Session 11: Upgrading Wastewater Treatment Facilities without Multi-Million Dollar Upgrades

Utility Management Conference: Making Progress More Apparent
Savannah, Georgia
February 26, 2014

Upgrading Wastewater Treatment Facilities without Multi-Million Dollar Upgrades

Paul LaVigne – State of Montana
Jay Young - Plainfield, Connecticut
Bob Trombley - Montague, Massachusetts
Grant Weaver - The Water Planet Company

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Our Story: Operations First

Nutrient Limits are Coming!

Approaches to Meeting New Permit Limits

1. Traditional: Facility Upgrade
2. Experiment with Operational Changes (Model A)

Empowered Operators can oftentimes make Existing Equipment meet new Permit Limits at Incredible Financial Savings

- $10s Millions on Upgrades
- $100s Thousands in O&M Costs

Case Studies

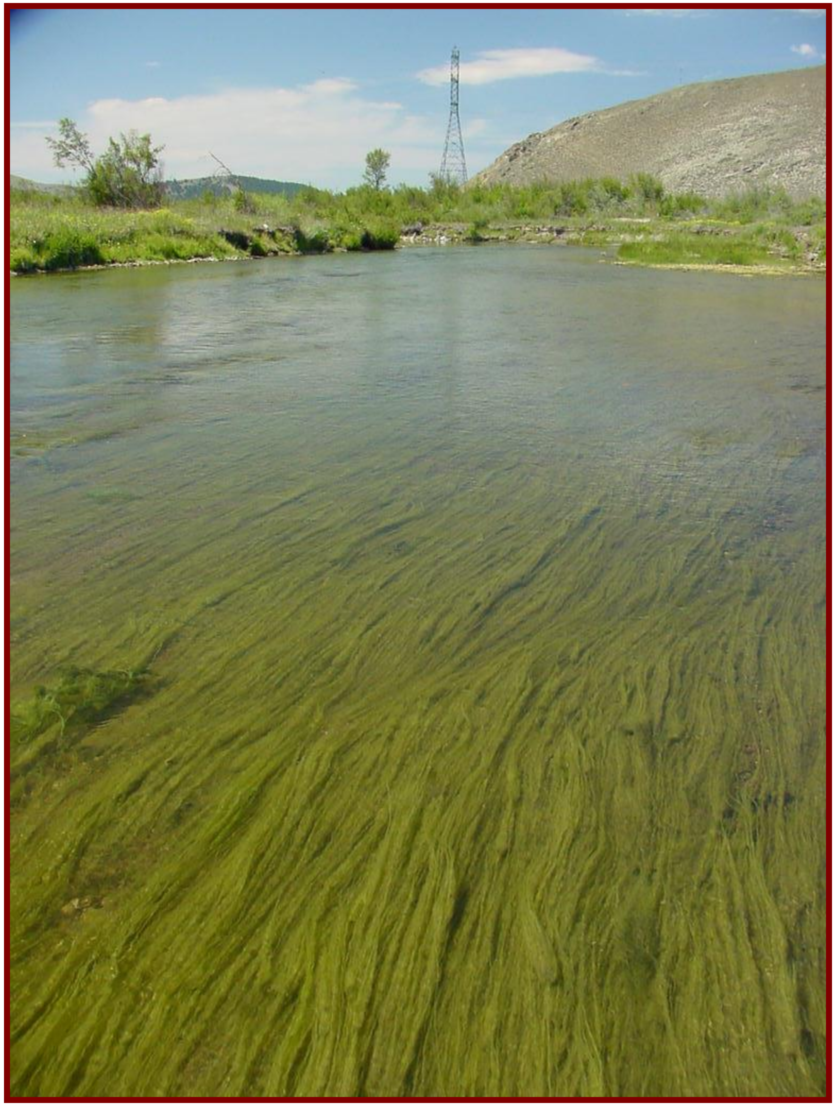
Q&A


Paul LaVigne
State of Montana

EMPOWERING OPERATORS to IMPROVE NUTRIENT REMOVAL at WASTEWATER TREATMENT PLANTS

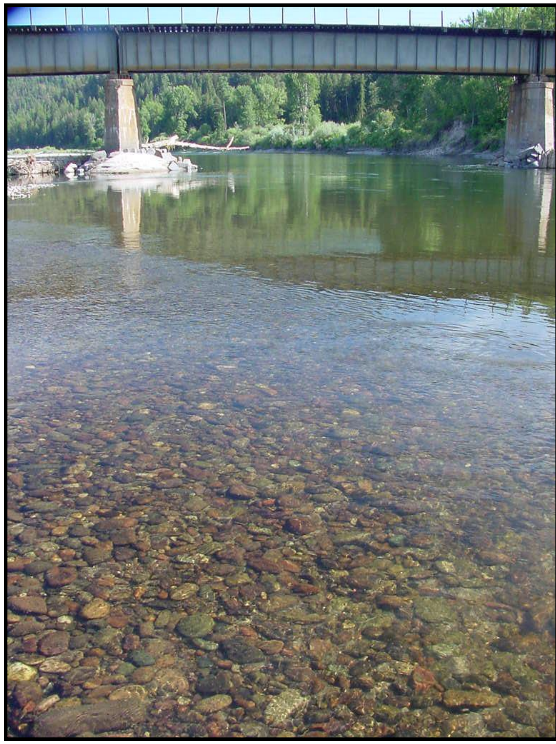
CHANGING THE FOCUS FROM CAPITAL IMPROVEMENT PROJECTS TO OPTIMIZING OPERATIONS USING EXISTING INFRASTRUCTURE

First of all, Why Nutrients?



Nuisance algal growth, rivers & streams

Attached algae growth commonly quantified as chlorophyll *a* per square meter of stream bottom



40 mg Chl*a*/m^2

120 mg Chl*a*/m^2

300 mg Chl*a*/m^2

Nutrient Reduction

- Nitrogen and/or Phosphorous
  - Enhance eutrophication of streams and lakes
  - Municipal discharges are a concern
  - – there are other sources
  - Evolving numeric nutrient stds may affect many WWTPs that discharge to surface water
- Two Basic Options:
  - Eliminate or reduce the discharge – not always practical
  - Provide better treatment

Numeric Nutrient Stds Timing (Montana)

- After 5-years of outreach to stakeholders
- Variance process currently in law
- General variance is in law
- Stds rule package well underway
- Public hearing March 24, 2014
- Expected to be implemented this year as permits come up for renewal

Proposed Nutrient Limits (Montana)

In- Stream WQ Stds

- Ecoregion-based
- TP – 0.006 – 0.124 mg/l
- TN – 0.209 – 1.358 mg/l

Effluent Limits

- Variance Processes
  - Affordability-based
  - Hyd. Capacity-based
- Phased approach
- Mech. WWTP > 1MGD
  - TP 1 mg/l, TN 10 mg/l
  - TP 0.5 mg/l, TN 8 mg/l
  - ??? (lower) ???
  - Meet Stds in 20 yrs ???

Better Treatment: Changing the Model

- Model for the past 40+ years for Wastewater Treatment Improvement:
  - Identify a deficiency
  - Hire an engineer to prepare Facilities Plan
  - Obtain loans and grants
  - Raise user rates to pay the debt
  - Design and construct a capital project
  - Train operators to manage the facility
    - Directed by design engineer or their predecessor

A New Model

- Model A for Wastewater Treatment
  - Identify a deficiency (lower N and P limits)
  - Look in-house at possible solutions
    - Look at EXISTING infrastructure
    - Look CLOSELY at the operations as a solution
  - Train operators to TAKE CONTROL of the Facility (make it do what we want it to)
  - THEN, if not successful, hire an engineer to begin planning

Put Another Way……

- Using existing infrastructure, can we re-engineer our operations to make the facility do things it was not originally designed to do?

 OR

- Can we get better performance from our existing infrastructure by operating the facility differently?

Comparison of Models

Old Model

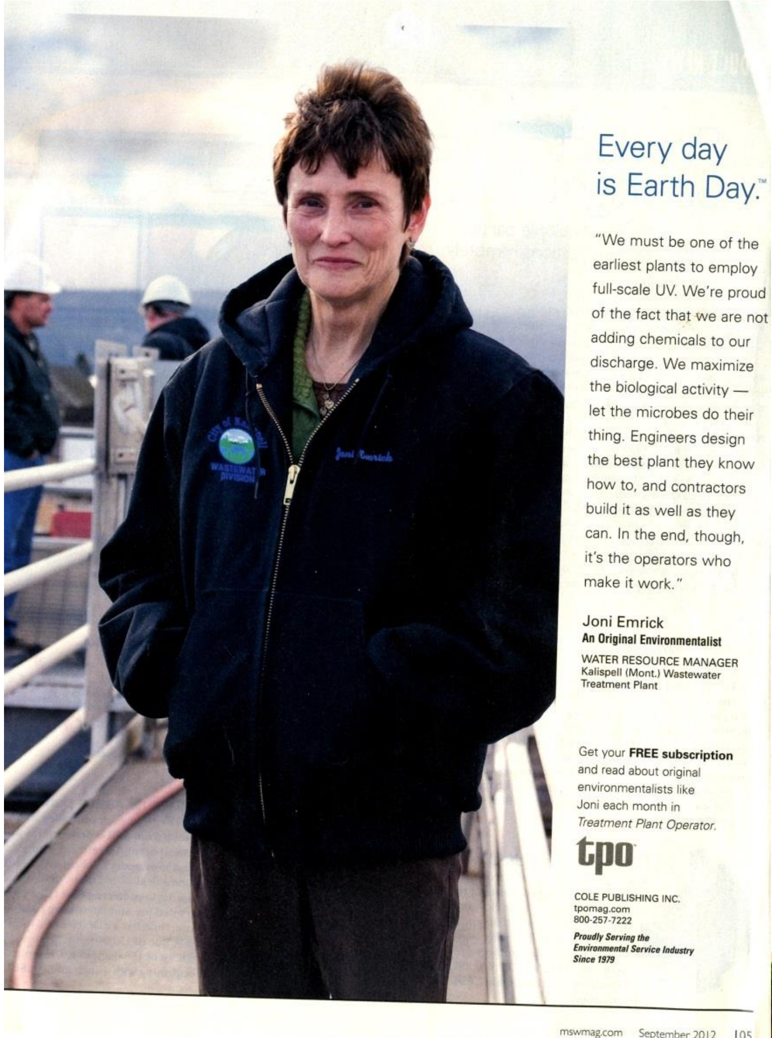
- Engineer-intensive
- Capital-intensive
- Rate increases
- May be based on models
- Still relies on operator knowledge – nutrients
- Results in lower effluent N & P

Model A

- Operator-intensive
- Training and follow up
- Non-Capital-intensive
- May not need rate increases
- Based on actual bio and chemical data
- Results in lower effluent N & P
- Sustainability

The Problem with Operators

- UNDERPAID
- UNDER-APPRECIATED
- UNDER-UTILIZED
- UNDER-TRAINED



Training

- The trainer’s qualifications and intent are critical to the success of this approach.
  - – No substitute for operational experience
  - – Operators relate to other operators
  - – Typically a microbiologist or biochemist
  - – Engineer????
  - – A motivational person –
    - May live in a van down by the river
- There aren’t many qualified trainers left

Your Facility

- What is important to success?
  - Existing Infrastructure – what do you have?
  - Loading - industrial sources?
  - Capacity – growth?
  - Public works/City council buy-in
  - Regulator cooperation/understanding
    - Training EPA
  - Operations staff attitude – most important

With Classroom Training Alone

Before

- Manhattan, MT
  - Biowheel
  - TN - 10.7 mg/l

Chinook, MT

Oxidation ditch

TN – 25.3 mg/l

Conrad, MT

Biolac

TN - 26.3 mg/l

After

- Manhattan
  - TN – 7.4 mg/l
  - 31% improvement
- Chinook
  - TN – 13.1 mg/l
  - 48% improvement
- Conrad
  - TN – 4.7 mg/l
  - 82% improvement

What Happens After the Trainer Leaves??

- Operators have a much better understanding of wastewater treatment
- Operators are typically more engaged in the performance of the facility.
  - Collect meaningful data
  - Understand why the data is important
  - Understand how to use data to improve performance
- You've empowered your operators

Summary

- Major retrofits or upgrades for nutrient removal can be avoided in many cases through well thought-out operational strategies – enormous cost savings
- The trainer/consultant is critical to success
  - Choose him or her carefully
- We’re shifting the focus from engineers to operators – choose them wisely.
- Operators are cool.

Operators Are Sexy

Jay Young
Plainfield, Connecticut (population 15,000)

Two 40-year old wastewater treatment facilities – both well "beyond their design life" – were to be replaced with one new 1.5 MGD treatment facility at a cost of $45 million.

Facility planning had been completed, approved by the state, and recently updated.

Changes in USDA funding rules changed Plainfield's grant eligibility.

Plainfield, Connecticut

Meanwhile, stimulated by Connecticut's nitrogen trading program to reduce effluent nitrogen, Plainfield experimented with operations and found both plants capable of removing nitrogen.

The ten year strategy to build new was scrapped in favor of renovating the two existing facilities at a cost of $5 million.

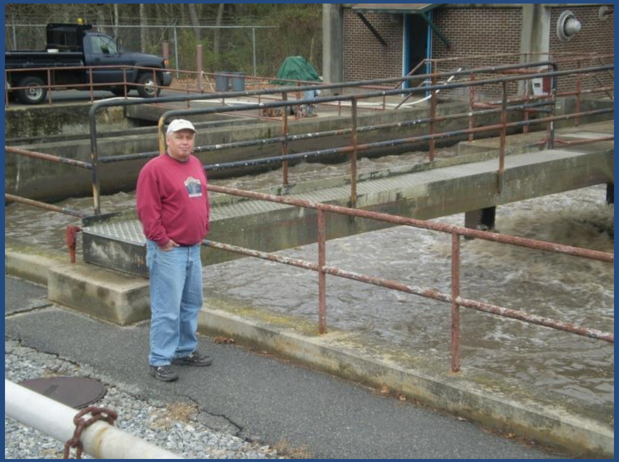
Plainfield, Connecticut (population 15,000)
1.5 MGD (two plants)

Traditional Facility Plan Solution:

- Demolish two existing treatment facilities
- Build one new wastewater treatment plant
- Construct new pumping station and force main

Cost: $45,000,000

ReEngineer Operations



Instead …

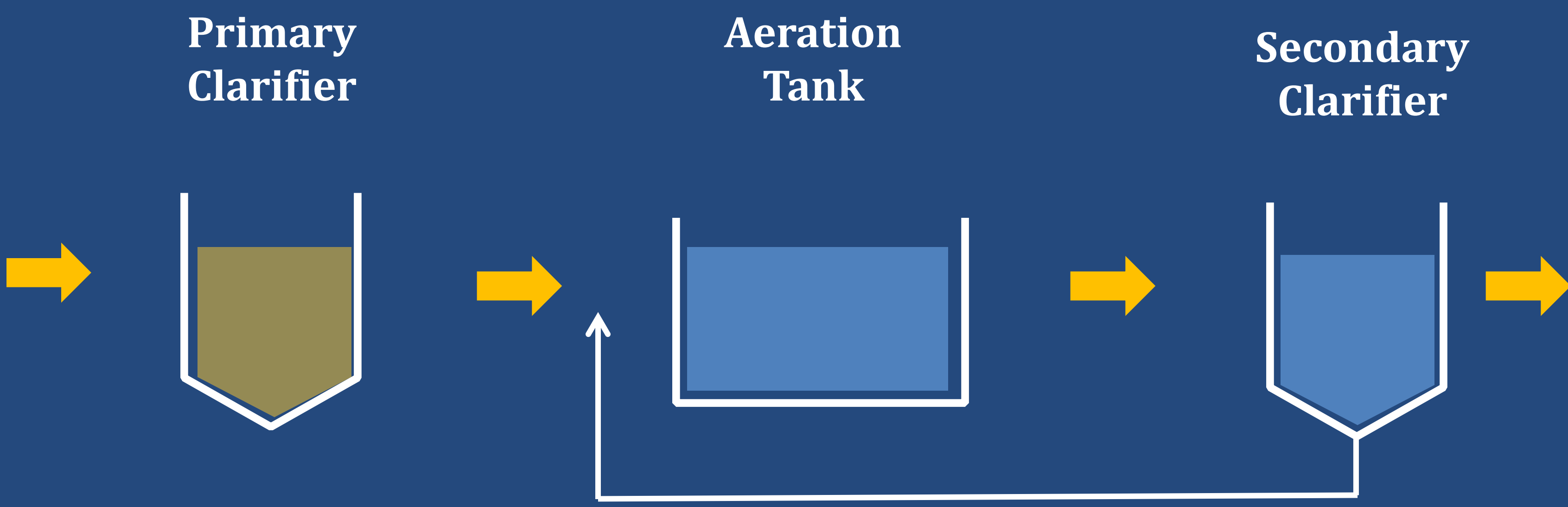
- $10,000 investment in monitoring equipment
- Two years of technical support

Resulted in …

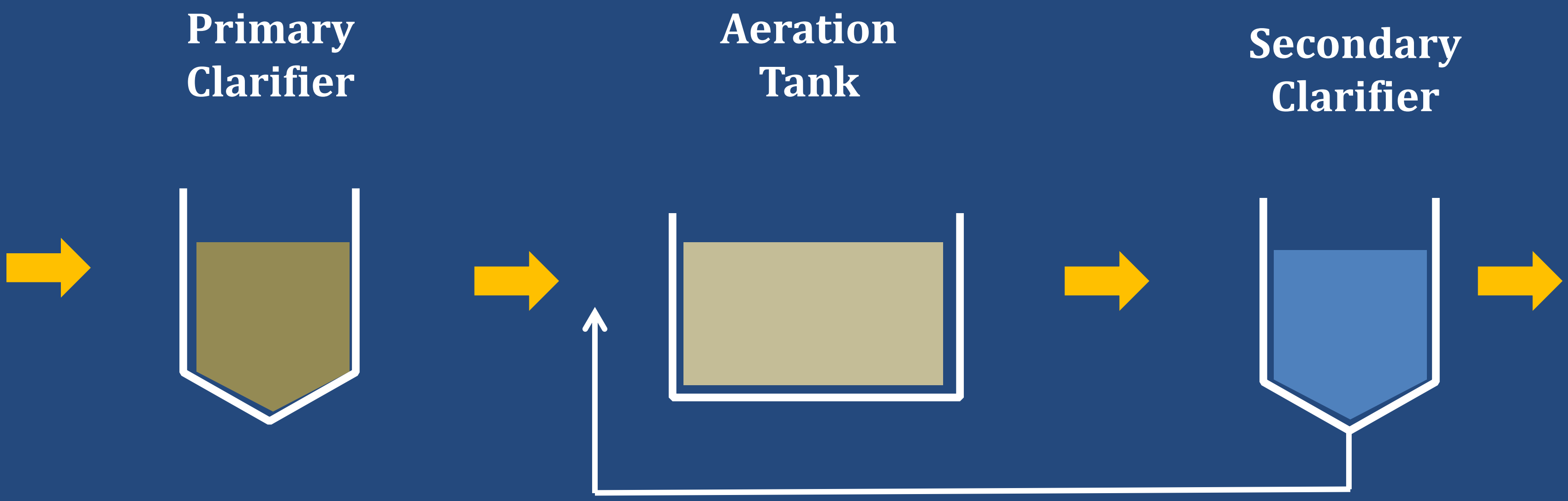
- Improved conventional treatment (TSS & BOD) - permit compliance
- 50% nitrogen reduction
- 75% phosphorus reduction (Village Plant)
- Without increasing O&M expenses

And …

- Decision to forgo upgrade and instead replace existing equipment at cost of $5,000,000



North Plant (1.0 MGD)
Plainfield, Connecticut



North Plant (1.0 MGD)
Plainfield, Connecticut

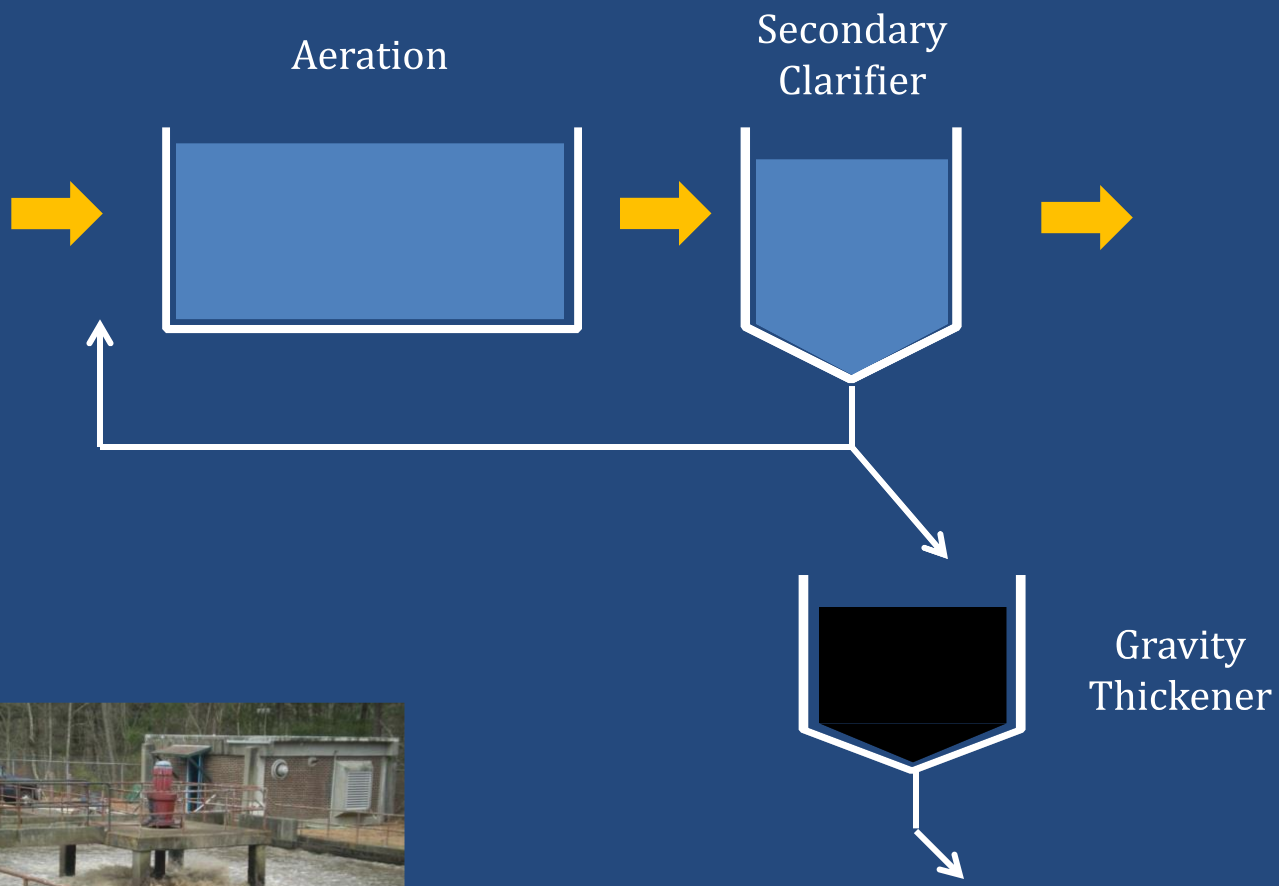
Plainfield North Connecticut

Raise bacterial population (mixed liquor)
Cycle air ON for Ammonia removal / air OFF for Nitrate removal
Monitor with in plant ORP probe
Daily test strip testing for:

- Ammonia
- Nitrate
- Nitrite
- Alkalinity

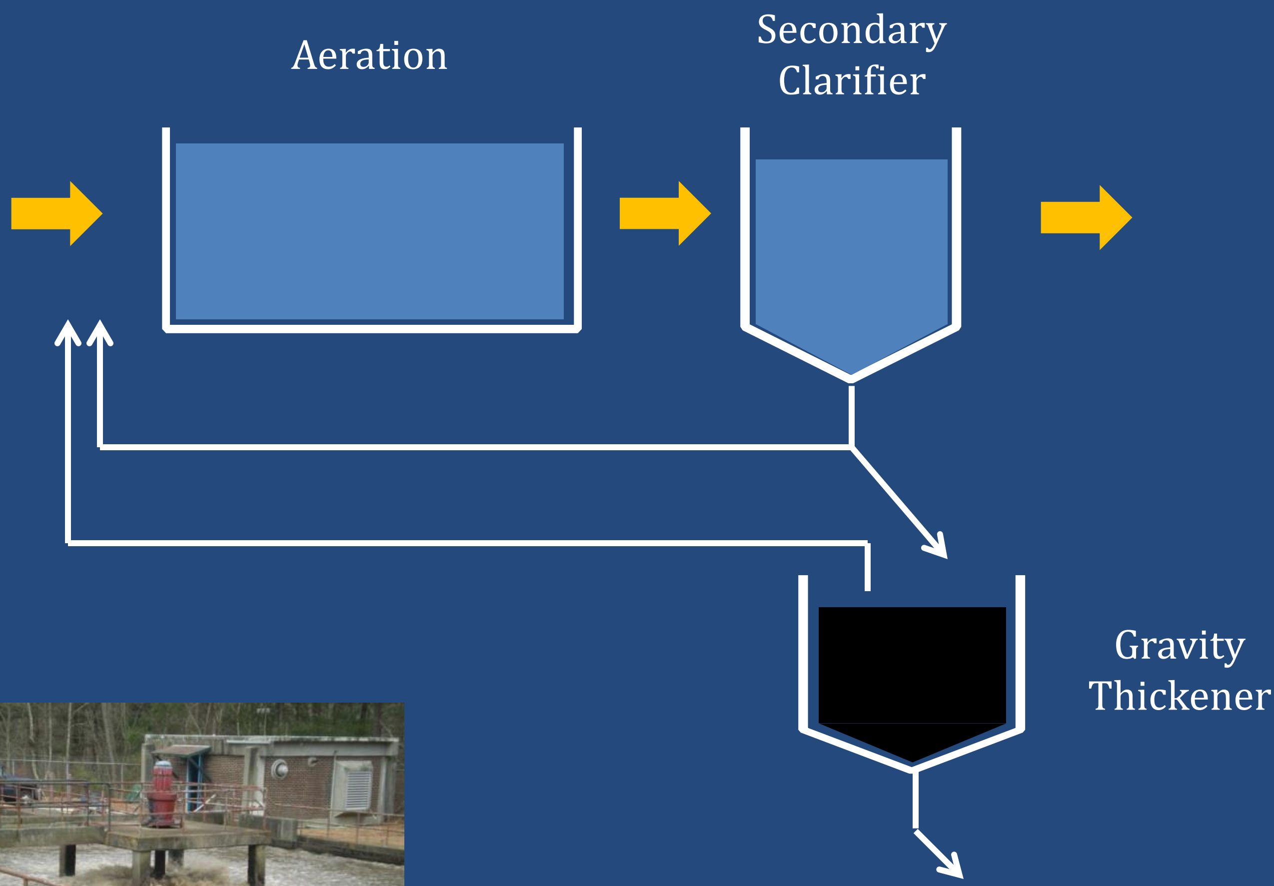
Weekly site visits to adjust air ON and air OFF cycles

Plainfield Village (0.5 MGD)
Plainfield, Connecticut



Conventional Operations

Plainfield Village (0.5 MGD)
Plainfield, Connecticut



Modified Operations

Plainfield Village Connecticut

Raise bacterial population (mixed liquor)
Keep fixed speed mechanical aerator operating 24/7
Route a percentage of the RAS through the Gravity Thickener
Daily test strip testing for:

- Ammonia
- Nitrate
- Nitrite
- Alkalinity

Weekly data review

Plainfield, Connecticut

New Facility Upgrade: **$5,000,000**

Renovate both treatment plants

Original Facility Upgrade: **$45,000,000**

Replace Village Plant with Pumping Station

Build all new plant at site of existing North Plant

$40 million savings


Bob Trombley
Montague, Massachusetts
Staff commitment to reducing operating costs …
Capital investment of $75,000 …
Five years of ongoing adjustments …
Two years of technical support …
- resulted in -
Nutrient Removal
Huge Monetary Savings

Montague, Massachusetts (population 8,500)

1.8 MGD design / 1.0 MGD average day

1962 upgrade
Primary Treatment

1982 upgrade
Secondary Treatment

2009 upgrade
Combined Sewer Overflow

2012 upgrade
Sludge Press

2012-2014 projects
Sequenced Aeration
Sludge Composting

Monetary Savings

Capital Savings

- Projected cost of Facility Upgrade for Nitrogen Removal: $4.5 million
- Actual cost: $75,000

Annual O&M Savings*

- $400,000 Increased Revenues from Trucked-In Wastes
- $250,000 Reduced Expenses
  - Sludge disposal
  - Chemicals

*50% improvement to Montague's annual budget of $1.25 million

Nutrient Removal

5 mg/L total-Nitrogen

0.75 mg/L total-Phosphorus

18 mg/L BOD

22 mg/L TSS

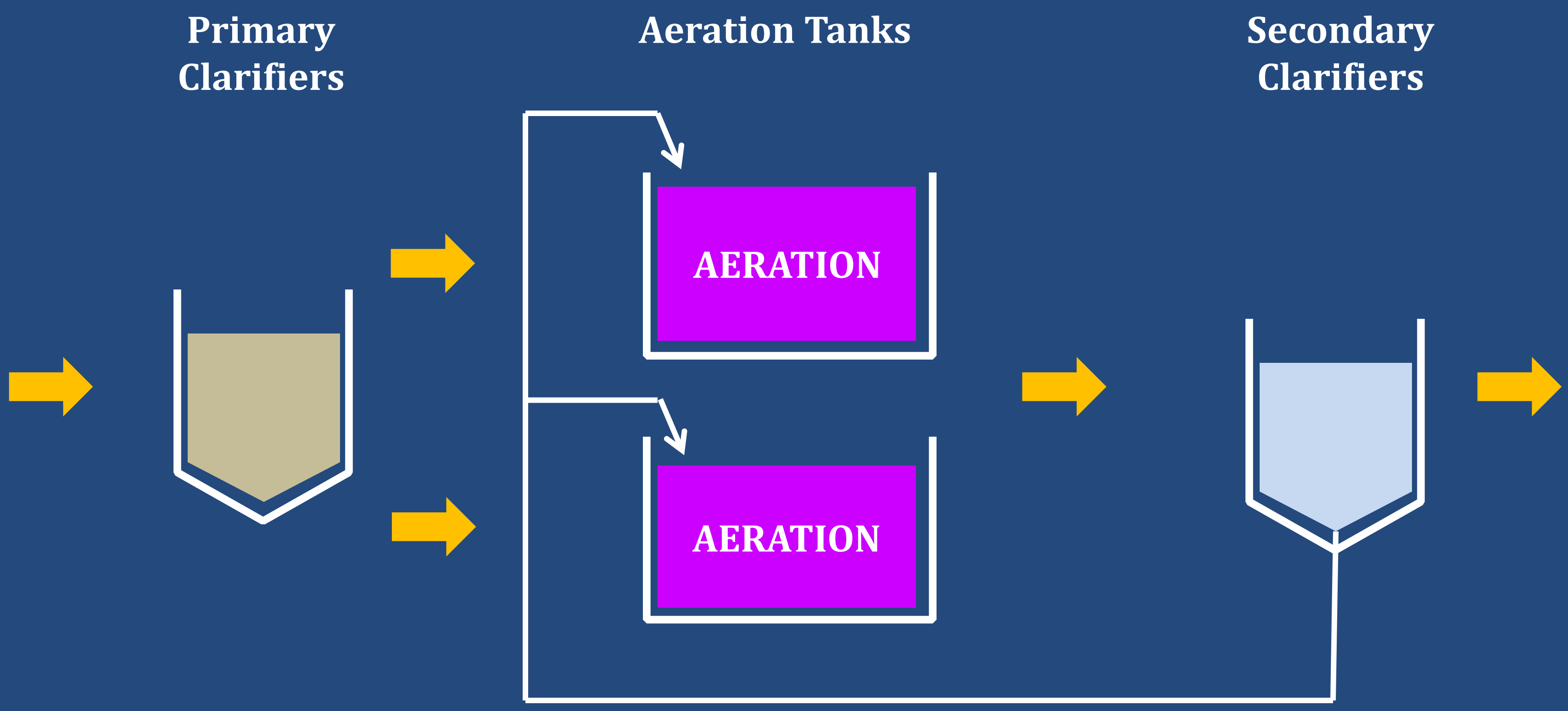
Current Mode of Operation: Sequenced Aeration

Sequenced Aeration

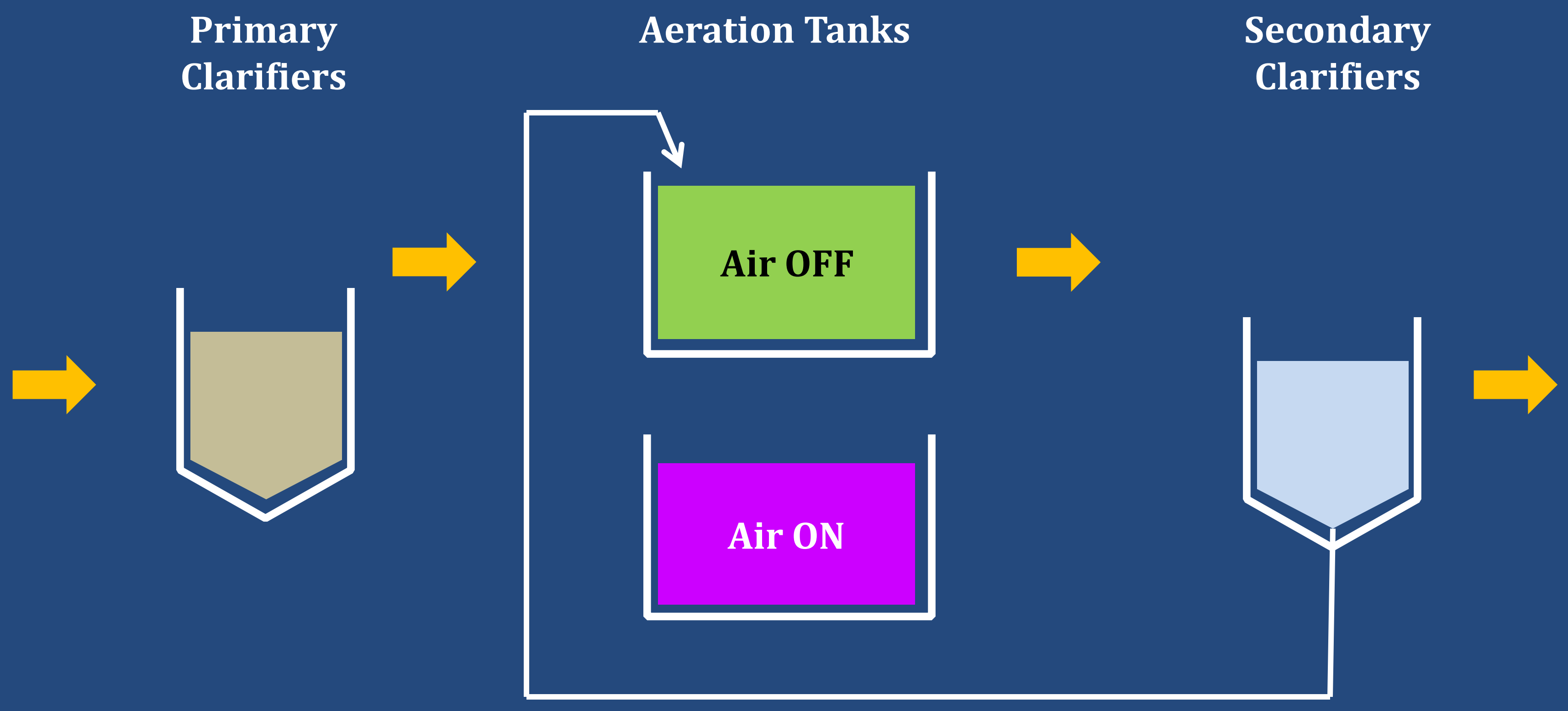
Every 1-1½ hours, valves open and close to switch conditions in the aeration tanks, much like a Sequencing Batch Reactor

Air ON cycle
- Influent valve closes
- Aeration valve opens
- RAS valve closes

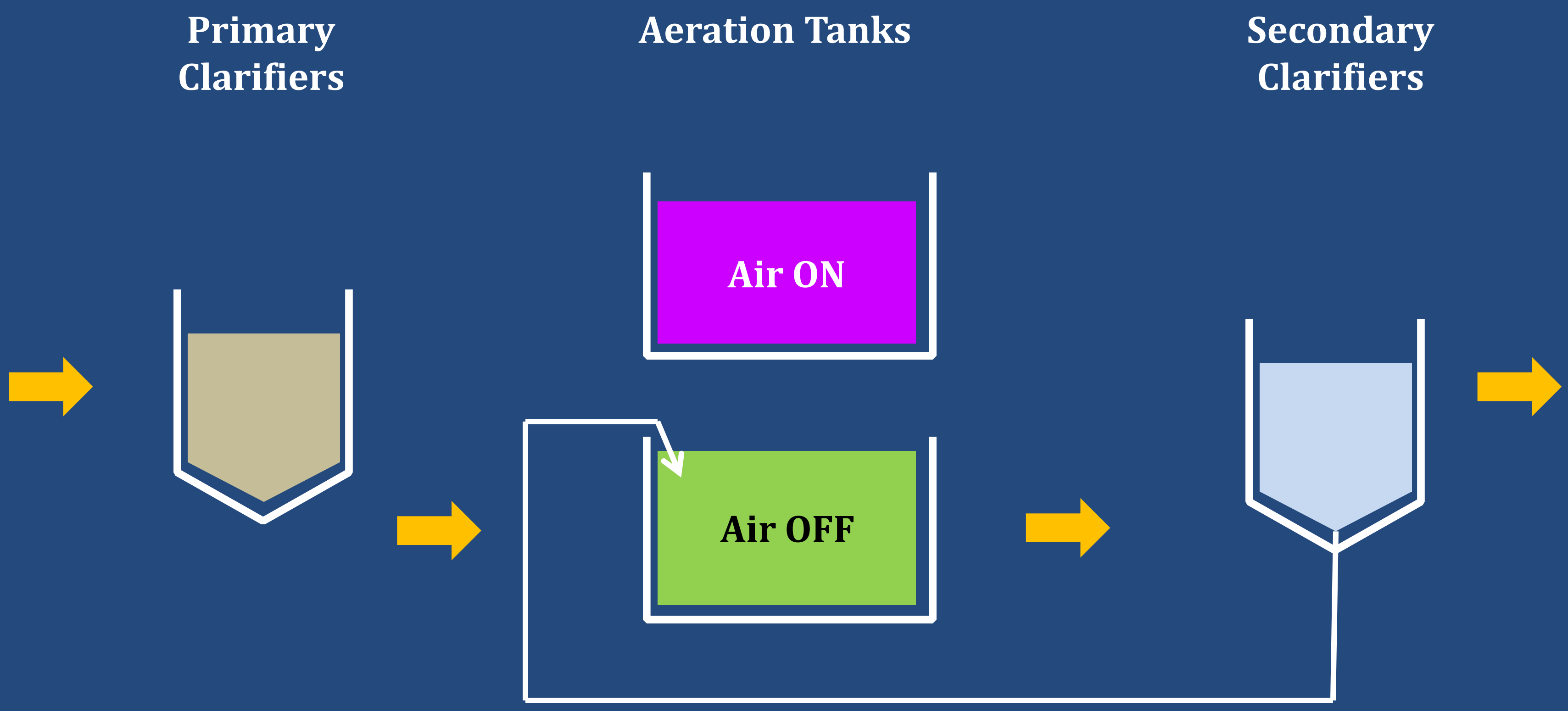
Air OFF cycle
- Influent valve opens
- Aeration valve closes
- RAS valve opens



Conventional Activated Sludge



Sequenced Aeration



Sequenced Aeration

Sequenced Aeration

Raise bacterial population (MLSS) for …
- Ammonia-Nitrogen removal
- Reduce the amount of waste sludge

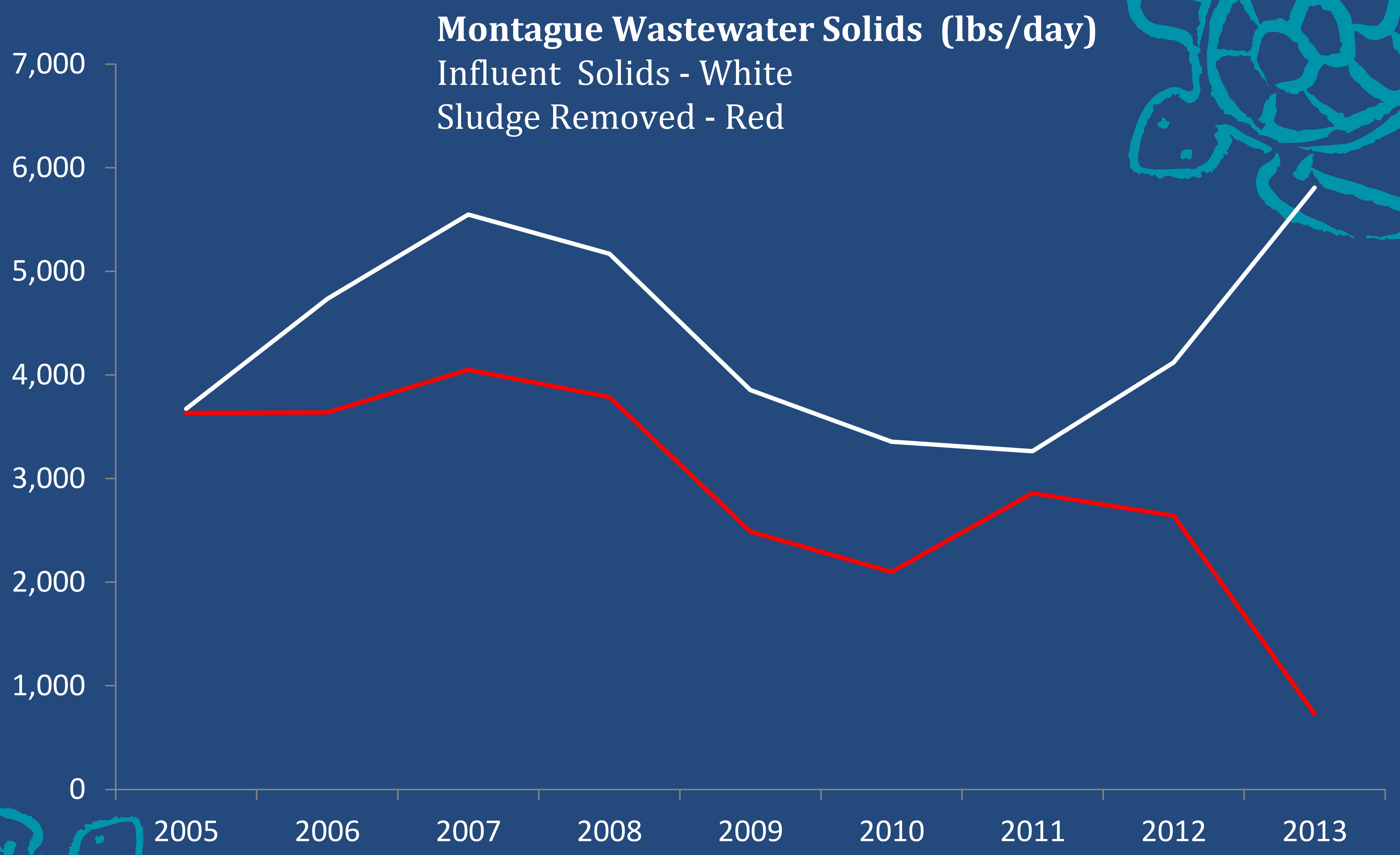
Cycle air ON and OFF to create habitats for …
- Ammonia removal (air ON)
- Nitrate removal (air OFF)

Open and Close inlet and RAS valves to …
- Optimize treatment time in air ON and air OFF zones
- Reduce solids loading on secondary clarifiers

Return sludge and create zero oxygen zones in Primary Clarifiers to …
- Remove Phosphorus
- Biodegrade sludge by recycling RAS to headworks (25% volatile suspended solids)

Montague, Massachusetts
Operating Data

Jun-Dec '13	Flow (MGD)	Influent (mg/L)				Final Effluent (mg/L)			
		Total N	BOD	TSS	Total P	Total N	BOD	TSS	Total P
	0.916	69	747	921	12	5.0	18	22	0.72


Montague Wastewater Solids (lbs/day)
Influent Solids - White
Sludge Removed - Red
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
2005
2006
2007
2008
2009
2010
2011
2012
2013

Montague, Massachusetts
Sewer Department
Operating Revenues

Operating Income	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
Sewer Customers	$1,348,541	$1,312,016	$1,384,937	$1,457,858	$1,356,392	$1,225,822
	96%	97%	94%	92%	86%	73%
Trucked-In Waste	$53,301	$40,865	$81,757	$122,649	$224,267	$457,937
	4%	3%	6%	8%	14%	27%

Montague, Massachusetts

"We as Operators run the Plant.
The Plant doesn't run us."

Operator John Little

Grant Weaver Summation

Two Approaches for Permit Compliance
- New Equipment – Traditional Facility Planning
- Existing Equipment – the "Model A" approach

A small Investment in Wastewater Operations can provide BIG Paybacks
- Improved Water Quality
- Financial Savings
  - Capital
  - O&M

More Case Studies

Discussion / Q&A

Traditional Approach: Facility Planning

your design solution

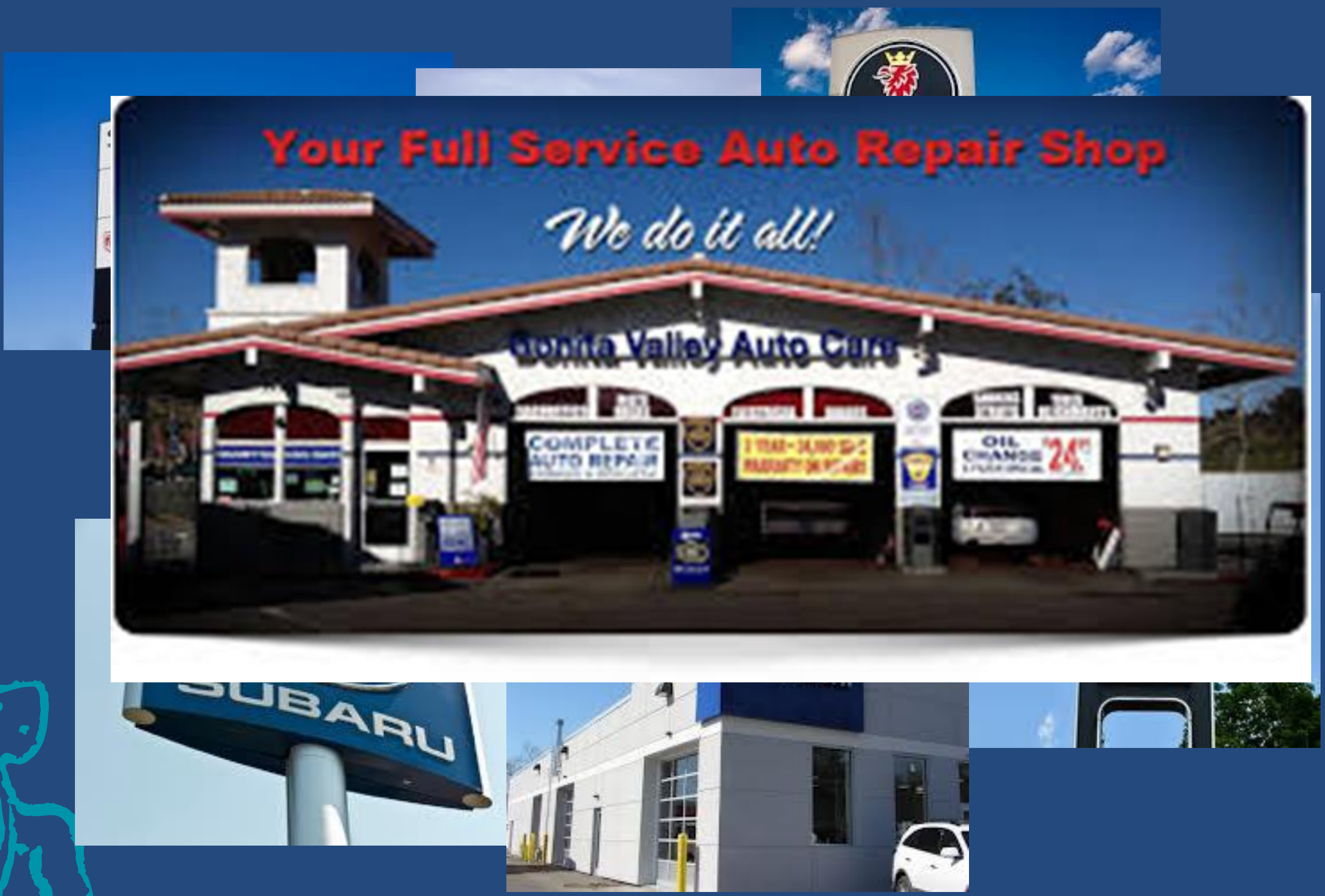
{ web video print app }

As an analogy, let's assume …

I have a six year old car that squeaks and sputters.
I'm looking for advice.

As an analogy, let’s assume …

I have a six year old car that squeaks and sputters. I’m looking for advice.



Alternative Approach: Operations

Montana DES

Two Day Classroom Seminar (2012)

	t-N Before (mg/L)	t-N After (mg/L)
Chinook	25	13
Conrad	26	5
Manhattan	11	7

Case Studies: these are not isolated examples

18 Wastewater Treatment Plants: Personal Experience

Case studies:
Chinook (MT), Conrad (MT), Manhattan (MT), Montague (MA), Plainfield North & Village (CT)

N-Removal Projects:
Amherst (MA), Farmington (MA), Northfield (MA) & Upton (MA)

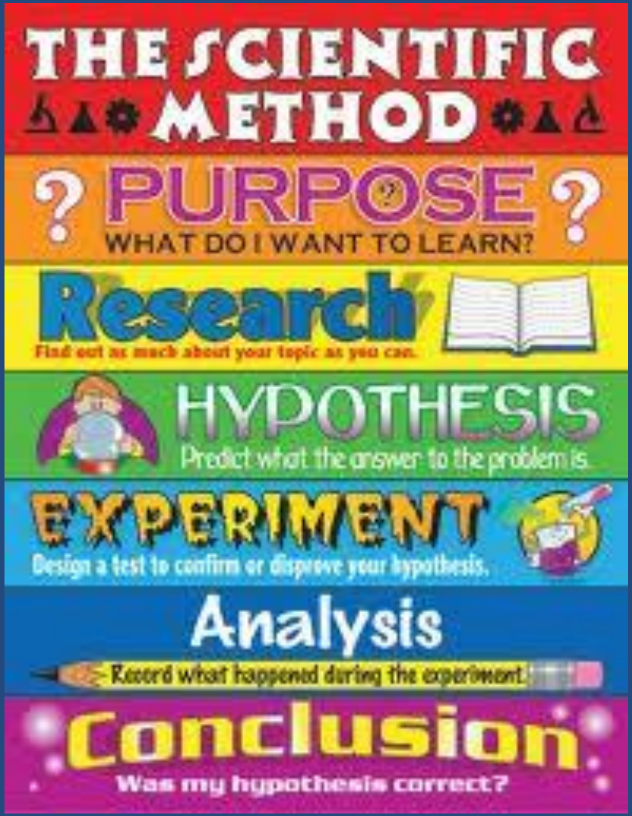
P-Removal Projects:
Columbia Falls (MT), East Haddam (CT), Keene (NH) & Suffield (CT)

Ongoing N &P Projects:
Easthampton (MA), Greenfield (MA), Palmer (MA) Westfield (MA)

2008 MA DEP Study:
11 of 21 studied can be "operated to remove Nitrogen"

2014 NEIWPCC Study (*Preliminary Findings*):
24 of 29 plants studied can remove Nitrogen with "minor" upgrade

$110 Million Savings @ 3 Communities



> 50% Nitrogen Reduction

> 75% Phosphorus Reduction

Existing equipment: No New Tanks

O&M cost SAVINGS

- Fewer Chemicals
- Less Electricity
- Less Sludge

Carbon Footprint: REDUCED

Plainfield, Connecticut (population 15,000)
1.5 MGD (two plants)

Nitrogen Targets: ~6 mg/L
Phosphorus Limit for Village Plant: 0.7 mg/L

Facility Plan: Build one new plant and demolish existing facilities.

Instead, a 2-year optimization effort and $10,000 in equipment …
improved TSS & BOD removal, 50% less nitrogen & 75% less phosphorus at Village Plant

Facility Plan Proposal: $45,000,000
New Facility Upgrade: $5,000,000

$40 Million Savings

Amherst, Massachusetts (population 38,000)
7.2 MGD

New Nitrogen Limit: 546.5 pounds/day, approximately 15 mg/L

2008 BioWin modeling results:

> *"The existing facility has half of the necessary volume at the current flows ...*
> *... there are no operational or minor modifications/retrofits that could be implemented at this facility to consistently achieve nitrogen removal. "*

Instead, by cycling air on and off, the facility is meeting its limit.

Facility Upgrade cost estimate: $61,000,000
Cost of compliance $100,000

$60 Million Savings

Keene, New Hampshire (population 23,000)
6.0 MGD

New Phosphorus Limit: 0.2 mg/L

BioWin modeling determined new equipment needed.

Instead, by fermenting wastewater in an existing tank, biological phosphorus removal has cut chemical usage in half while meeting a restrictive effluent limit.

Facility Upgrade budget: $16,000,000
Revised project $4,500,000

$10 Million Savings

$110 million savings

Combined Population: 76,000
Total Design Capacity: 14.7 MGD

	total-N (mg/L)	total-P (mg/L)
Amherst, Massachusetts	25 to 10	
Keene, New Hampshire		3.0 to 0.2
Plainfield, Connecticut		
North Plant	15 to 8	
Village Plant	20 to 8	3.0 to 0.8

O&M Costs

Amherst, MA	$30,000/yr Savings (sludge disposal)
Keene, NH	$50,000/yr Savings (chemical usage)
Plainfield, CT	Small Savings

Educating & Empowering Operators

Knowledge

- Nitrogen biochemistry
- Phosphorus biochemistry

Information (*in-tank instrumentation w/computer display*)

- Continuously monitor conditions
- Interpret data daily

Action

- Daily adjustments
- Preemptive changes
- Reactive changes

The Right Equipment?

Educated, Empowered Operations?

Kitchen?

Chef?

Clubs?

Golfer?

Car …

… and …

Driver!

Facility Upgrade?

ReEngineer Operations?

THE WATER PLANET COMPANY

Making clean water affordable

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Grant Weaver, Your Moderator

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President
The Water Planet Company

Licensing

Professional Engineer

Wastewater Operator

Education

Massachusetts Institute of Technology (MIT):
Post-Graduate Studies in Environmental Toxicology

Oklahoma State University (OSU):
MS Bio-Environmental Engineering

Kansas State University (KSU):
BS Biology

Thank You!

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