INTEGRATED MODELLING USING DATA DRIVEN MODELS

ED GOWER
JOSS PLANT
AGENDA

- Background
- Previous Modelling
- New Methodology
  - Baseline performance
  - Future performance
- Results and Discussion
- Conclusions and Innovation

Water quality assessments can be carried out without full models of the catchment
BACKGROUND

Client: UK water company

Sewage Treatment Works Upgrade Project

- Improve treated effluent quality
- Minimise construction

Water quality study required to justify proposals
REGULATORY CONTEXT

• Urban Pollution Management study
PREVIOUS MODELLING

Verified network model

Sewage Treatment Works
NEW METHODOLOGY

Baseline performance
HISTORIC SPILL PERFORMANCE

A + B − C = D

Diagram showing the flow of water from different levels and stages, with arrows indicating movement and labels for each component.
INTERMEDIATE LEVEL INLET WORKS
D: RATE OF EMPTYING/FILLING OF THE INTERMEDIATE LEVEL INLET WORKS

\[ A + B - C = D \]

- Positive = Filling
- Negative = Emptying
- 0 = Steady State
CONVERTING D (FILLING / EMPTYING) TO SPILLS

Intermediate Level Wet Well

Storm Tank Weir Level

Ultrasonic Depth Measurement
CONVERTING D (FILLING/EMPTYING) TO SPILLS

Observed Spill Flows

Spill Coincides with 85% Depth

Observed Intermediate Wet Well Depth
CONVERTING FROM D (FILLING/EMPTYING) TO SPILLS

\[ A + B - C = D \]

- When depth \( \geq 85\% \), spills to watercourse occurring
- Available storage filled and system in steady state
- For these periods:

\[ D = \text{Spills} \]
NEW METHODOLOGY

Future performance
REFINING METHODOLOGY

• Future scenario includes:
  • Growth
  • Reduced Flow to Full Treatment
  • Automatic return.

• Methodology uses combination:

  • Historic rainfall
  • Population and infiltration removed.
FUTURE MODELLING: GROWTH

Full model inc subcatchments

Growth catchments only
FUTURE MODELLING

Growth

Low Level Inlet Works

Archimedes Screw Pumps

Northern TPS

A

Inlet Works Model

B

FFT

Treatment

Spills to Watercourse

Spills

METHODOLOGY: FUTURE PERFORMANCE
FUTURE MODELLING

New inflow into inlet works
KEY ASSUMPTIONS IN FUTURE MODELLING

• Future flows not throttled
• Double counting
CALCULATION OF RETURN FLOWS

- Included in existing data
- Storm tank emptied manually

Low Level Inlet Works → Archimedes Screw Pumps → Intermediate Level Inlet Works → Storm Storage → Northern TPS → Pumped FFT → Treatment

- Return flows to Storm Storage
- Spills to Storm Tanks
- Spills to Watercourse
RESULTS AND DISCUSSION
RESULTS OF THE UPM: SPILL COUNT

Results and Discussion

- Current STW
- Future STW & Growth
- Future STW & Growth (returns removed)
RESULTS OF THE UPM: SPILL VOLUME

Total Spill Volume [m³]

0 400,000 800,000 1,200,000 1,600,000

Current STW

Future STW & Growth

Future STW & Growth (returns removed)
RESULTS OF THE UPM

BOD 99%ile [mg/l]

- Current STW: 0.73, 7.01
- Future STW & Growth: 0.78, 6.82
- Future STW & Growth (returns removed): 0.75, 6.54

Ammonia 99%ile (mg/l)

- Current STW: 0.0236
- Future STW & Growth: 0.38
- Future STW & Growth (returns removed): 0.38

BOD 90%ile

- Current STW: 0.73, 7.01
- Future STW & Growth: 0.78, 6.82
- Future STW & Growth (returns removed): 0.75, 6.54

Ammonia 90%ile

- Current STW: 0.0236
- Future STW & Growth: 0.38
- Future STW & Growth (returns removed): 0.38
CONCLUSIONS AND INNOVATION
CONCLUSIONS

• Using a network model not always possible.
• Network model under predicts the existing spills.
• Manual operation difficult to represent in network model
• Data driven methodology matches actual performance.
• Methodology relies on telemetry data
INNOVATION

• Uses telemetry
• Spreadsheet based
• Matches anecdotal evidence
• Accounts for manual operation
QUESTIONS?
Building a world of difference.

Together

BLACK & VEATCH
A: INFLOW FROM THE SCREW PUMPS

Historic Telemetry Depth

Head-Discharge

0-1350 l/s
B: INFLOW FROM NORTHERN TERMINAL PUMPING STATION

0-284 l/s
C: FLOW TO FULL TREATMENT FROM TELEMETRY DATA
# RESULTS OF THE UPM

<table>
<thead>
<tr>
<th>Scenario No.</th>
<th>Description</th>
<th>Total Spill Volume (m³)</th>
<th>Spills Per Year</th>
<th>90%ile concentration</th>
<th>99%ile Concentration</th>
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<tbody>
<tr>
<td>1</td>
<td>River Only</td>
<td>N/A</td>
<td>N/A</td>
<td>2.78</td>
<td>0.09</td>
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<td>2</td>
<td>River &amp; STW (Current)</td>
<td>N/A</td>
<td>N/A</td>
<td>3.28</td>
<td>0.34</td>
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<td>3</td>
<td>2006-2008 (Current)</td>
<td>1,557,879</td>
<td>36</td>
<td>3.42</td>
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<td>4</td>
<td>River &amp; STW (Future)</td>
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<td>N/A</td>
<td>3.35</td>
<td>0.37</td>
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<td>5</td>
<td>2006-2008 with growth (return flows included)</td>
<td>1,480,713</td>
<td>24</td>
<td>3.46</td>
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<td>2006-2008 with growth (return flows removed)</td>
<td>1,157,296</td>
<td>20</td>
<td>3.44</td>
<td>0.38</td>
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</tbody>
</table>

(WFD High) RE1
(4.0) 2.5 (0.3) 0.3 5.0 0.6

(WFD Good) RE2
(5.0) 4.0 (0.6) 0.6 9.0 1.5

(WFD Moderate) RE3
(6.5) 6.0 (1.1) 1.3 14.0 3.0

(WFD Poor) RE4
(9.0) 8.0 (2.5) 2.5 19.0 6.0