The Big Data Behind the Flush

Jessica Gooch – Asset Manager
City of Portland Maine, Water Resources Division
City of Portland - Demographics

- Largest City in Maine
  - Over 66,000 residents and
  - 16,500 Residential and Commercial sewer users
- Land area – 21 sq miles including 48 sq miles of water
- First settled in 1632 and incorporated on July 4, 1786
- Ranked top craft beer city in the WORLD!!!
Water Resources Overview

- Water Resources Division – Created in 2014
- Protect human health and the environment
- EPA Administrative Order – required separate funding streams
- 40 Full-time staff – Water Resources Manager, Compliance, Engineers, Asset Management and GIS, Stormwater team, Field Operations

Water Resources Programs
- Sewer Stormwater System Evaluation – CCTV, Dye and Smoke Testing, Inspections
- Asset Management – GIS, COF/LOF Risk Analysis
- Industrial Pretreatment, Fats Oils and Grease
- Stormwater Utility Fee
- Stormwater Education
- Infiltration and Inflow
- Pump stations and SCADA
- Construction projects, Street Sweeping, Training
Compliance Directives

- **EPA Administrative Order**
  - Inventory of collection system, assign unique identifiers to every asset
  - O&M practices
  - Causes of leaks, spills, releases of sewerage
  - SSO (Sanitary sewer overflows) listing and reporting
  - CCTV 6% of the system each year
  - Integrate CCTV data into CMMS
  - Flow monitoring

- **Capacity, Management, Operation and Maintenance (CMOM)**
  - Asset Management
  - Operations and Maintenance
  - Wastewater Programs and Ordinance Assessment
  - Capital Planning and Prioritization – Wishes and needs vs. Risk Based approach
  - Staffing and Organizational Analysis

- **Municipal Separate Stormwater Sewer System (MS4)**
  - Clean Water Act
  - 30 communities in Maine
  - Addresses stormwater discharges

- **Municipal Separate Stormwater Sewer System (MS4)**
  - Clean Water Act
  - 30 communities in Maine
  - Addresses stormwater discharges
What We Need to Manage:

- 93 miles of Sanitary Sewer Pipe
- 120 miles of Stormwater Pipe
- 143 miles of Combined Pipe
- 9 Wastewater Pump Stations
- 15,000 Storm and Sewer Manholes and Catch Basins
- 12 CSO Outfalls
- East End WWTF Shared-Responsibility
History of the Sewer System

- Portland’s Sewer system = Very old!
  - Combined sewer system
  - Diameters range from 8” to 96”
  - Earliest known sewer main – 18”
    Brick sewer built circa 1864 on Munjoy Hill
- Combined vs Separated
  - 236 miles of pipe
    - 143 combined
    - 93 separated
  - 9 pump stations
  - 30 Combined Sewer Overflows

Brick Sewer Circa 1864
East End Age of Pipe

Install Date
- > 11/6/1989
- 1/3/1958
- < 3/2/1926
- Other
Outline of the Data Gathering System

• Historical Records
• GIS Data
• CMMS – Cityworks
• CCTV – IT Pipes
• Web Mapping/Mobile Data Collection
Historical Data Collection

- The Vault – Location of all of the City plans dating back to the mid 1800’s
Historical Data Collection

- Catalog System
- Field books
- Sewer Cards
- Plan References
Historical Data Collection

- Infiltration and Inflow maps
- Site Plans
Old vs. New

Sewer Connections Field Book

198 Walton St Sewer Lateral page

198 Walton St Sewer Storm GIS
Modern Data Gathering and Review

- GIS Conversion of paper maps – using plans, I&I study, catch basin and lateral cards – GIS digitization of sewers began in the 1990’s
- CCTV of mains and manholes – gathers GIS and condition data
- Field Data Collection – iPads, GPS, Survey
- Aerial Imagery – used to check locations of manholes and catch basins
- CMMS – Service Requests, Inspections, Work Orders
- GIS Updates – CAD, ESRI tools, historical & abandoned features
CCTV Software

• Old...
  • CCTV Data used to be stored on VHS tapes with no way to integrate the data into our systems and GIS
  • No data quality check was performed
  • No easy way to update GIS or share data
**CCTV Software**

- New!!!
  - Implemented new CCTV software in 2015
  - PACP/MACP/LACP database – industry standard data collection
  - QAQC of data
  - Seamless integration with GIS – both to receive data into GIS and push data out
  - Uploads CCTV data directly into the City’s CMMS
  - Data is easily shared via web maps
<table>
<thead>
<tr>
<th>Pipe Segment</th>
<th>D.O.Y.</th>
<th>Site</th>
<th>Street</th>
<th>Mainline MH</th>
<th>Downstream MH</th>
<th>Pipe Material</th>
<th>Length</th>
<th>Width</th>
<th>Asset Owner</th>
<th>Asset ID</th>
<th>Waterlines</th>
<th>Pipe Size</th>
<th>Year Lifted</th>
<th>Screen Location Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSWW-0003</td>
<td>001</td>
<td>PWW</td>
<td>SE 16th St</td>
<td>$30-1000</td>
<td>$39-1000</td>
<td>Steel Pipe</td>
<td>22</td>
<td>22</td>
<td>Combined</td>
<td>$30-1000</td>
<td>1</td>
<td>Yes</td>
<td>1934</td>
<td>Light Highway</td>
</tr>
<tr>
<td>PSWW-0004</td>
<td>002</td>
<td>PWW</td>
<td>SE 16th St</td>
<td>$30-1000</td>
<td>$39-1000</td>
<td>Steel Pipe</td>
<td>22</td>
<td>22</td>
<td>Combined</td>
<td>$30-1000</td>
<td>1</td>
<td>Yes</td>
<td>1934</td>
<td>Light Highway</td>
</tr>
<tr>
<td>PSWW-0005</td>
<td>003</td>
<td>PWW</td>
<td>SE 16th St</td>
<td>$30-1000</td>
<td>$39-1000</td>
<td>Steel Pipe</td>
<td>22</td>
<td>22</td>
<td>Combined</td>
<td>$30-1000</td>
<td>1</td>
<td>Yes</td>
<td>1934</td>
<td>Light Highway</td>
</tr>
<tr>
<td>PSWW-0006</td>
<td>004</td>
<td>PWW</td>
<td>SE 16th St</td>
<td>$30-1000</td>
<td>$39-1000</td>
<td>Steel Pipe</td>
<td>22</td>
<td>22</td>
<td>Combined</td>
<td>$30-1000</td>
<td>1</td>
<td>Yes</td>
<td>1934</td>
<td>Light Highway</td>
</tr>
<tr>
<td>PSWW-0007</td>
<td>005</td>
<td>PWW</td>
<td>SE 16th St</td>
<td>$30-1000</td>
<td>$39-1000</td>
<td>Steel Pipe</td>
<td>22</td>
<td>22</td>
<td>Combined</td>
<td>$30-1000</td>
<td>1</td>
<td>Yes</td>
<td>1934</td>
<td>Light Highway</td>
</tr>
<tr>
<td>PSWW-0008</td>
<td>006</td>
<td>PWW</td>
<td>SE 16th St</td>
<td>$30-1000</td>
<td>$39-1000</td>
<td>Steel Pipe</td>
<td>22</td>
<td>22</td>
<td>Combined</td>
<td>$30-1000</td>
<td>1</td>
<td>Yes</td>
<td>1934</td>
<td>Light Highway</td>
</tr>
<tr>
<td>PSWW-0009</td>
<td>007</td>
<td>PWW</td>
<td>SE 16th St</td>
<td>$30-1000</td>
<td>$39-1000</td>
<td>Steel Pipe</td>
<td>22</td>
<td>22</td>
<td>Combined</td>
<td>$30-1000</td>
<td>1</td>
<td>Yes</td>
<td>1934</td>
<td>Light Highway</td>
</tr>
<tr>
<td>PSWW-0010</td>
<td>008</td>
<td>PWW</td>
<td>SE 16th St</td>
<td>$30-1000</td>
<td>$39-1000</td>
<td>Steel Pipe</td>
<td>22</td>
<td>22</td>
<td>Combined</td>
<td>$30-1000</td>
<td>1</td>
<td>Yes</td>
<td>1934</td>
<td>Light Highway</td>
</tr>
<tr>
<td>PSWW-0011</td>
<td>009</td>
<td>PWW</td>
<td>SE 16th St</td>
<td>$30-1000</td>
<td>$39-1000</td>
<td>Steel Pipe</td>
<td>22</td>
<td>22</td>
<td>Combined</td>
<td>$30-1000</td>
<td>1</td>
<td>Yes</td>
<td>1934</td>
<td>Light Highway</td>
</tr>
<tr>
<td>PSWW-0012</td>
<td>010</td>
<td>PWW</td>
<td>SE 16th St</td>
<td>$30-1000</td>
<td>$39-1000</td>
<td>Steel Pipe</td>
<td>22</td>
<td>22</td>
<td>Combined</td>
<td>$30-1000</td>
<td>1</td>
<td>Yes</td>
<td>1934</td>
<td>Light Highway</td>
</tr>
<tr>
<td>PSWW-0013</td>
<td>011</td>
<td>PWW</td>
<td>SE 16th St</td>
<td>$30-1000</td>
<td>$39-1000</td>
<td>Steel Pipe</td>
<td>22</td>
<td>22</td>
<td>Combined</td>
<td>$30-1000</td>
<td>1</td>
<td>Yes</td>
<td>1934</td>
<td>Light Highway</td>
</tr>
<tr>
<td>PSWW-0014</td>
<td>012</td>
<td>PWW</td>
<td>SE 16th St</td>
<td>$30-1000</td>
<td>$39-1000</td>
<td>Steel Pipe</td>
<td>22</td>
<td>22</td>
<td>Combined</td>
<td>$30-1000</td>
<td>1</td>
<td>Yes</td>
<td>1934</td>
<td>Light Highway</td>
</tr>
<tr>
<td>PSWW-0015</td>
<td>013</td>
<td>PWW</td>
<td>SE 16th St</td>
<td>$30-1000</td>
<td>$39-1000</td>
<td>Steel Pipe</td>
<td>22</td>
<td>22</td>
<td>Combined</td>
<td>$30-1000</td>
<td>1</td>
<td>Yes</td>
<td>1934</td>
<td>Light Highway</td>
</tr>
<tr>
<td>PSWW-0016</td>
<td>014</td>
<td>PWW</td>
<td>SE 16th St</td>
<td>$30-1000</td>
<td>$39-1000</td>
<td>Steel Pipe</td>
<td>22</td>
<td>22</td>
<td>Combined</td>
<td>$30-1000</td>
<td>1</td>
<td>Yes</td>
<td>1934</td>
<td>Light Highway</td>
</tr>
<tr>
<td>PSWW-0017</td>
<td>015</td>
<td>PWW</td>
<td>SE 16th St</td>
<td>$30-1000</td>
<td>$39-1000</td>
<td>Steel Pipe</td>
<td>22</td>
<td>22</td>
<td>Combined</td>
<td>$30-1000</td>
<td>1</td>
<td>Yes</td>
<td>1934</td>
<td>Light Highway</td>
</tr>
<tr>
<td>PSWW-0018</td>
<td>016</td>
<td>PWW</td>
<td>SE 16th St</td>
<td>$30-1000</td>
<td>$39-1000</td>
<td>Steel Pipe</td>
<td>22</td>
<td>22</td>
<td>Combined</td>
<td>$30-1000</td>
<td>1</td>
<td>Yes</td>
<td>1934</td>
<td>Light Highway</td>
</tr>
<tr>
<td>PSWW-0019</td>
<td>017</td>
<td>PWW</td>
<td>SE 16th St</td>
<td>$30-1000</td>
<td>$39-1000</td>
<td>Steel Pipe</td>
<td>22</td>
<td>22</td>
<td>Combined</td>
<td>$30-1000</td>
<td>1</td>
<td>Yes</td>
<td>1934</td>
<td>Light Highway</td>
</tr>
<tr>
<td>PSWW-0020</td>
<td>018</td>
<td>PWW</td>
<td>SE 16th St</td>
<td>$30-1000</td>
<td>$39-1000</td>
<td>Steel Pipe</td>
<td>22</td>
<td>22</td>
<td>Combined</td>
<td>$30-1000</td>
<td>1</td>
<td>Yes</td>
<td>1934</td>
<td>Light Highway</td>
</tr>
<tr>
<td>PSWW-0021</td>
<td>019</td>
<td>PWW</td>
<td>SE 16th St</td>
<td>$30-1000</td>
<td>$39-1000</td>
<td>Steel Pipe</td>
<td>22</td>
<td>22</td>
<td>Combined</td>
<td>$30-1000</td>
<td>1</td>
<td>Yes</td>
<td>1934</td>
<td>Light Highway</td>
</tr>
</tbody>
</table>
### CCTV Software

#### Pipe Observations

<table>
<thead>
<tr>
<th>Dist.</th>
<th>Description</th>
<th>Value 1</th>
<th>Value 2</th>
<th>%</th>
<th>VCR Time</th>
<th>Code</th>
<th>Clock 1</th>
<th>Clock 2</th>
<th>Joint</th>
<th>Remarks</th>
<th>Grade</th>
<th>Cond.</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Manhole</td>
<td>0</td>
<td></td>
<td>0</td>
<td></td>
<td>AMH</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>02</td>
<td>Water Level</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td>MwL</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Tap Break in Active</td>
<td>4</td>
<td></td>
<td>0</td>
<td></td>
<td>TBA</td>
<td>10</td>
<td>0</td>
<td></td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>31.4</td>
<td>Tap Factory Capped</td>
<td>6</td>
<td></td>
<td>0</td>
<td></td>
<td>TFC</td>
<td>10</td>
<td>0</td>
<td></td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>13.7</td>
<td>Roots Tape Joint</td>
<td>1</td>
<td></td>
<td>0</td>
<td></td>
<td>RJU</td>
<td>9</td>
<td>0</td>
<td></td>
<td></td>
<td>2</td>
<td>44.34</td>
</tr>
<tr>
<td>24.15</td>
<td>Deposits Sediment Gravel</td>
<td>15</td>
<td></td>
<td>5</td>
<td></td>
<td>DSGV</td>
<td>7</td>
<td>0</td>
<td></td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>37.9</td>
<td>Deposits Sediment Gravel</td>
<td>15</td>
<td></td>
<td>5</td>
<td></td>
<td>DSGV</td>
<td>7</td>
<td>0</td>
<td></td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>58.2</td>
<td>Water Level</td>
<td>25</td>
<td></td>
<td></td>
<td></td>
<td>MwL</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>67.6</td>
<td>Tap Break in Active</td>
<td>6</td>
<td></td>
<td>0</td>
<td></td>
<td>TBA</td>
<td>10</td>
<td>0</td>
<td></td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>82.2</td>
<td>Deposits Sediment Gravel</td>
<td>10</td>
<td></td>
<td>5</td>
<td></td>
<td>DSGV</td>
<td>7</td>
<td>0</td>
<td></td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>105.2</td>
<td>Tap Break in Active</td>
<td>6</td>
<td></td>
<td>0</td>
<td></td>
<td>TBA</td>
<td>10</td>
<td>0</td>
<td></td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>108</td>
<td>Water Level</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td>MwL</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>110</td>
<td>Initiation Wesley</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td>IW</td>
<td>1</td>
<td>0</td>
<td></td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>128.6</td>
<td>Tap Factory Capped</td>
<td>6</td>
<td></td>
<td>0</td>
<td></td>
<td>TFC</td>
<td>10</td>
<td>0</td>
<td></td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>227.5</td>
<td>Manhole</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td>AMH</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>
CCTV Software

Unique Facility ID’s

Videos and Images

Observations
Update GIS with CCTV info

- ITpipes has GIS tools to import asset information from ITpipes to GIS
- CCTV Operator enters the asset information in the field
- Asset Management team runs the tools and double checks the data
- Data is updated through the GIS tools within ArcGIS
6% of the System

- EPA AO requires the City to CCTV 6% of the system
- Larger, planned projects use ArcGIS Online web maps to outline project areas
PORTLAND CCTV Inspection Data into CMMS

- EPA AO – Requires CCTV Inspection data to be integrated with our CMMS
- IT Pipes and Cityworks use a sync tool to sync data between the two
- Data must be coded properly for this to work
- Sync logs are created to identify issues and success
- Inspection information, videos and images are added to Cityworks for each inspection that is complete

Sync Client – connects IT Pipes and Cityworks

Inspection information added to Cityworks
CCTV Inspection Data into CMMS

Sync Logs – verify sync

Videos and images available in Cityworks
Web Maps

- ArcGIS Online web maps and apps
- Share information easily
- Staff, contractors, public
- Sewer maps
- Street sweeping
- COF/LOF Risk
- Catch basin inspections
- ID GIS updates
- CCTV
• Observations and Images are available for review by members of the AGOL group
What do we do with all the data???

• Consequence of Failure/Likelihood of Failure
  • COF – Proximity to services, hospitals, waterbodies etc.
  • LOF – Age, material, use
• Risk Analysis calculation of COF*LOF
• Life Cycle Analysis
  • Determine life cycle timeline and costs of assets
• Project Planning
  • Reactive to Proactive
  • Decision making to be based on risk based analysis rather than a wish list
  • Short and long-term budget using lifecycle-analysis
  • Lining vs. repair or replace
COF/LOF to Calculate Risk

East End WWTF
CMMS – Managing the work and data

• Asset Management
• Work order management
• Mobile data collection
• Data repository
• Compliance reporting
• Dashboards to share progress and information
• Track material, costs and equipment
Asset Management

- Asset Information
  - GIS
  - City Works
  - CCTV
  - Hydraulic Model

- Risk
  - COF
  - LOF
  - Risk Matrix
  - Failure Model

- Maintenance Practices
  - Short Term Renewal Projects
  - Long Term Planning Budget

- Renewal Plan
- Cost Information
What is next?

- Infiltration and Inflow study
- Refine Mobile Workflows
- Digitize Laterals
Thank you!!!

Jessica Gooch – Water Resources Asset Manager
City of Portland, ME
jag@portlandmaine.gov