Using Wastewater Treatment Simulators for Improving Operations

Thursday August 23, 2018
1:00 – 3:00 PM EST

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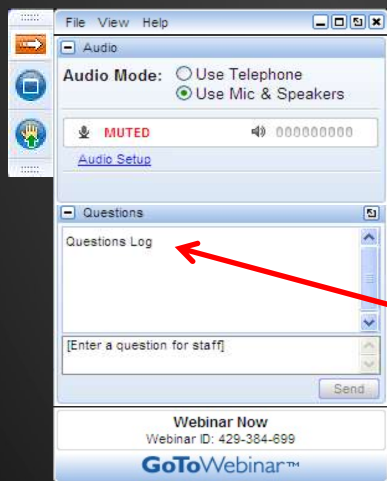
How to Participate Today



- Audio Modes
  - Listen using Mic & Speakers
  - Or, select "Use Telephone" and dial the conference (please remember long distance phone charges apply).
- **Submit your questions using the Questions pane.**
- **A recording will be available for replay shortly after this webcast.**

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Today's Moderator

John B. Copp Ph.D.
Primodal Inc.
Hamilton, Ontario

Primodal Earth Essential Technologies

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Ops Modeling – Aug. 23, 2018

An MRRDC Webcast

Modeling for Operations

- Topics:
  - Introduction to Modeling for Operations
  - Model Features
  - Operations Case Studies

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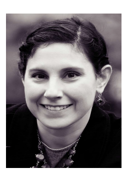
Ops Modeling – Aug. 23, 2018

An MRRDC Webcast

Modeling for Operations

- Speakers:


Spencer Snowling	Adrienne Menniti	Lina Belia	Jared Buzo	George Sprouse
Hydromantis	Clean Water Services	Primodal	Oakland County, MI	Metropolitan Council

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Our Next Speaker

Spencer Snowling, Ph.D
V.P., Product Development

Hydromantis
Environmental Software Solutions, Inc.

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Introduction to Modelling as an Operational Tool

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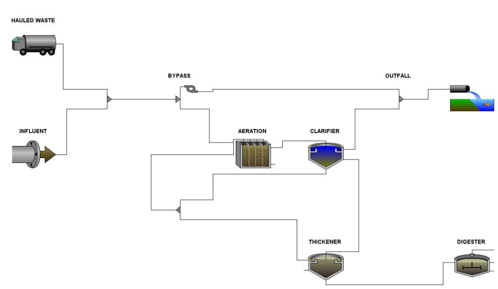
Agenda

- Introduction to Wastewater Models
- Modelling and Simulation as a Wastewater Engineering Tool
- Typical Applications

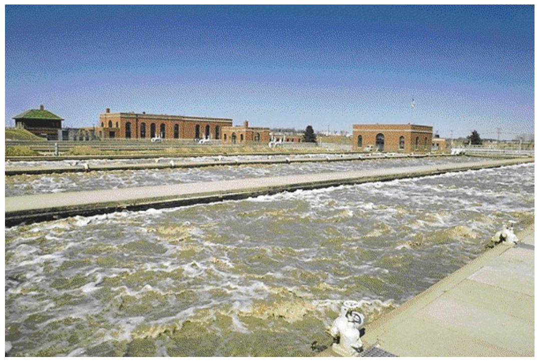
Activated Sludge Modeling

- Activated Sludge Models (ASM) have been a standard tool for wastewater process design for three decades



Activated Sludge Modeling

- Based on mass balance of COD, nitrogen, phosphorus and other components



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Activated Sludge Modeling

- Requires data from the plant:
  - Tank sizes, clarifier surface areas, depths
  - Operational settings (aeration, RAS, WAS)
  - Influent information (flow, concentrations)
  - Performance data (effluent quality)
- Models have to be calibrated to known plant performance

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Activated Sludge Modeling

- Once calibrated, models allow us to predict the concentrations throughout the water resource recovery facility (WRRF)

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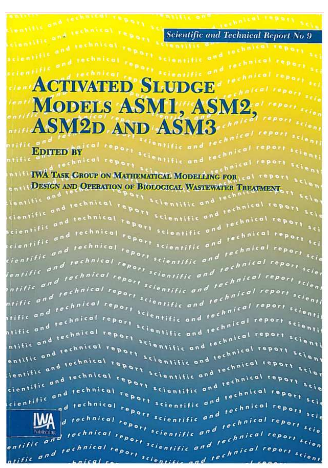
History of Activated Sludge Models



ASM1, ASM2d, ASM3 defined the original model structure

IWA Scientific and Technical Report No. 9

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Activated Sludge Modeling

- Model can “**stand in**” for the real system when it’s not feasible for testing:
  - Too risky (compliance concerns)
  - Physically not possible (e.g. retrofits)
  - Operationally not possible (bypass/splits)
  - Cost
  - Physical conditions (e.g. storms)
  - Time (I need an answer now!)

Why Use Simulation?

- Models are usually cost-effective first steps to implementing change
- Gives a degree of confidence that decisions are supported with data and analysis

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Typical Applications

- **Engineering design assistance:**
  - Using the model to check/confirm designs
  - Optimization of tank and clarifier sizes

Typical Applications

- **Trouble-shooting and optimization:**
  - "What if" scenario analysis
  - Operating cost optimization (energy, chemicals)

Typical Applications

- **Planning:**
  - Taking units out of service
  - Risk analysis

Typical Applications

- **Operator training and education:**
  - Interactive simulation-based education
  - WEF Operations Challenge competition

Conclusions

- The traditional IWA model structure (ASM1, ASM2d, etc.) has extended beyond its original design origins to be used for operational decision-making, planning and training

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Our Next Speaker

Adrienne Menniti

Senior Process Technologist

Clean Water Services

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Key things to consider when building a modeling program

Adrienne Menniti
Clean Water Services, Oregon

The evolution of a proven tool[1]

Academic
Process engineers

↓

Consulting
Process engineers

↓

Utilities
Process engineers

↓

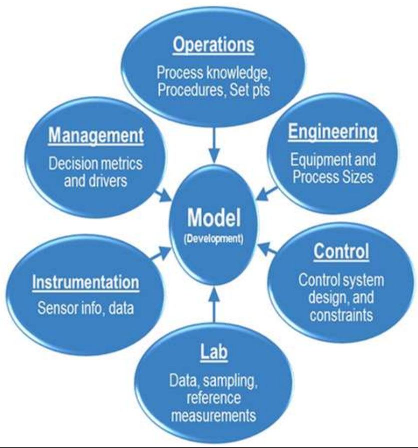
Utilities
Operators

More and more utilities are building programs for process modelling to support decision making.

1. Belia *et al.* (2015) *The evolution of a proven tool: Adapting process models for operations staff.* WE&T, **27**(9), 65-69.

Why?

Modeling is data intensive



Belia, E. (2017) *Incorporating models into the daily work of site staff*. WEFTEC 2017.

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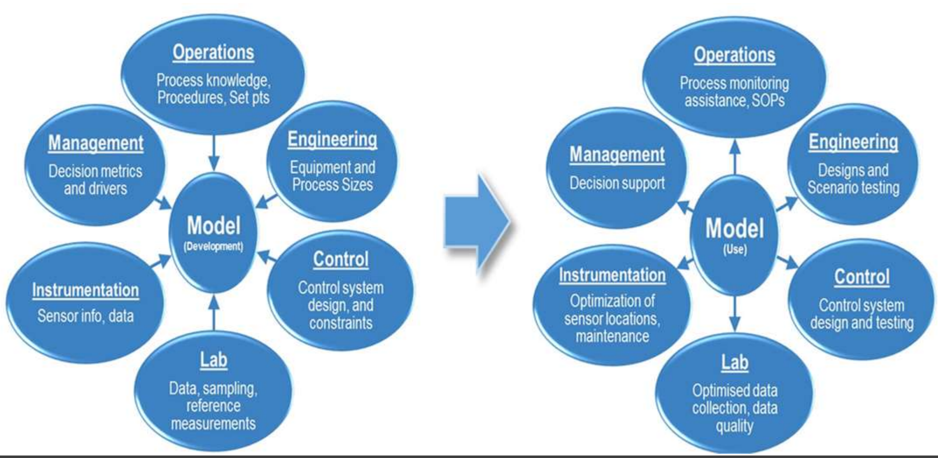
Why?

The knowledge gained through model development and use is a significant asset



Belia, E. (2017) *Incorporating models into the daily work of site staff*. WEFTEC 2017.

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Survey to understand how models are used at utilities

- Performed by Models for Operations Task Group
- Phone interviews
- 22 U.S. utilities
- 33 medium and large facilities
- Results presented:
  - 2014 WEFTEC workshop
  - September 2015 WE&T article

The evolution of a proven tool

Adapting process models for operations staff

Evangelina Belia, Jennifer Walsh, Stacy Passaro, Phill Yi, Kristin Waller, Adrienne Menniti, and Maureen O'Shaughnessy

Process models help every day in the evaluation, optimization, and design of water resource recovery facilities (WRRFs). Traditionally, models have been seen as capital design tools developed by engineers to be used by engineers. But process models can be powerful tools that help operations staff manage the challenges of today's more complex facilities and balance such goals as effluent quality, energy conservation, energy production, greenhouse-gas emissions minimization, and nutrient recovery.

To find a path toward increased model use by operations teams, the Water Environment Federation (WEF) Task Group on Modeling for Operations conducted a survey of municipal WRRFs. Understanding the challenges to overcome and identifying solutions can smooth the transition of process models from one-time-use design tools to daily operational tools for utility engineers and operators.

Survey details

To better understand the current experience with models, the task group conducted phone interviews with representatives of 22 utilities across the U.S. (See Figure 1, below.) The facilities ranged in treatment capacities, effluent requirements, stormwater issues, and operational strategies. Those interviewed were asked whether their facilities used models, what they used them for, and what major challenges and barriers prevented or hindered model use.

Figure 2 (p. 69) shows that more than half of the surveyed utilities do or are planning to use models for operation support. The seven utilities using in-house models operate one or more facilities that range in size from 4 to 492 ML/d (1 to 130 mgd) and have senior process-staff members who have previous modeling experience.

The surveyed utilities were categorized to identify their level of modeling activity: actively using process models, planning to implement models, or no plans to implement modeling.

Figure 1. Geographical location of utilities surveyed

WWW.WEF.ORG/MAGAZINE | SEPTEMBER 2015 | WE&T 65

1. Belia *et al.* (2015) *The evolution of a proven tool: Adapting process models for operations staff.* WE&T, **27**(9), 65-69.

Common barriers for model implementation at utilities

1. Time and funding
2. Staff familiarity and training
3. Confidence in model predictions
4. Data collection and management

Challenge: Time and Funding

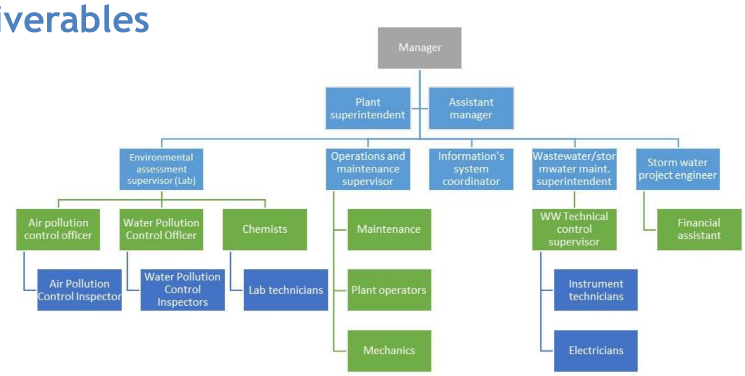
Model-related tasks are time consuming.

Utilities need to understand the level of investment required to produce desired outcomes

Solutions: Time and Funding

All levels in organization find value/support

One or more positions have key model-focused deliverables



Solutions: Time and Funding

Case studies with time/costs more accessible

Utility	Typical Internal Hours/Week	Yearly External Support Contract
Clean Water Services, OR	8 - 16	$30,000
Trinity River Authority, TX (internally maintained model)	16	
Trinity River Authority, TX (consultant maintained model)		$20,000
City of Raleigh Public Utilities, NC	8	
Metropolitan Council Environmental Services, MN	8 - 20	$5,000 (staff training by software vendor)
Ontario Clean Water Agency, ON	4 - 6	

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Challenge: Staff familiarity/training

Process modelling requires a specialized skill set that is not typically required of today's operations staff

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Solutions: Staff familiarity/training

Hire experienced staff → process engineer

Consultant or developer support

Utility	Internal	Internal & External	External
Clean Water Services, OR		X	
Trinity River Authority, TX	X		
City of Grand Rapids, MI			X
Oakland County, MI		X	
City of Raleigh Public Utilities, NC	X		
Howard County Little Pantunxent WWTF, MD		X	
Metropolitan Council Environmental Services, MN		X	
Ontario Clean Water Agency, ON	X		

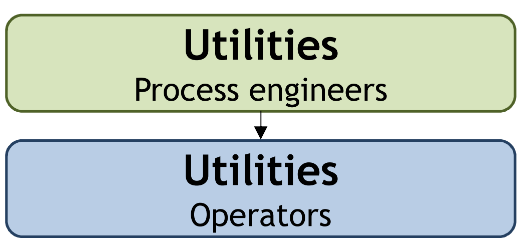
Solutions: Staff familiarity/training

Build from operations challenge

- Incorporate models into operator training programs

Use model for routine operations tasks

- What should my wasting rate be?



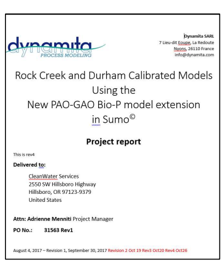
Challenge: Confidence in predictions

Skepticism of the model predictions can hinder model transition from engineers to operators

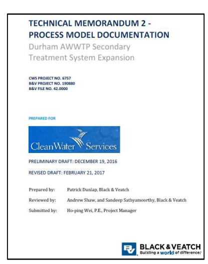
Solutions: Confidence in predictions

Structured documentation program → reports

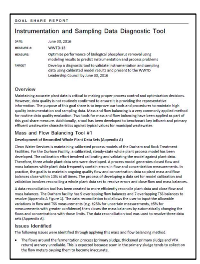
Ongoing maintenance program


Rock Creek and Durham Calibrated Models Using the New PAO-GAO Bio-P model extension in Sumo©

Project report

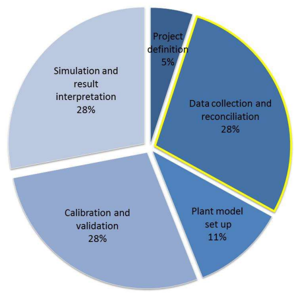

TECHNICAL MEMORANDUM 2 - PROCESS MODEL DOCUMENTATION

Durham AWWTP Secondary Treatment System Expansion


Instrumentation and Sampling Data Diagnostic Tool

Challenge: Data

Collecting, organizing, validating and transferring the data needed for routine model use is time-consuming and cumbersome



Adapted from
Hauduc *et al* (2009) Activated sludge modelling in practice – an international survey. WS&T 61(4) 1943
Rieger *et al* (2013) Guidelines for using activated sludge models. IWA STR No. 22

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Solutions: Data

Acknowledged importance of data quality and organization

Custom developed tools

Rigorous data management approaches

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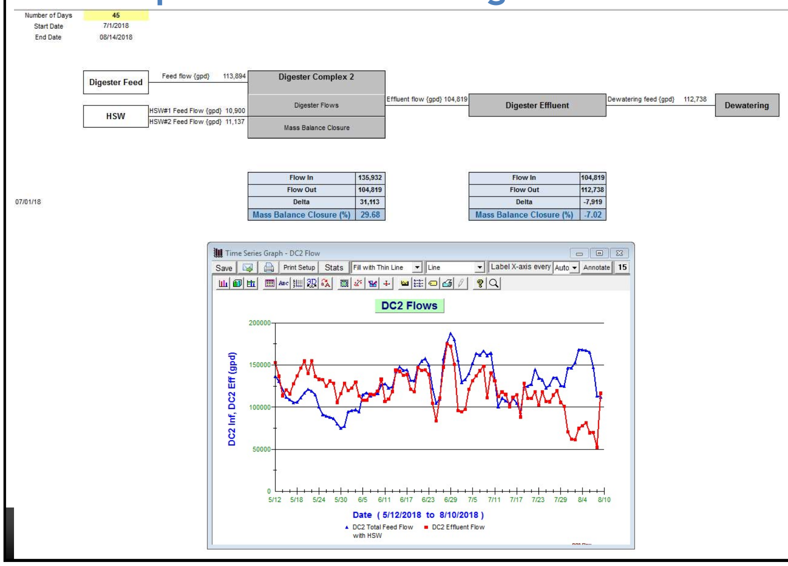
Solutions: Data

Example - Flow balancing dash board



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Conclusion

Utilities are increasingly investing in process modelling programs

Sharing lessons and resources amongst utilities is valuable and encouraged

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Our Next Speakers

Jared Buzo, P.E.
Oakland County, Michigan

WRC
WATER RESOURCES COMMISSIONER
Jim Nash

Evangelina Belia, Ph.D., P.Eng.
Primodal Inc.
US & Canada

Primodal
Earth Essential Technologies

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Whole Plant Modeling of the Clinton River WRRF: Creating and Using a Model for Practical Applications

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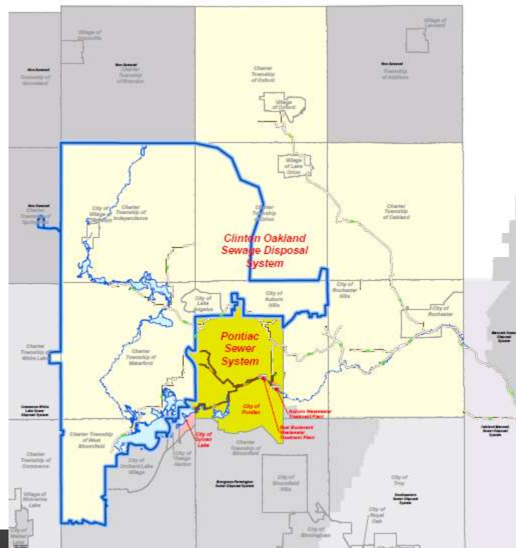
Clinton River WRRF

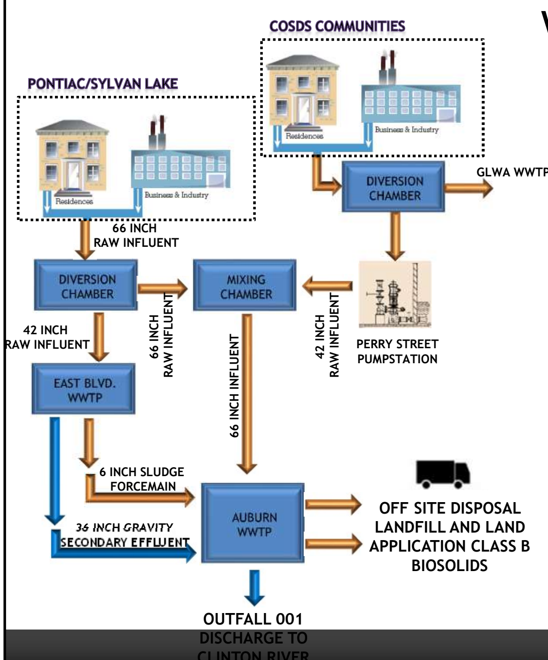
Influent	Primary Effluent	Mixed Liquor	Secondary Effluent	Final Effluent

Agenda

- Introduction to the Clinton River WRRF
- Model Initiation
- Model Training/Strategy
- Continued Use
- Summary

Wastewater System





Wastewater System

- Service
  - City of Pontiac – 55,870 (population)
  - Sylvan Lake – 1,835
  - 30% of the COSDS - 125,038 (population)
    - Approximately 70% of the 8 tributary communities
- Pontiac WWTP activated sludge plant
  - Treatment Capacity 30.5 MGD
  - Peak flow rate 41.3 MGD
  - Average flow of 20 MGD
- Solids Disposal
  - Average day -15.6 Dry tons
  - Peak of 26.5 Dry tons

East Boulevard Site Layout

Auburn Site Layout

Plant effluent limits

Parameter	Maximum Limits for Quantity or Loading Monthly	7-Day	Daily	Units	Maximum Limits for Quality or Concentration Monthly	7-Day	Daily	Units	Monitoring Frequency	Sample Type
Flow	(report)	---	(report)	MGD	---	---	---	---	Daily	Report Total Daily Flow
Carbonaceous Biochemical Oxygen Demand ($CBOD_5$)										
May 1 – Nov 30	1000	2600	---	lbs/day	4	—	10	mg/l	Daily	24-Hr Composite
Dec 1–Mar 31	4300	6600	---	lbs/day	17	---	26	mg/l	Daily	24-Hr Composite
Apr 1 – Apr 30	2000	3100	---	lbs/day	8	—	12	mg/l	Daily	24-Hr Composite
Total Suspended Solids										
May 1 – Nov 30	5100	7700	—	lbs/day	20	30	---	mg/l	Daily	24-Hr Composite
Dec 1–Mar 31	7700	11000	—	lbs/day	30	45	—	mg/l	Daily	24-Hr Composite
Apr 1 – Apr 30	6100	9200	—	lbs/day	24	36	—	mg/l	Daily	24-Hr Composite
Ammonia Nitrogen (as N)										
May 1 – Nov 30	130	510	—	lbs/day	0.5	---	2	mg/l	Daily	24-Hr Composite
Dec 1–Mar31	1500	3600	—	lbs/day	6.0	---	14	mg/l	Daily	24-Hr Composite
Apr 1 – Apr 30	920	1200	—	lbs/day	3.6	---	4.6	mg/l	Daily	24-Hr Composite
Total Phosphorus (as P)	210	---	—	lbs/day	0.82	---	---	mg/l	Daily	24-Hr Composite
Fecal Coliform Bacteria	---	---	—	---	200	400	—	ct/100 ml	Daily	Grab
Total Residual Chlorine	---	---	---	---	---	---	0.038	mg/l	Daily	Grab

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Model Initiation

- Model created as part of a larger project
  - Immediate beneficial results
  - Catalyst to complete the model
- Able to utilize SAW Grant Funding

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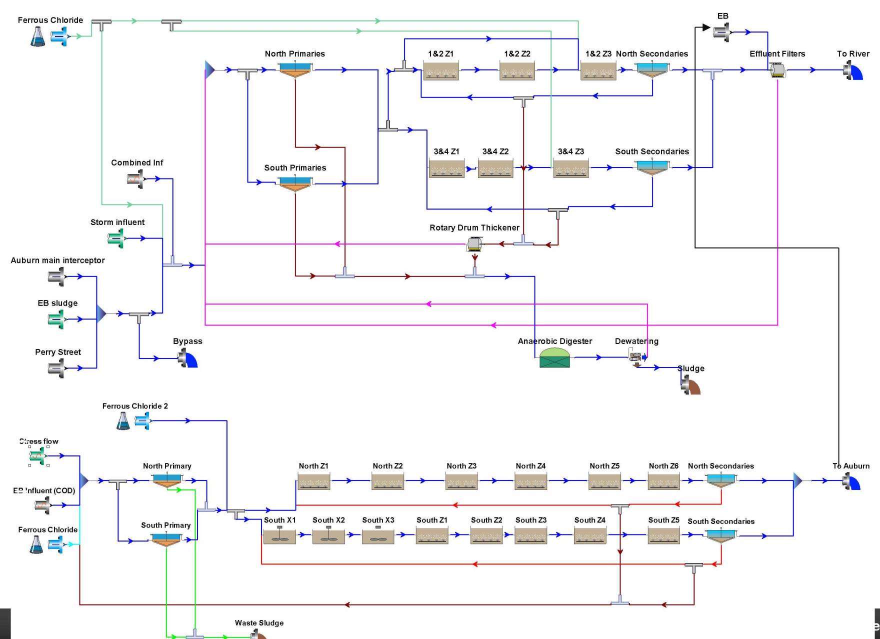
Model Initiation Project

- Capacity Evaluation
  - Increased load and wet-weather capacity evaluation
  - Wet-weather scenarios based on actual plant data profiles that included:
    - the maximum flow seen for 24 consecutive hours
    - the maximum flow seen for 30 consecutive days
  - "Stress" profile developed and progressively increased until one or more processes operating at limit

Model-based Capacity Evaluation



Model-based Capacity Evaluation

- Primary tanks performance evaluation
- Nitrification (shorter HRT)
- Final clarifier performance evaluation
- Impact of sludge processing bottleneck (storing sludge)
- Tertiary filters not evaluated

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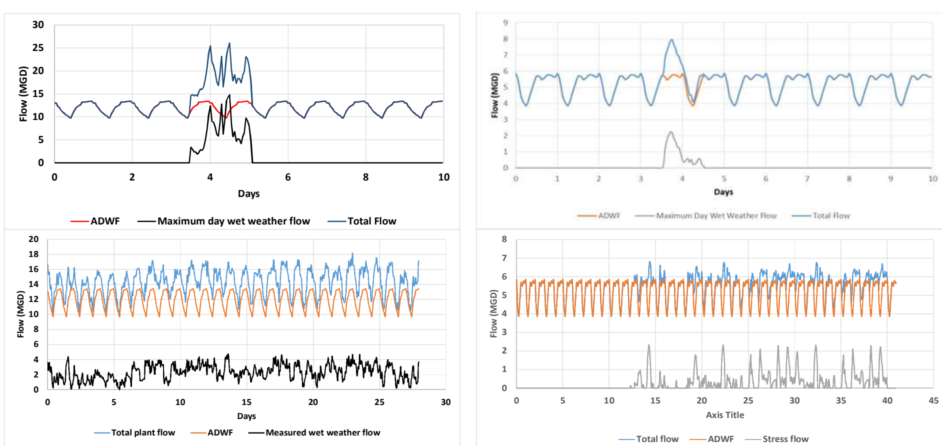
Auburn and EB stress scenarios



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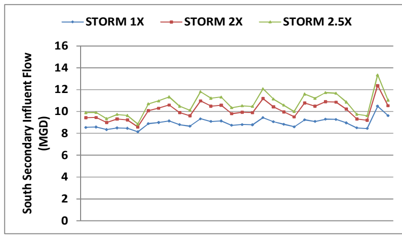
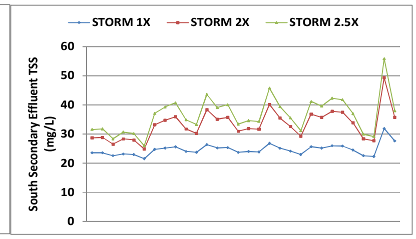
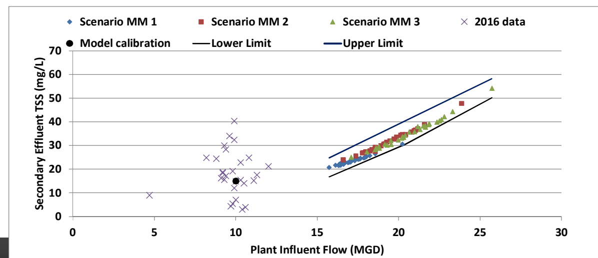
Capacity evaluation results: Maximum Month Scenarios - Auburn

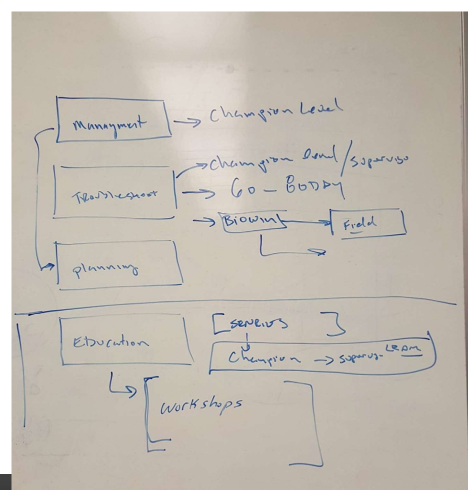






Model Training/Strategy

- After initiation – 3 day training workshop
  - Hands on
  - Key staff members
- Hired Consultant
  - Model updates
  - Complex scenarios
  - Continued training



Continued Use – Consultant

Table 2. Average plant influent flow and units in operation

Scenarios	Flow	Flow split	Primary clarifiers	Bioreactors North	Bioreactors South	Final Clarifiers North	Final Clarifiers South	Temp.
	(MGD)	%	(No)	(No)	(No)	(No)	(No)	(°C)
Validation Scenario	7.14	50-50	4	1	1	2	1	12.5
Scenario 1	9.14	50-50	4	1	1	2	1	12.5
Scenario 2	9.14	50-50	4	1	1	2	2	12.5
Scenario 3	9.14	50-50	4	2	1	2	2	12.5
Scenario 4a	11	50-50	4	2	1	2	2	14.5
Scenario 4b	11	60-40	4	2	1	2	2	14.5
Scenario 5a	12.5	50-50	4	2	1	2	2	14.5
Scenario 5b	12.5	60-40	4	2	1	2	2	14.5

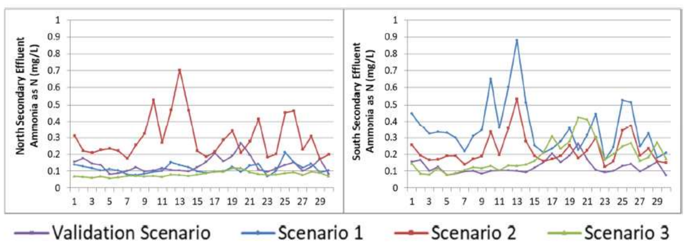
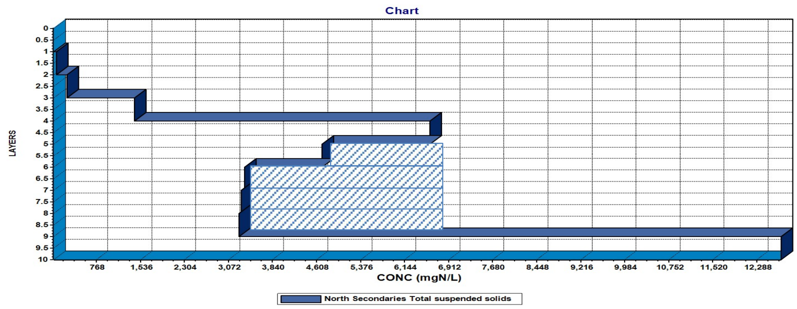


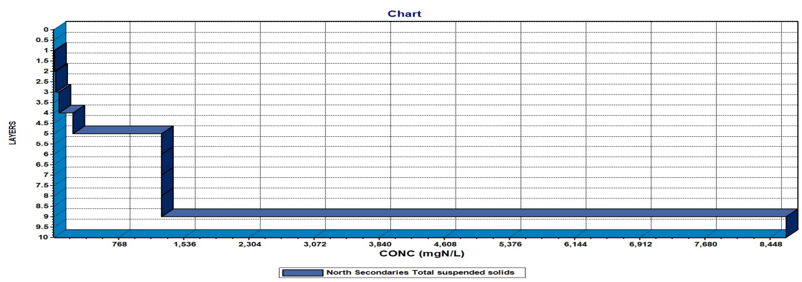
Figure 10. Capacity evaluation scenarios showing North and South secondary effluent ammonia.

Continued Use – Plant Staff

- Temporary loss of digester as part of biosolids improvement project
- Increased flow from upstream pump station
- WAS Thickening system down
  - Co-settle solids

Continued Use – Plant Staff





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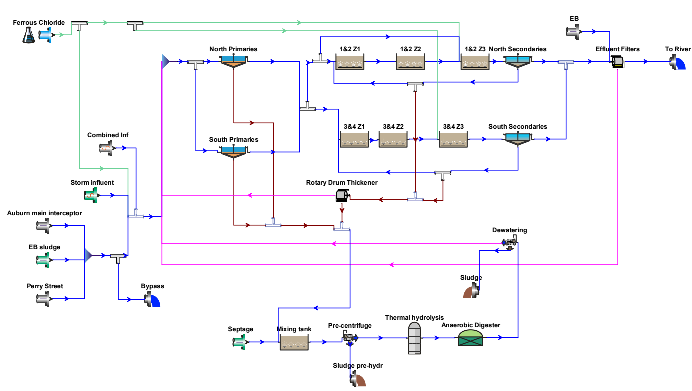
Future Use – Biosolids Handling



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Summary

- Catalyst to initiate the model
- Training
- Multiple resources
- Emphasize planning and experimentation

Questions?

Jared Buzo – Operations Engineer

buzoj@oakgov.com

Our Next Speaker

George Sprouse

Manager of Process Engineering, R&D, and Air Quality Monitoring

With input and ideas from:
- Elizabeth Brown
- Mike Rieth
- Adam Sealock
- Christine Voigt

METROPOLITAN COUNCIL

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Case Study 2: MCES Minneapolis/St. Paul Metro Area

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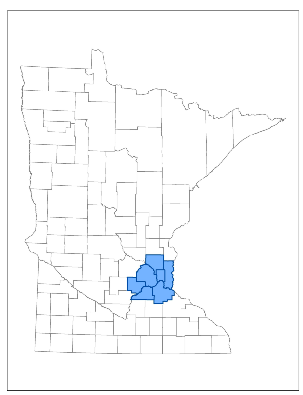
Outline

- Our organization
- Our use of models
- Examples
- Observations and conclusions

MCES

- Provides service to the metropolitan area of Minneapolis/Saint Paul
- 8 WWTPs, 970 km (600 miles) of interceptors, ~908 MLD (240 mgd) wastewater treated, 108 communities served

Plant	~Average Flow	
Metro	644 MLD	(170 mgd)
Blue Lake	102 MLD	(27 mgd)
Seneca	91 MLD	(24 mgd)
Empire	38 MLD	(10.0 mgd)
Eagle Point	16.7 MLD	(4.4 mgd)
Saint Croix Valley	11.0 MLD	(2.9 mgd)
Hastings	5.3 MLD	(1.4 mgd)
East Bethel	151 m^3/d	(40,000 gpd)

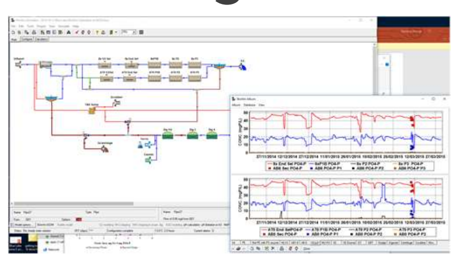


MCES – Process Engineering/R&D

- Supports all 8 plants
  - 9 Engineers
  - 2 Scientists
  - 1 Data Specialist
- ~ 6 have been trained on use of WWTP modeling software
  - ~ US$2k/yr training budget
- 3 WWTP software licenses
  - Out right purchase
  - Some are legacy from former groups
- 2+ regular users of WWTP modeling software

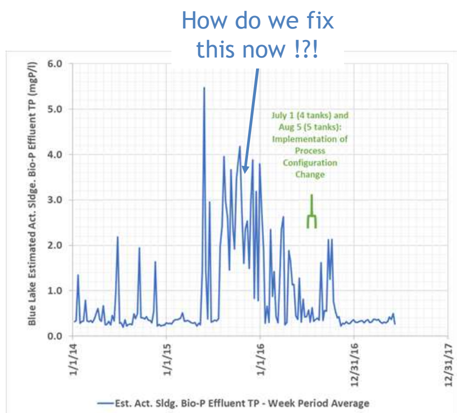
MCES uses models to support capital planning and design

- Most treatment process projects have included WWTP modeling by the planning/design consultant
- Phosphorus removal addition projects included wastewater characterization and model calibration
- Model files were delivered to MCES as part of the project
  - We have both used those files and developed new config files in our work with operations



Process engineering/R&D uses models to support operations

- Aid in troubleshooting
- Evaluate situations and ideas
  - For improvements and process changes
  - To explain observations
  - For planning maintenance activities
  - For full scale plants
  - For pilot scale experimental design
- For all of the above, assist in explaining ideas and suggested plans to operators and managers



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Aid in troubleshooting - examples

- Improve P performance at Blue Lake WWTP
  - Determine if conversion of an anaerobic zone to RAS denitrification would improve P performance
- Modeling for N Removal Upset Causes and Response/Recovery at East Bethel
  - Recovery time estimates and intermittent wasting strategies
- Investigate the possibility an industrial discharge was contributing to poor dewatering performance at Empire WWTP
  - Specific model addressing full scale waste diversion experiment performance observations
- Improve P performance at Empire WWTP
  - Explain and demonstrate the impact of lowering RAS ratio on P performance in response

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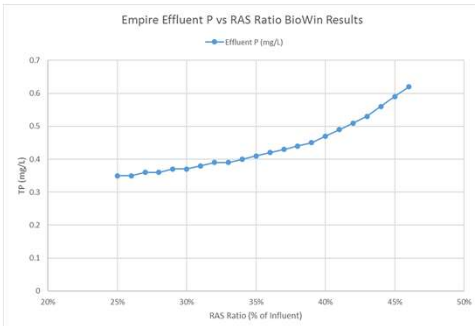
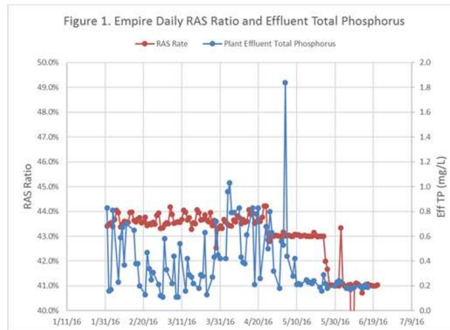
Aid in troubleshooting

- P performance at Empire WWTP
  - Explain and demonstrate the impact of lowering RAS ratio on P performance





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Evaluate situations and ideas – full scale examples

- For all of the below, modeling assisted in explaining ideas and plans to operators and managers but not necessarily to predict exact results
- Metro WWTP: Investigate impact of sludge storage on P recycle and performance
- Empire WWTP: Evaluate digester feed addition location/heating control and digester temperature options (with control/general modeling software, not WWTP modeling software)
- Blue Lake WWTP: Evaluate proposed idea that nitrification was inhibited at plant (it was low DO not nitrification rate)
- Blue Lake WWTP: Explain the potential impact of nitrate addition in the collection for odor control on phosphorus removal
- East Bethel MBR Earlier Year Flows and Carbon Addition: Investigate the carbon addition and P performance, bio-P or enhanced bio-P
- Metro WWTP: Evaluate approaches to taking tanks off-line for maintenance

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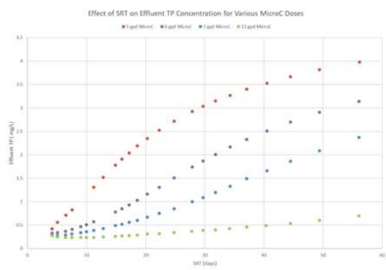
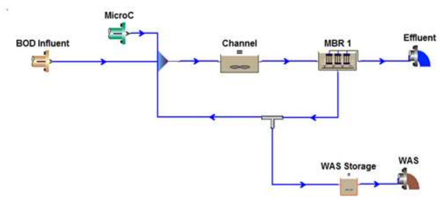
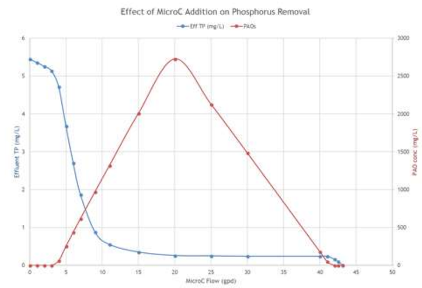
Evaluate situations and ideas – full scale examples

- East Bethel MBR Earlier Year Flows and Carbon Addition: Investigate P performance, bio-P or enhanced bio-P

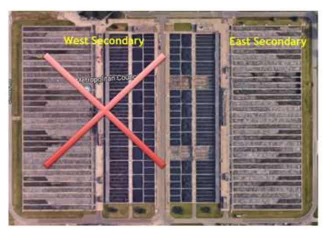






Evaluate situations and ideas – full scale examples

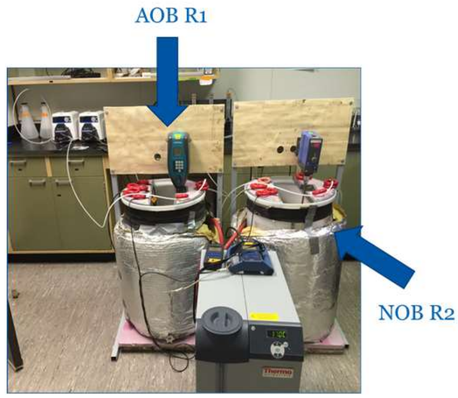
- Metro WWTP: Approach to taking tanks off-line for gate replacement maintenance
  - *BENEFITS*
    - Helped confirm that the plant could handle half of secondary treatment being out of service and the maximum amount of time it could be down
    - Helped decide what plant flows were "safe" for East Secondary to handle and what to watch out for during maintenance
  - *CHALLENGES*
    - Model clarifier calibration needs: Effluent TSS in model was higher than observed at plant



Operations suggested/requested this model simulation!

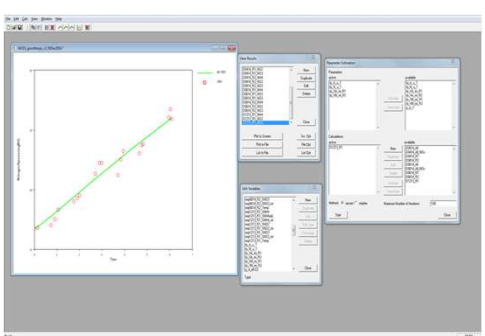
Evaluate situation and ideas – pilot scale examples

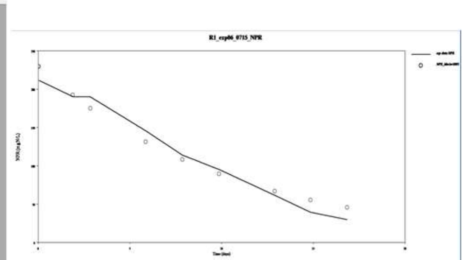
- Nitrification rate testing *(WEF Methods for Wastewater Characterization in AS Modeling)*: Use modeling and associated parameter fitting to evaluate maximum nitrifier growth rates and decay rate experimental data
- Metro and Empire WWTPs: Use models to help design and the evaluate results of bench scale testing of simple methods of implementing N removal in existing tanks



Evaluate situation and ideas – pilot scale examples

- Use modeling software to incorporate model structure (e.g. AOBs and NOBs, approach to decay) into parameter estimation upfront and to accomplish parameter estimation over various experiments

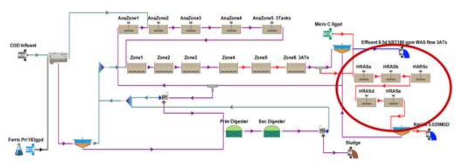




Evaluate situation and ideas – pilot scale examples

- Metro and Empire WWTPs: Use models to help design and the evaluate results of bench scale testing. Simple methods of implementing N removal in existing tanks were evaluated.

Initial modeling using BioWin Model (typical)



Batch Testing Reactors

Observations and conclusions

- Models help the Process and R&D engineers:
  - Explain, demonstrate, and communicate with operators and operations managers
  - Understand their systems
  - Test their ideas (full and pilot scale)
  - Improve plant performance and expand their troubleshooting range
- Our plant data often aren’t “model ready”
  - A step of data reconciliation may be needed with plant data prior to input and calibration
  - Predictive modeling for specific interests/projects may require special data collection and analysis
- Concerns and barriers to expanded use:
  - Staff time for training and use
  - Need to understand concepts before using models
  - Expectations: prediction tool versus process understanding aid
  - WWTP software models don’t address all of our questions
  - Reaching a critical mass of expertise and confidence in models and modeling
  - IS hardware and program update constraints
- There are better tools than spreadsheets!

Our Next Speaker

Spencer Snowling, Ph.D
V.P., Product Development

Hydromantis
Environmental Software Solutions, Inc.

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Case Study 3: WEF Operations Challenge Competition

Spencer Snowling, Ph.D
Hydromantis ESS, Inc.

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Agenda

- Use of Modeling for Operator Training
- WEF Operations Challenge Competition
- Analysis of WEFTEC competition results
- Conclusions

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Simulation for Operator Training

- Significant loss of process knowledge anticipated over the coming decade
- Wastewater field predicted to suffer more than other industries, due to longer-than-average tenure (AWWA Research Foundation, 2005)

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Simulation for Operator Training

- Modeling is an established tool in process engineering world
- Growing interest in simulation as a wastewater training tool over the past decade
- Interactive nature of simulators allows for "hands on" learning styles

Simulation for Operator Training

Simulation for Operator Training

The “Link Trainer” – circa 1940

Simulation for Operator Training

Modern Training Simulator

Simulation for Operator Training

High-fidelity patient simulators

Simulation for Operator Training

Nuclear Operations Control Room Simulator

Benefits

- **instantaneous results** – no need to wait 3 weeks to see if the SRT change had any effect
- **no consequences** – if you fail your virtual clarifiers, there is no virtual fine
- **low-cost testing** – you can implement new tanks, settlers, control systems, etc., for free and see what happens

Benefits

- **control of inputs** – you can whip up a wet-weather event anytime you like, rather than waiting for one to happen
- **repeatability** – users can repeat simulations, lesson, etc., as much as needed
- **comfort level** – users can move at their own pace
- **portability** – desktop virtual plants can be run on any computer anywhere

Operations Challenge™ Competition

Laboratory Event

Safety Event

Collections

Maintenance

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WEF Operations Challenge 2016

Process Control Event

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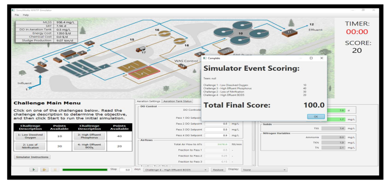
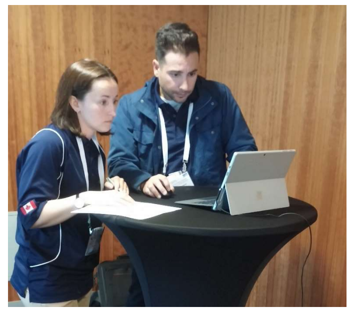
WEF Operations Challenge



- Simulation part of WEF Operations Challenge since 2016
- Realistic, challenging scenarios
- Operator friendly, and easy to use
- Tracks progress, enables scoring



WEF Operations Challenge: Simulation as a Process Skill

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WEF Operations Challenge

- Each challenge question is a simulation of plant that is in not in compliance
- Operators trouble-shoot the problem and make changes to operation of the plant
- Point awarded for meeting effluent criteria and other targets

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WEF Operations Challenge

- 15 challenges in 15 minutes
- Points for meeting effluent criteria:
  - TSS, TKN, BOD_5, etc.
- Points for achieving target operational conditions:
  - Minimum MLSS, target DO range
- Points for achieving operating cost targets:
  - energy costs
  - chemical costs
- Each team worked with a practice simulator prior to the competition

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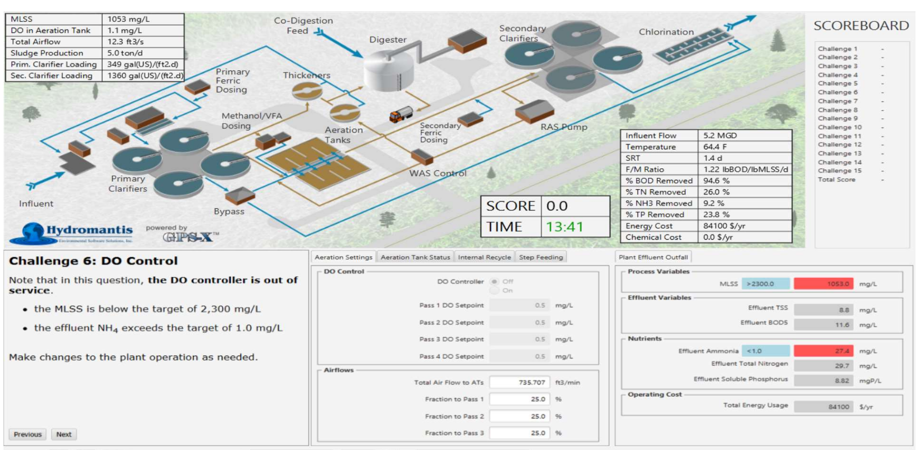
WEF Operations Challenge



OpTool™ Wastewater Process Simulator

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WEF Operations Challenge 2017

Process Control Event

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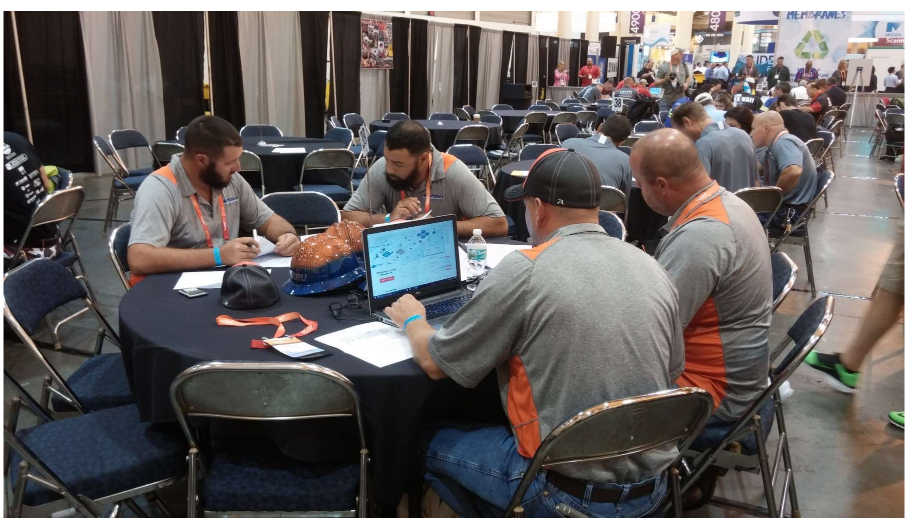

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Process Control Simulator

- Successful implementation in 2016
- Operators have adopted simulation technology very quickly
- Had to increase complexity of questions significantly to keep ahead of teams over the past 2 years

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Analyzing the Results

- We analyzed the data to see what the highest-scoring teams did differently than the others
- What can we learn about how the expert trouble-shooters perform under pressure?

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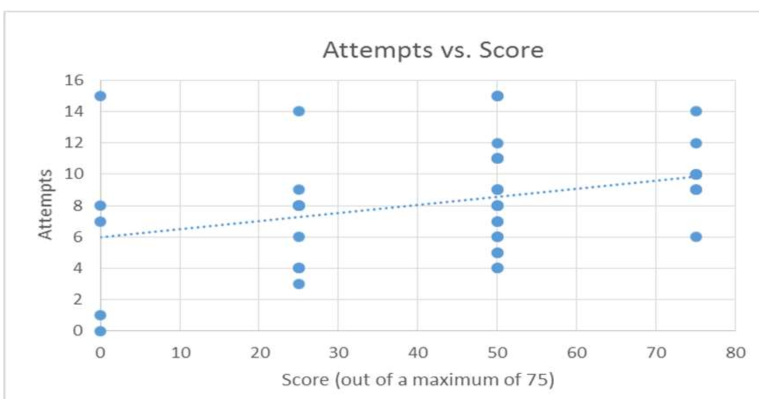
Analyzing the Results



No significant correlation between number of attempts and score

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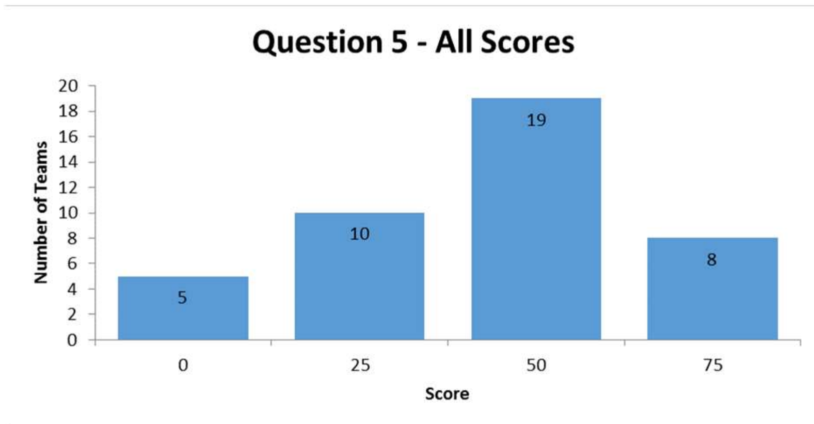
Analyzing the Results



Eight teams (out of 42) scored a perfect 75 points

Analyzing the Results

- Eight teams (out of 42) scored a perfect 75 points
- Three of those teams answered the question in 10 attempts or less
- Those teams all took the same problem-solving approach to the question

Analyzing the Results

- The most optimal problem-solving approach was to take the following actions, in order:

1) Increase airflow to aeration basin by turning on a DO controller
2) Bring one or more of the off-line secondary clarifiers on-line
3) Turn off the methanol dosage to the bioreactor
4) Increase ferric dosage (at one or both dosage points)
5) Increase wastage to manage MLSS and effluent solids

Analyzing the Results

- These trouble-shooting actions had the effect of addressing the problems via a systematic, optimized methodology:
  - first bring aeration and effluent solids into line
  - then make chemical dosage adjustments (for cost and effluent quality)
  - then make wastage adjustment to handle the excess solids generated from the chemical precipitation of phosphorus.

Conclusions

- Operators can make use of the interactive, non-linear, "systems-thinking" environment that simulators provide to become efficient at solving activated sludge problems
- Operations Challenge teams have devised their own methods to trouble-shoot complex multi-target activated sludge problems
- The most successful teams had a common approach

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Conclusions

- The best OpsChallenge teams have become **very good** at process problem-solving via simulation
- We have increased the complexity of the treatment plant and the process challenge questions

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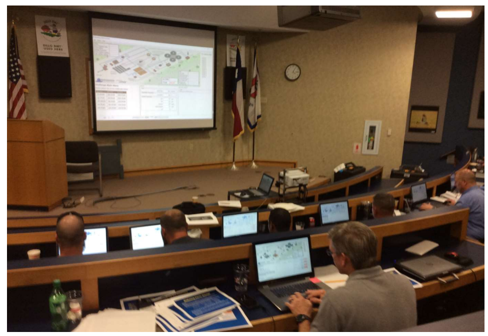
Conclusions

- Lots of enthusiastic participation in competitions and training sessions
- Some regions now certifying simulation-based training courses



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Ops Modeling – Aug. 23, 2018

An MRRDC Webcast

Modeling for Operations

- Final Q & A:

Moderator	→	John Copp	Primodal
Intro	→	Spencer Snowling	Hydromantis
Models	→	Adrienne Menniti	Clean Water Serv.
Application	→	Lina Belia	Primodal
Application	→	Jared Buzo	Oakland County
Application	→	George Sprouse	Metro. Council

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Resources

- IWA STR 22
  Guidelines for Using Activated Sludge Models
- WEF MOP 31
  Wastewater Treatment Process Modeling
- WEF On Demand Wastewater Library (OWWL)
  https://www.wef.org/resources/publications/owwls/
  Under Municipal Resource Recovery Design
- WEF 2017 session 507
- Models for Operations group
  Email Adrienne Menniti or Spencer Snowling