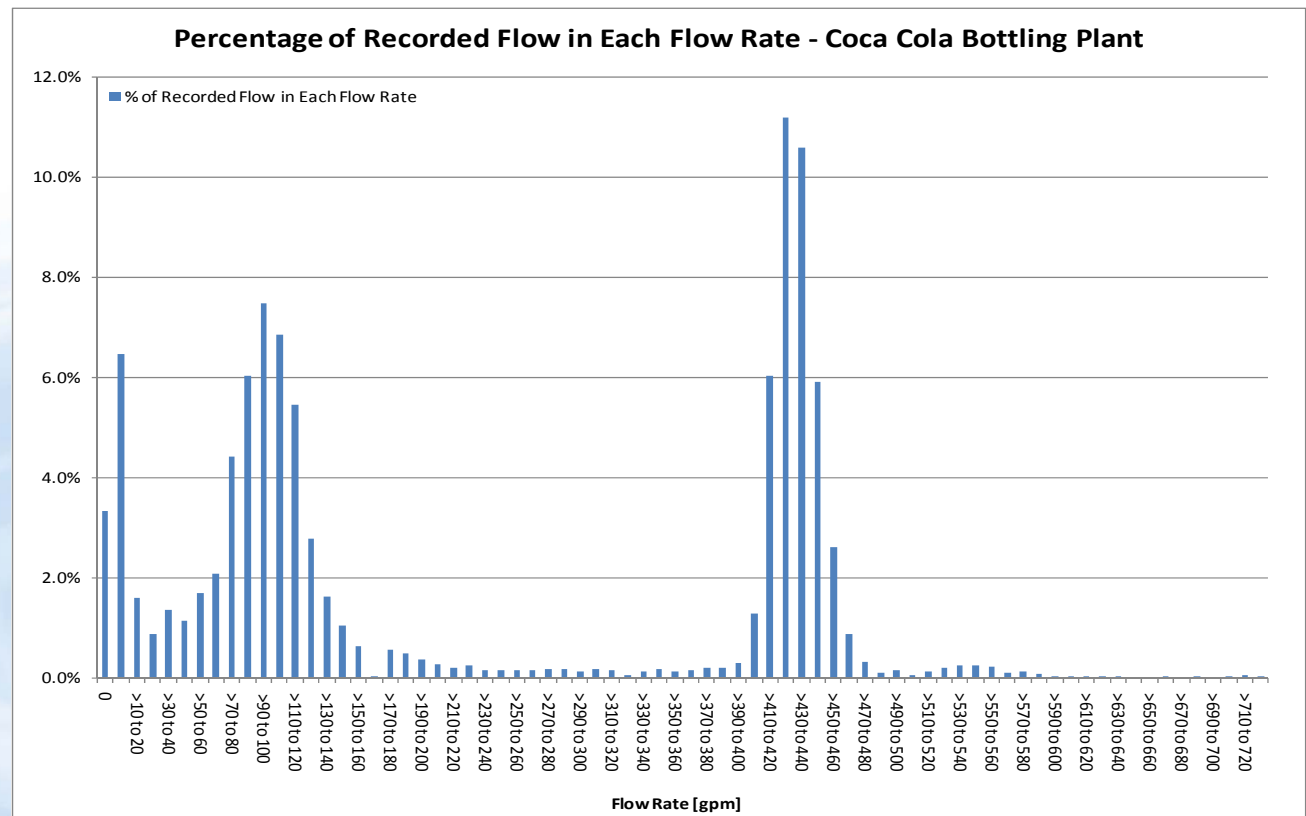
Data-loggers installer on a 4-inch compound meter in a high school



# PWD Large Customer Meter Study

## 🔹 Coca Cola Bottling Plant

- 6-inch Sensus compound meter
- Data-logging data collection: Sept 2010

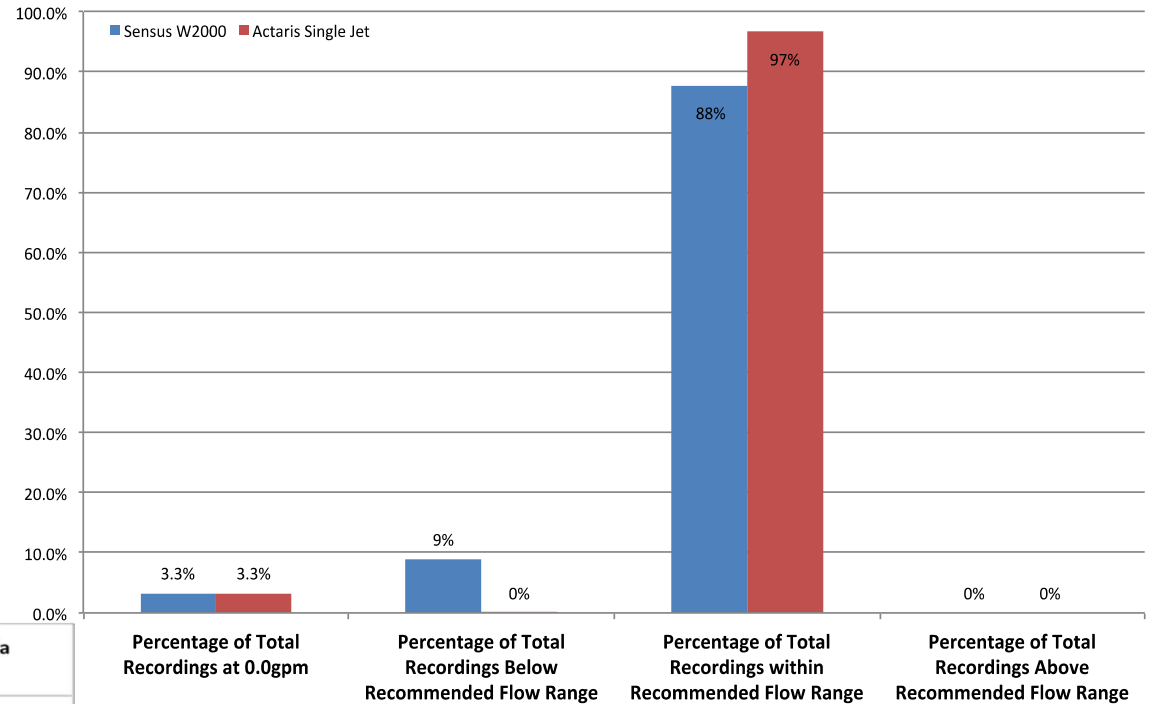


Wide variations in flowrate occur. This meter is adequately sized, but a different meter (single jet) might register more flow

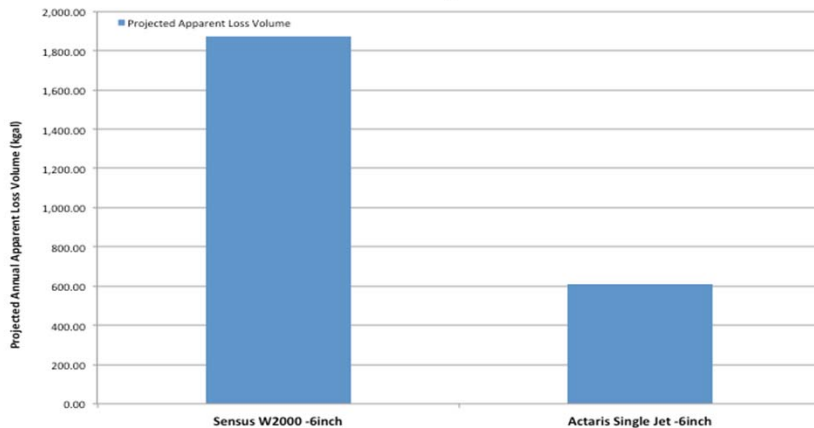
# PWD Large Customer Meter Study

- Coca Cola Bottling Plant
- Time profile and economic analysis
  - Potential payback in 0.6 year with single jet meter, which costs \$4,050

Flow Range Comparison for Sensus W2000 and Actaris Single Jet Flow Meters - 6inch Meter - Coca Cola Bottling Plant



Projected Annual Apparent Loss Volume by Meter Brand - Coca Cola Bottling Plant



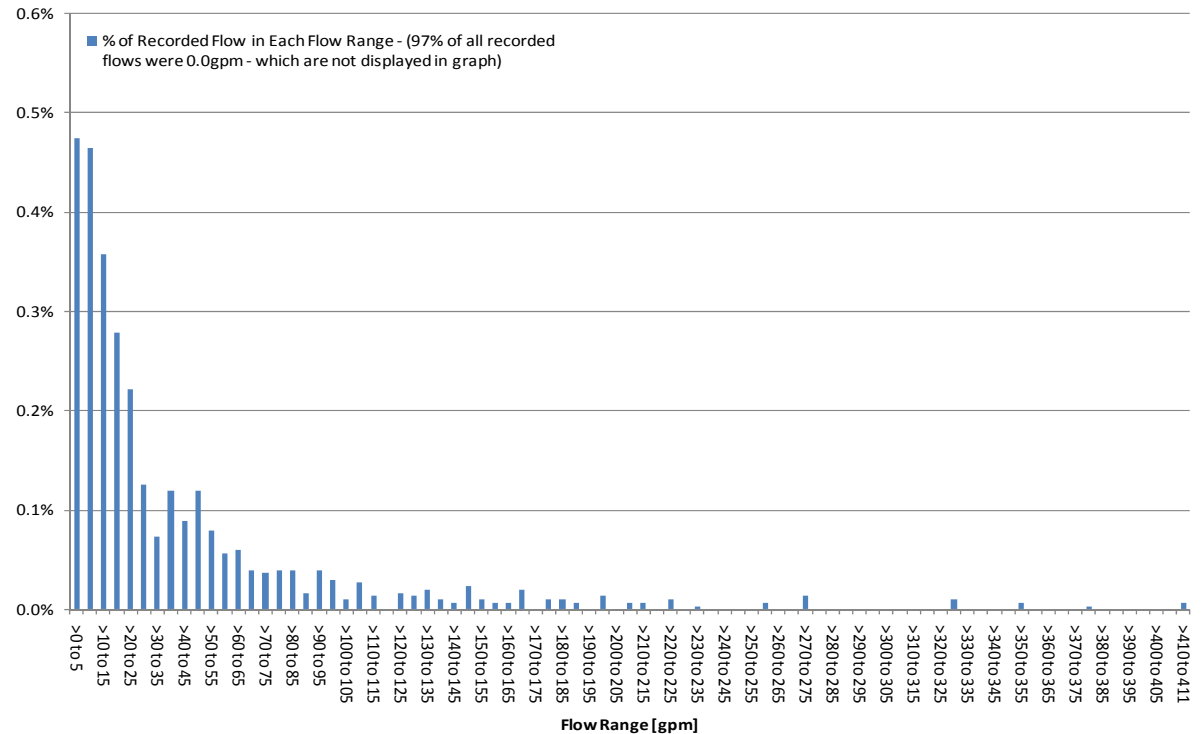
| Projected Annual Savings                      | Monetary (\$/year) | Volume (kgal/year) |
|---|--------------------|--------------------|
| Sensus Total Apparent Losses                  | \$10,900.45        | 1,870.28           |
| Actaris Total Apparent Losses                 | \$3,562.33         | 611.22             |
| Savings from switching from Sensus to Actaris | \$7,338.12         | 1,259.06           |

# PWD Large Customer Meter Study

- St. Joseph's University – Drexel Library
  - 3-inch ABB turbine meter



Percentage of Recorded Flow in Each Flow Rate - Saint Joseph's University Drexel Library Building

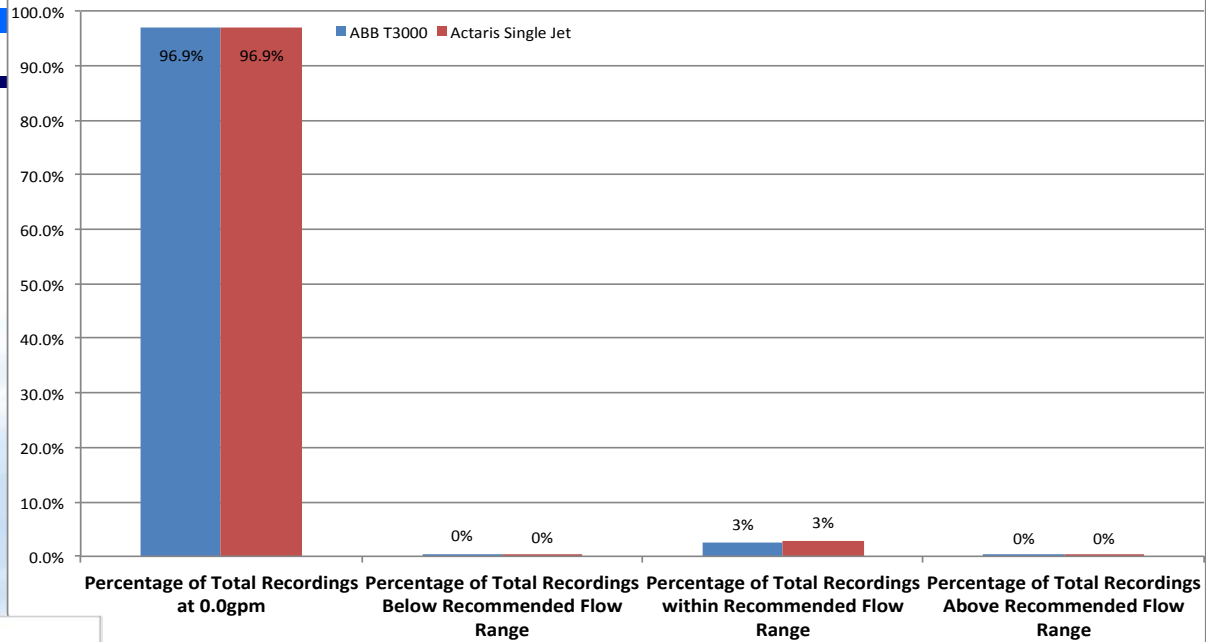


Note: flow through this meter is zero for 97% of the data-logged values. The above graph shows the profile for the remaining 3% of data values. This meter is dramatically oversized.

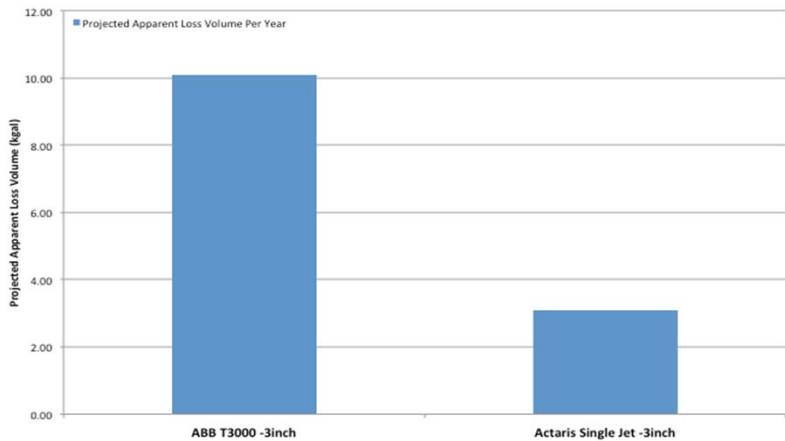
# PWD Large Customer Meter Study

- St. Joseph's University – Drexel Library
- Time profile and economic analysis
  - Potential payback in 46 years with single jet meter, which costs \$2,014

Flow Range Comparison for ABB T3000 and Actaris Single Jet Flow Meters - 3inch Meter - Saint Joseph's University - Drexel Library



Projected Annual Apparent Loss Volume by Meter Brands - Saint Joseph's University Drexel Library Building



| Projected Annual Savings                         | Monetary (\$/year) | Volume (kgal/year) |
|--|--------------------|--------------------|
| ABB T3000 Total Apparent Losses                  | \$63.40            | 10.09              |
| Actaris Total Apparent Losses                    | \$19.37            | 3.08               |
| Savings from switching from ABB T3000 to Actaris | \$44.04            | 7.01               |

# Automatic Meter Reading (AMR) Advanced Metering Infrastructure (AMI)

- *AMR can efficiently gather meter readings with limited errors vs. manual meter reading*
- *AMI has capabilities of a permanent communication link with one way or two way communications*
  - *Provide consumption data at short intervals to reveal usage patterns*
  - *Can receive additional data: leak noise alerts, water pressure, tamper*
  - *Can send signals to automatic shutoff valves*



Philadelphia: 2<sup>nd</sup> largest water utility  
AMR System in the United States



# Unauthorized Consumption



# *Unauthorized Consumption occurs in many ways*

- *Fire Hydrants*
- *Tampering with Meters*
- *Tampering with Meter Reading Equipment*
- *Illegal Bypasses and connections*
- *Illegal restoration of shutoff service connections (payment delinquency)*





# Addressing Unauthorized Consumption

## 💧 Strategy

- Policy & Regulations
- Detection
- Enforcement

## 💧 Tactics

- Investigate unusual billing patterns: zero consumption accounts, wildly varying consumption
- Automatic Meter Reading (AMR) Systems can provide tamper alerts
- Fire Hydrant locking devices



**Unfortunately, bypassing a water meter isn't complicated. This photo shows a "cheater" or "jumper" pipe (top) that was illegally used to replace the meter in this meter setter in Morgantown, W Va. In the lower part of this meter pit, is a typical 5/8th-inch residential meter**

# Philadelphia's Revenue Protection & Reinspection Programs

| PWD - WRB Revenue Recovery History |                    |                      |                     |  |                         |                                |                         |
|------------------------------------|--------------------|----------------------|---------------------|--|-------------------------|--------------------------------|-------------------------|
| PWD Revenue Protection Program     |                    |                      |                     |  | WRB Reinspection        |                                | Total                   |
| Fiscal Year                        | Accounts Recovered | Water Recovered, MGD | Revenue Recovered   | Categories of Greatest Recovery**  | Reinspection Recoveries | Reinspections Revenue Recovery | Total Recovered Revenue |
| 2010                               | 2,467              | 1.58                 | \$2,384,528         | Investigation of Zero Consumption accounts: 61% of 2,467 recovered accounts were "missing meter" | 1,516                   | \$169,733                      | \$2,554,261             |
| 2009                               | 1,659              | n/a                  | \$1,603,540         | Investigation of Zero Consumption accounts: 80% of 1,659 recovered accounts were "missing meter" | 1,632                   | \$199,732                      | \$1,803,272             |
| 2008                               | n/a                | n/a                  | \$636,250           | n/a  | 2597                    | \$390,670                      | \$1,026,920             |
| 2007                               | 449                | 0.36                 | \$531,400           | NB9 (Vacant properties) & NB3 (Shutoff for non-payment)  | 2,984                   | \$340,380                      | \$871,780               |
| 2006                               | 1,436              | 1.01                 | \$1,413,000         | Estimated Accounts (#1), Non-billed Accounts (#3,#9) and Zero Consumption Accounts               | 2,513                   | \$209,768                      | \$1,622,768             |
| 2005                               | 2,397              | 1.74                 | \$2,835,000         | NB3 & Zero consumption accounts  | 2,553                   | \$249,261                      | \$3,084,261             |
| 2004                               | 1,941              | 1.67                 | \$2,003,000         | Zero consumption accounts 0.74 MGD; tampering is most common cause of lost water in this group   | 1,991                   | \$446,327                      | \$2,449,327             |
| 2003                               | 1,360              | 1.14                 | \$1,782,000         | Zero Consumption Accounts  | 2,221                   | \$604,379                      | \$2,386,379             |
| 2002                               | 932                | 0.69                 | \$1,037,000         | Zero Consumption Accounts  | 2,721                   | \$668,932                      | \$1,705,932             |
| 2001                               | 711                | 5.81                 | \$2,900,000         | Missing Accounts, Hand Estimates, NB6 accounts   | 3,261                   | \$498,952                      | \$3,398,952             |
| 2000                               | 716                | 1.39                 | \$2,100,000         | NB6 accounts   | 2,737                   | \$393,949                      | \$2,493,949             |
| <b>Total</b>                       | <b>14,068</b>      | <b>15.39</b>         | <b>\$19,225,718</b> |  | <b>26,726</b>           | <b>\$4,172,083</b>             | <b>\$23,397,801</b>     |

# Summary

- ◆ *Apparent Loss control improves the accuracy of customer consumption measures and optimizes the billing process*
- ◆ *Apparent Loss interventions are often expedient and highly cost effective*
- ◆ *Any water utility can utilize new tools to identify apparent losses, improve their customer consumption data, and recover uncaptured revenue*

