DATA MANAGEMENT FOR BIOSOLIDS LAND APPLICATION
THE PHILADELPHIA WATER DEPARTMENT EXPERIENCE

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Biosolids Data Management

- Received little industry attention

- Available spreadsheet systems are effective calculators but have limited report generation capabilities and are not designed to store data

- Many relational database systems are either very complex using enterprise-scale software platforms or are cumbersome to use
PWD Data Management System
Objectives/Requirements

- Store relevant data for several years for reference
- Generate regulatory reports directly from system meeting PA DEP format requirements
- Calculate agronomic loading rate according to state protocol and requirements
- Track and update CPLR without user intervention (system doesn’t need human help)
- Track and consider biosolids residual nitrogen and other nitrogen sources as required by PA DEP
- Track total solids production, not just solids going to Agricultural Utilization
- Track disposition of all solids, not just solids going to Agricultural Utilization
- Designed to be operated easily by users with only basic computer skills and/or infrequent users
- Accomplish all in a single, centralized system
PWD Treatment System and Solids Processing/Management

- Average daily flow = 450 MGD from three treatment plants serving 2.3 million customers

- Anaerobic digestion is primary process means of achieving Class B pathogen reduction and qualifying process vector attraction reduction

- Solids from three plants dewatered at the PWD Biosolids Recycling Center near the Philadelphia International Airport

- Class B solids land applied to agricultural land, disturbed land for reclamation, disposed in landfills, or processed further using static-aerated pile composting to achieve Class A pathogen reduction in preparation for product marketing and distribution

- Approximately 35% of solids goes to agricultural utilization
PWD Biosolids Recycling Center
PWD PA Agricultural Utilization
Class B Land Application Program

- 57 farms operating under two regulatory permitting or qualification programs in 5 counties in southeastern Pennsylvania

- Approximately 4,100 acres of cropland available for land application

- Over 700 fields (‘operating units’) delineated on farms, average field size is just over 5 acres.

- Land application data on those 700+ fields must be tracked individually
Biosolids Land Application Program Data Management Requirements

- Regulatory requirements
- Public information requirements
Regulatory requirements

Public information requirements (project pending)
PWD Biosolids Managers Data Management Regulatory Requirements

**Biosolids Quality**
- Pollutant Content
- Pathogen Reduction (Process or Assay)
- Vector Attraction Reduction Reduction (Process or Barrier)

**Solids Utilization/Disposal**
- Disposal site/method, solids source
- Land application site operating unit identification (aka field), application rate, year and method, cropping information (type & yield goal), other nitrogen sources and nitrogen from legume crops
PA DEP Chapter 75 effective in 1977. Land application operated under site specific permits.

PA DEP Chapter 275 effective in 1988 (modified in 1994 to comply with 40 CFR Part 503 standards and requirements). Land application operated under site specific permits. (In effect until 2007)

PA DEP Chapter 271 effective in 1997. Land application operated under General permits.
<table>
<thead>
<tr>
<th>Regulation</th>
<th>Requirement</th>
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<tbody>
<tr>
<td>Chapter 75</td>
<td>Simple annual calculation. No residual tracking.</td>
</tr>
<tr>
<td>Chapter 275</td>
<td>Calculation dependent upon solids type, track residual over 3 years (&gt; 1988).</td>
</tr>
<tr>
<td>Chapter 271</td>
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Complicated agronomic loading rate calculation and required use of biosolids application data and analytical information from a 3-year period

Introduced concept of ‘Crop Year’ where some biosolids applications had nutrients credited to the next calendar year - annual nutrient application reporting now spans data entered over two years.
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<tr>
<td>Chapter 75</td>
<td>Cadmium (Cd) Lifetime Loading Rate</td>
</tr>
<tr>
<td>Chapter 275</td>
<td>Seven metals (Cd, Cr, Cu, Pb, Hg, Ni, Zn) + PCB, Lifetime Loading Rate &amp; CPLR</td>
</tr>
<tr>
<td>Chapter 271</td>
<td>Nine metals (As, Cd, Cu, Pb, Hg, Mo, Ni, Se, Zn) + PCB, CPLR</td>
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In 1994, Chapter 275 was amended to come into compliance with 40 CFR Part 503 metals tracking.

PA DEP required generators to back calculate to 1988 the amended list of metals (absent analytical results for As and Se).
Biosolids Pollutant Tracking

- Track pollutant application on a calendar year basis
- Track and calculate CPLR, even for Table 3 quality Class B solids
Biosolids N and Metals Reporting

- Biosolids nitrogen applied is reported in the calendar year Annual Operating Report (AOR) but may include solids applied in the previous calendar year.

- Pollutants applied includes only solids applied in the AOR calendar year.

- Pollutant and nutrient reporting is juxtaposed presenting an interesting data handling and treatment challenge for spreadsheet systems.
Land Application Data Volume for PWD

Tracking the following parameters for each field

- Biosolids applications and descriptive load characteristics (10 data points per load);
- Agronomic loading rate factors (10 data points);
- Biosolids analytical information (2 reports/28 data points);
- Farm field identifying information (4 data points);
- CPLR (10 data points) and residual nitrogen (12 data points).
Assume PWD’s average 4 acre farm field and 6 truckloads of biosolids cake applied/field and biosolids applied to 400 farm fields for one Crop Year/Calendar Year.

PWD must utilize nearly 50,000 data points in variably related records to satisfy PA DEP regulatory reporting requirements annually.
Proprietary spreadsheet system designed to calculate agronomic loading rate and CPLR per PA DEP requirements

Reporting capabilities were limited – did not generate PA DEP formats

Farm, field, etc. data entered repetitively

Agronomic loading rate and CPLR tracking functions/formulas exist in several spreadsheet cells (an issue if a formula modification is required). Difficult to track nitrogen application rate status of fields (i.e. status of ‘over-application’ potential)
Data entry consistency prone to operator error

Data stored in spreadsheet cells in several worksheets (i.e. not in centralized data tables)

Historical data references/linkages become more complex with time

CPLR calculations, especially when farm fields are not used every year for biosolids applications, become cumbersome and prone to data loss
In 2000, PWD elected to separate its CPLR tracking and agronomic loading rate system into two systems.

**Reason:** Land application vendor responsible for agronomic data management. Vendor operating at a facility distant from the PWD BRC. Vendor not using same spreadsheet data management system for agronomic calculations as PWD but one constructed by the vendor.

**Consequence:** Considerable data entered manually in duplicate. The opportunity for data consistency issues and manual entry error increased considerably. Confidence in accuracy of AOR was reduced.
In 2004, PWD assembled a team to investigate the feasibility of replacing the existing spreadsheet-based system with a relational database system.

Used data management requirements stated at presentation beginning as a starting point.

In addition, wanted land application vendor to have access to system (i.e., let’s all use one system) and to be capable of providing information via the WWW for public viewing.
Developed a customized solution based on Material Matters Material Manager™ database system for biosolids data management.

Added functions as required for total solids data management per PWD requirements.

Provided land application vendor access to system via internet.

Material Matters operates and maintains the system via the internet.
Key Data Management System Features and Capabilities

- Data entered one-time, no repetitive or duplicate data entry required. Historical data stored in centralized data tables easily referenced by the system.
- Data entry facilitated by ‘drop-down’ lists. This feature has greatly reduced the potential for data entry inconsistency and error.
- Agronomic loading rate calculations made according to specific state protocols. *Formula exists in only one place in system.*
Key Data Management System Features and Capabilities

- CPLR is tracked automatically on the basis of biosolids application data and analytical results stored in the system and is updated as the user requires.

- Residual nitrogen is calculated using historical biosolids application and analytical data in the system and applied according to state specific protocol. Formula exists in only one place in the system.
PA DEP AOR is produced in the correct report form format and at the click of a mouse button. Supporting biosolids application data by farm field and updated CPLR also generated at button click.

Nitrogen application status can be monitored in ‘real-time’ at the click of a mouse button.
PWD Data Management System

Key Benefits

- Data entry error greatly reduced and facilitated through system-provided lists
- Agronomic and CPLR related calculations handled centrally, consistently and accurately.
- PA DEP reports generated consistently, accurately and in less than 1/3 the time compared to spreadsheet systems
- System available 24/7 via internet
- Provides functional control within an EMS system as a consistent data management tool and compatible with providing the public with program information
PWD Data Management Project Team

- Bill Toffey, PWD Biosolids Program Manager
- Byron Hampton, PWD Agronomist
- Rick Creamer, Material Matters Senior Information Systems Manager
- Dr. Robin Brandt, Material Matters VP of Research
- Stefan Weaver, Material Matters Project Scientist
- Jodie Potter, Material Matters Data Quality Specialist
- Aaron Stephens, Material Matters Systems Development Specialist
Thanks are due the Philadelphia Water Department for financial support, defining system requirements development and critical system review.