REAL-WORLD MODELLING

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Overview

- Modelling Approach
- 3 Case Studies
  - specific features of interest
  - challenges

Modelling Approach

- Data
- Plant Operation
- Influent Characterisation
- Inconsistency Explanation
- Scenario Definition

Data

- Physical
  - tank sizes, connectivity, aeration
- Operational
  - flows (recycles & surplus)
- Process
  - influent, effluent, internal

Plant Operation

- Control Strategies
  - aeration
  - MLSS targets
  - recycle control
- Plant-Specific Operational Issues
  - low DOs during storms
  - weekly trends

Influent Characterisation

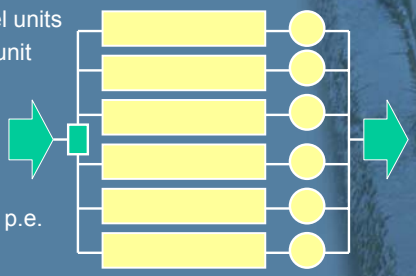
- Most Important Aspect
  - reduction to constant ratios
  - site specific (source dependent)
- State vs Composite Variables
  - typical measurements

Inconsistency Explanation

- Inconsistent Ratios
- Variable Settling
- Parallel Units *not* Parallel
  - hydraulic impacts
  - aeration differences
  - SAS rates not the same

Case Study 1

- 6 parallel units
- 4 lanes/unit



- 1 million p.e.

Case Study 1

- Inconsistency in Parallel Lanes
  - symptoms:
    - uneven air demand
    - blower activity
    - SAS rates
  - BUT, flow meters showed equal flows to all lanes

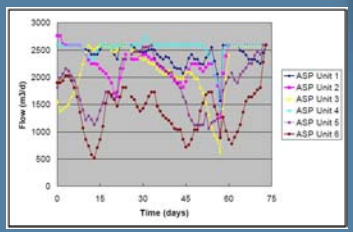
Case Study 1

- Inconsistency in Parallel Lanes
  - symptoms:
    - uneven air demand
    - blower activity $O_{2,1} \neq O_{2,2} \neq O_{2,3} \neq O_{2,4} \neq O_{2,5} \neq O_{2,6}$
    - SAS rates
  - BUT, flow meters showed equal flows to all lanes

$$Q_{inf,1} = Q_{inf,2} = Q_{inf,3} = Q_{inf,4} = Q_{inf,5} = Q_{inf,6}$$

Case Study 1

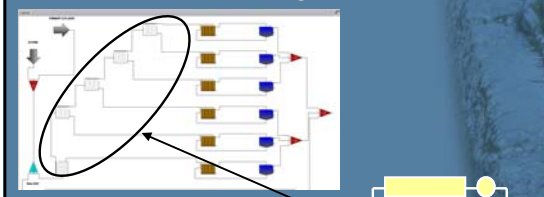
- SAS Rates (Waste Sludge)

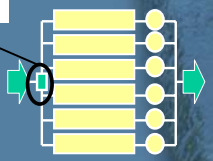


Case Study 1

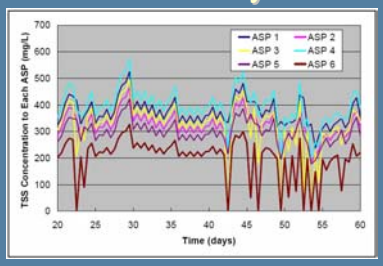
- Inconsistency in Parallel Lanes
  - solution:
    - suspicion of engineer
    - ASP splitter box model
    - 6 membrane objects
    - hydraulic & solubles evenly split
    - particles unevenly split

Case Study 1





Case Study 1



Case Study 1

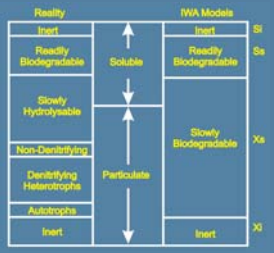
- Calibration – Influent Focus
  - state vs composite variables
  - variable meaning
    - measured vs modelled
    - reconciling data
  - consistency in approach
    - mathematics vs modelling

Influent Characterisation

- "Particulate" Consideration
  - Lab - based on what the filter paper (normally 0.45um) captures
  - Model – substrate that undergoes slow hydrolysis

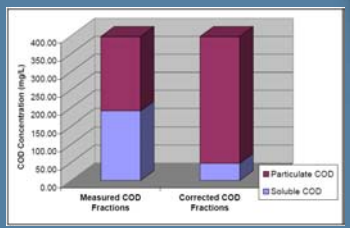
Influent Characterisation

- State Variable Fractionation



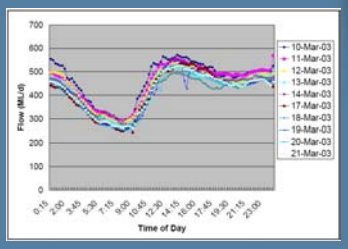
Case Study 1

- Measured vs Modelled



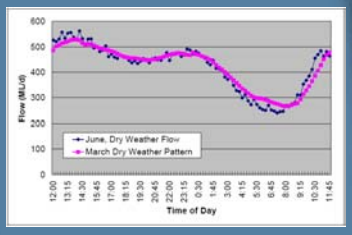
Case Study 1

- Influent Dry Diurnal Flows



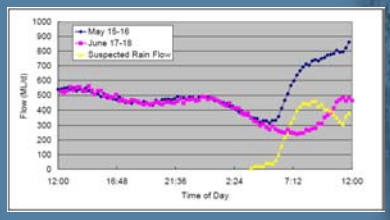
Case Study 1

- Influent Dry Diurnal Flows



Case Study 1

- Influent Storm Flows

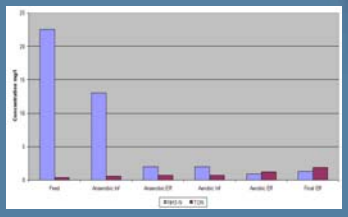


Case Study 1

- Goal
  - to explain apparent inconsistencies
  - to develop an influent model
    - constant ratios
    - variable loads and flows
  - to develop a usable tool

Case Study 2

- Inconsistent Process Data
  - ammonia drop across anaerobic zone



Case Study 2

- Ammonia Drop / Mass Balance
  - not expected, not typical
  - consistent with other pilot plants
- Possible Explanations
  - struvite
  - air infiltration
  - back-mixing

Case Study 2

- Struvite
  - $Mg(NH_4)PO_4 \cdot 6H_2O$
  - anaerobic precipitation
  - pH dependent
- Model
  - 600mg/L of Mg required

Case Study 2

- Air Filtration
  - simultaneous nite/denite
- Model
  - eff P & NO3 too high
  - low anaerobic P release
  - anaerobic ammonia too high

Case Study 2

- Unintentional Back-Mixing
  - recycling of aerobic tank contents
- Model
  - estimated flow to fit data
  - eff P & NO3 good
  - P release correct
  - confirmed possibility in empty pilot

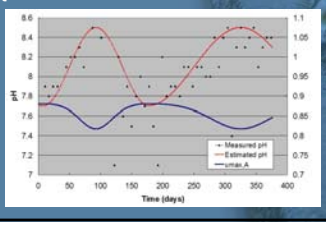
Case Study 2

- Filament Issues
  - peroxide dosing
  - nitrification inhibition
- Model
  - added inhibitory peroxide switch

$$peroxide\ switch \rightarrow \frac{k_{z,peroxide}}{k_{z,peroxide} + S_{peroxide}}$$

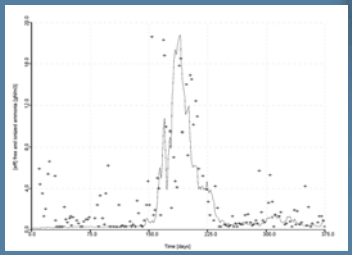
Case Study 2

- pH Issues
  - high pH measurements
  - nitrification impact
- Model
  - added pH code



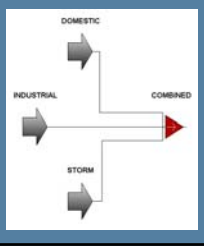
Case Study 2

- Effluent Ammonia



Influent Characterisation

- Influent Load Splitting
  - domestic, storm, industrial



Influent Splitting

- Better Influent Representation
- Impact of Specific Loads
  - storms, industrial changes

Influent Characterisation

- Storm Contributions
  - impact on loads
  - impact on behaviour
- Local Industrial Contributions
  - sometimes significant
  - impact of variability

Case Study 3

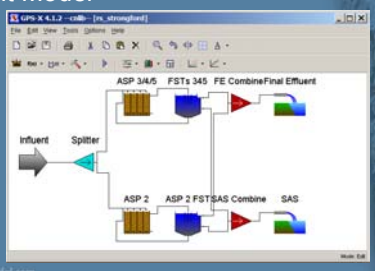
Easily the Most Complicated, Simple Project

Case Study 3

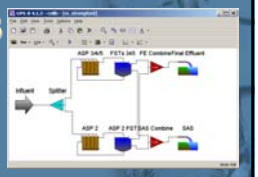
- Goal
  - to check previous client-developed model
  - to create a new model based on design

Case Study 3

- Client Model



Case Study 3



- Model Issues
  - solids not matching
  - flow splits from sources
  - flow distribution during rain events
- Model assumed ideal conditions

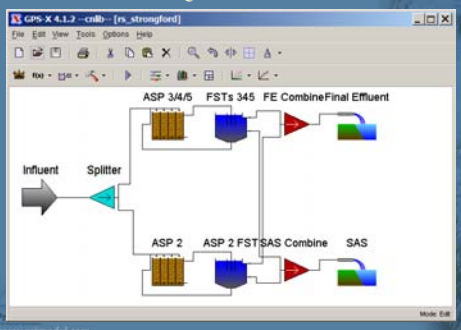
Case Study 3

- Influent Splitting
  - Guessing vs Estimating
    - influent characterisations
    - different sources (centrate, liquors, influent)
  - Goal
    - to justify realistic assumptions
    - use, obtain reasonable ratios

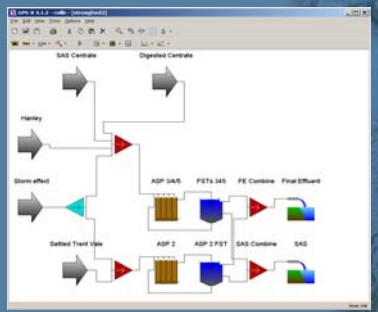
Case Study 3

- Flow Splitting
  - symptoms:
    - MLSS concentrations, SAS rates
  - solution:
    - uneven splitting of SAS centrate
    - 67% (3), 6% (4), 27% (5)
    - reflects operator suspicions

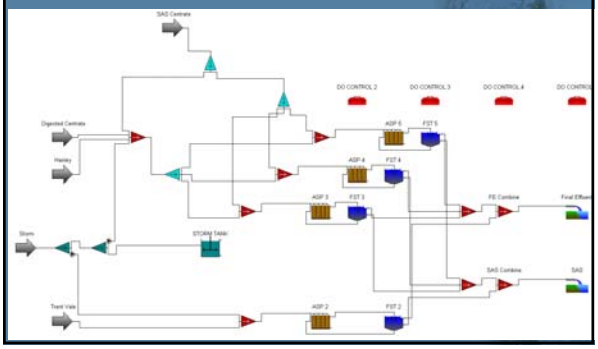
Case Study 3 - Ideal



Case Study 3 – Client Model



Case Study 3 – Primodal Model



Case Study 3 - Complexity

- Goal
  - to create model with a ***sufficient*** and ***justified*** level of complexity – no more
- Complexity…?
  - more complex ***not*** always better

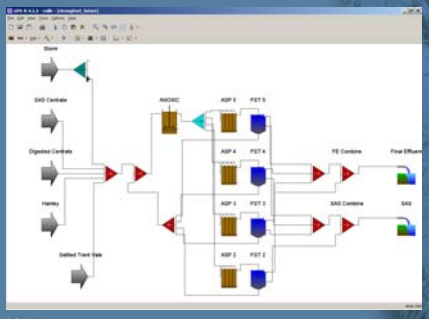
Case Study 3 - Complexity

- Issues
  - clearly different wastewater sources
  - know unequal domestic split of influent
  - ASP lanes clearly not parallel
  - storm flows unequal
  - more complex model only way to mimic measured behaviour

Case Study 3 - Complexity

- Current vs Future
  - measured behaviour
  - design consideration
  - ideal conditions vs reality
- Model Scope / Use
  - model ***must*** reflect this

Case Study 3 – Design Model



Inconsistencies

- Physical Reasons
  - flow splitting
  - connectivity, missing information
- Model Reasons
  - modelled behaviour insufficient
  - custom coding
  - new models

Summary

- Every Model
  - is different
  - is a special case
- Don't Lose Sight of The Goal