The Clinton-Oakland Sewage Disposal System

Collect sewage from about 250,000 people in 11 Cities, Villages and Townships (CVTs) for conveyance to the Detroit System for Disposal

- City of Auburn Hills
- Independence Township
- Lake Orion Village
- Oakland Township
- Orion Township
- Oxford Township
- Oxford Village
- City of Rochester
- City of Rochester Hills
- Waterford Township
- West Bloomfield Township
Map of the System
1996 Management Agreement

- Prior to 1996, it was recognized that the system had more capacity than originally allocated to the CVTs due to routing and travel time effects.
- A study was done to determine how much excess capacity was available.
- 1996 agreement allocated the capacity to CVTs and stipulated monthly penalties for exceeding capacities.
- Using this capacity “pushed the system” and necessitated better tracking of flows to ensure adequate system performance and tracking of CVT peak flows.
The Goal: Change the Billing System from REU-Based to Flow-Based

<table>
<thead>
<tr>
<th>Customer</th>
<th>REUs</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1</td>
<td>3,520</td>
</tr>
<tr>
<td>#2</td>
<td>8,455</td>
</tr>
</tbody>
</table>

![Chart showing flow and rain data for customers #1 and #2.]
The Challenge: Flow Metering is Not an Exact Science

- Even flumes are not perfect
- Dye testing helps, but still leaves discrepancies
- These tools alone are not enough
- There are millions of dollars on the line
Objectives of the Reporting System

- Enforce the COSDS 1996 Management Agreement, which allows for purchase capacity exceedances
- Bill based on more equitable methodology
- Encourage incentives for I/I control & reduction
- Proactively meet the State SSO Policy
- Serve as a diagnostic tool for system performance
Key Success Factors

- The right consultant
- Robust metering system
- Community interaction
- Technical flow review toolbox
The Right Consultant

- Steering committee formed and participated in selection
- QBS process used for selection
- OHM Selected
- Primary differentiator: value added tools for wet weather modeling
- Versatility on both technical abilities and communication with public officials
Robust Metering System

- Needed to accomplish more accurate billing
- More direct metered districts (22 new meters)
- Brought the total to 61 billing meter sites
- Parallel AV meters at flumes experiencing surcharging (6 new meters)

<table>
<thead>
<tr>
<th>CVT</th>
<th>% Directly Metered Previous Meters</th>
<th>% Directly Metered New Meters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auburn Hills</td>
<td>57%</td>
<td>97%</td>
</tr>
<tr>
<td>Independence Township</td>
<td>80%</td>
<td>80%</td>
</tr>
<tr>
<td>Lake Orion Village</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>Oakland Township</td>
<td>6%</td>
<td>59%</td>
</tr>
<tr>
<td>Orion Township</td>
<td>65%</td>
<td>80%</td>
</tr>
<tr>
<td>Oxford Township</td>
<td>0%</td>
<td>89%</td>
</tr>
<tr>
<td>Oxford Village</td>
<td>76%</td>
<td>76%</td>
</tr>
<tr>
<td>Rochester Hills</td>
<td>4%</td>
<td>62%</td>
</tr>
<tr>
<td>Waterford Township</td>
<td>0%</td>
<td>74%</td>
</tr>
<tr>
<td>West Bloomfield Township</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>COSDS System</td>
<td>28%</td>
<td>77%</td>
</tr>
</tbody>
</table>

* 23% incrementally metered
Community Interaction

- Steering committee participation
- Quarterly COSDS Meetings
- Individual community one-on-one meetings
- Mock-bills computed for one year
- Project web site established
Billing Flow Review
Toolbox
Billing Components

- Volumetric component - requires good understanding of dry weather flows
- Peak flow component - requires accuracy in metering system during wet weather flows

Volumetric Formula

+ Direct metered districts
+ Incremental Districts
+ Interceptor I/I Adjustment

= CVT Billed Flow
Billing Flow Review Tools

1. **Dye testing** - accurate metering
2. **Mass flow balance** - accurate allocation of incremental flow
3. **Wet weather flow editing** - fill in gaps during wet weather when a meter fails
4. **Hydraulic routing** - accounting for routing and travel time for accurate peak flow bills
5. **Interceptor I/I** - accurate identification and allocation
Tool #1 - Dye Testing

- Procedures / methodology
- How it was used - applied as a constant factor
- Dye testing periodically updated (annually)
Dye Results at Outlet
(all flows dye corrected)

Metered Upstream Flows to Meter 1001 = 40.7 cfs

Flow from 1001 and 1020 should balance with 1000

1001 + 1020 = 38.95 cfs

Investigation into 1001 later uncovered an issue with the dye test set-up.
Tool #2 - Mass Flow Balance

- Flows averaged for an entire quarter
- Dye factors applied as a constant factor
- Per capita flows computed for direct and incremental areas
- Incremental flows suggest ELPS is high
Tool #2 - Mass Flow Balance

- Reduced ELPS by 10%, which greatly improves the incremental balance
- Criteria developed for allowable minor changes
- Significant numerical changes reviewed by mass flow balance team
- Review of ELPS meters in field showed SCADA scaling issue

Local Direct Meters

- 1.3 cfs (126 gpcd)

1.3 cfs (126 gpcd)

Incremental:

- 1.3 cfs (149 gpcd)

12.7 cfs (100 gpcd)

ELPS

1.4 cfs (149 gpcd)

10.1 cfs (103 gpcd)

3.0 cfs (95 gpcd)
Tool #3 - Wet Weather Editing

- Wet weather flows are very important because of peak component to the billing system.
- Flow meters are more prone to issues and failure during peak flow events.
- Accurate editing tool desired to “fill in gaps” during periods of meter failure or inaccuracy.
- Two independent methods used to edit wet weather flows: meter correlations and the antecedent moisture model.
Antecedent Moisture Effects on Wet Weather Flows

- **April 9 Storm**: Rain = 1.1\" C% = 3.6%
- **April 26 Storm**: Rain = 1.6\" C% = 4.4%
- **May 31 Storm**: Rain = 1.0\" C% = 0.6%
- **June 16 Storm**: Rain = 0.6\" C% = 1.2%
- **July 7 Storm**: Rain = 0.8\" C% = 0.5%
- **August 6 Storm**: Rain = 3.5\" C% = 1.7%
The Antecedent Moisture Model

- Based on system identification techniques from aerospace control systems and digital signal processing
- Continuous modeling approach as opposed to an event based model for I/I
- Separate models for inflow and infiltration vary continuously
- Model at each time step adjusted based on antecedent rainfall and temperature
Antecedent Moisture Accurately Simulates Dry and Wet Conditions

- **April 9 Storm**: Rain = 1.1"  C% = 3.6%
- **April 26 Storm**: Rain = 1.6"  C% = 4.4%
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- **June 16 Storm**: Rain = 0.6"  C% = 1.2%
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- **August 6 Storm**: Rain = 3.5"  C% = 1.7%
Wet Data Editing

- Two methods used to review data
- Primary is meter correlation to adjacent meters
- Secondary is antecedent moisture model
Tool #4 - Incremental Districts
Hydraulic Routing

- EXTRAN hydraulic model used for routing
- Model accounts for routing & travel time effects
- Incremental hydrograph uniquely determined through iterative identification process
Tool #5 - Interceptor I/I

- Needs to be properly allocated to the system
- Can not be directly measured from metering data
- Use meter outlet meter (1000) nighttime flows as indicator of interceptor I/I
- Captures the variations in time in interceptor I/I
Tool Development Conclusions

- Flow meters are not perfect - some editing and corrections are needed for use in billing
- Dye testing alone will not initially result in adequate mass flow balance - other tools needed
- It is critical to involve the full team in reviewing numeric edits: data processors and field staff
- “Belt and Suspenders” - two methods to edit wet weather flows provides confidence in bills
- Billing system provided more value than just bills: system diagnostics & proactive SSO control
Billing System Conclusions

- Recognize that sewage flow metering is not an exact science

- But remember the objectives:
  - Bill based on more equitable methodology
  - Enforce the operating agreements
  - Serve as a diagnostic tool for system performance
  - Encourage incentives for I/I control & reduction
  - Proactively meet the State SSO Policy

- Flow metering meets the objectives better than prior REU methodology
Questions?