SAWEA 2005 November 29 – November 30, 2005

Enhanced Nitrogen Removal Using Upflow Biological Filtration

November 30, 2005

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METCALF & EDDY | AECOM

Presentation Outline

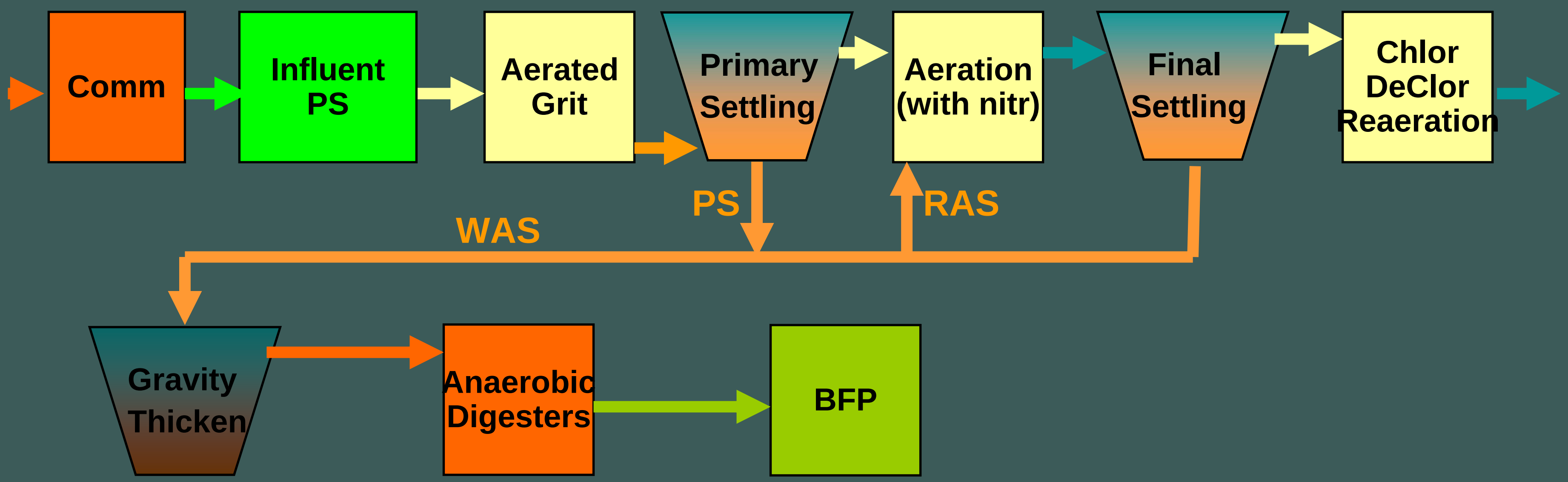
- Background
- Need for Project – CT General Permit
- Evaluation of Alternatives
- Project Delivery
- Implementation
- Summary

Background


Pawtucket
Providence
Hartford
209
6
8
New Britain
2
Warwick
17
52
Meriden
395
11
84
9w
Danbury
New Haven
95
Cheshire, CT
87
9
Bridgeport
Long Island Sound
287
Stamford
Paterson
New Rochelle
80
Passaic
495
24
Union City
Union
New York
Levittown
Taconic State Pwy
Kent Rd
River Rd
91

Background

- Cheshire, CT WPCP
  - 3.5 MGD (Ave. day)
  - Employs Advanced Secondary Treatment (Nitrification)



Need for Project - CT General Permit

- Determined that State water quality standards for Long Island Sound violated during summer months (< 6 mg/L DO)

- Nitrogen loading and subsequent algal growth/ death/ decay identified as primary cause of the hypoxia in Long Island Sound (low DO)

- CT DEP identified the need to reduce baseline TN loading from WPCP's by 65%

Need for Project - CT General Permit

- General Permit for Nitrogen Dischargers Developed
- Permit established the maximum acceptable annual mass loading of TN from each municipal WPCP
- For Cheshire – 78.3% reduction from 1997 to 1999 loadings

POTW	Equivalency Factor	Total Nitrogen (lbs/day)					
		2002	2003	2004	2005	2006	2014
Cheshire	0.49	205	190	173	151	125	103

Need for Project - CT General Permit

Waste Load Allocation

- Flows and Loads are Increasing above 1997-1999
  - 475 lbs/day in 1997-1999
  - 730 lbs/day at design flow (2014)
  - 2014 WLA (103 lbs/day)
- TN Limit of 3.5 mg/l (at design flow)
- NH_3 + Organic N component ~ 2.0 mg/l

- **Effluent NO_x-N Concentration of 1.5 mg/l**

Need for Project - CT General Permit

- WPCP's not meeting their TN limit must purchase credits to meet their waste load allocation

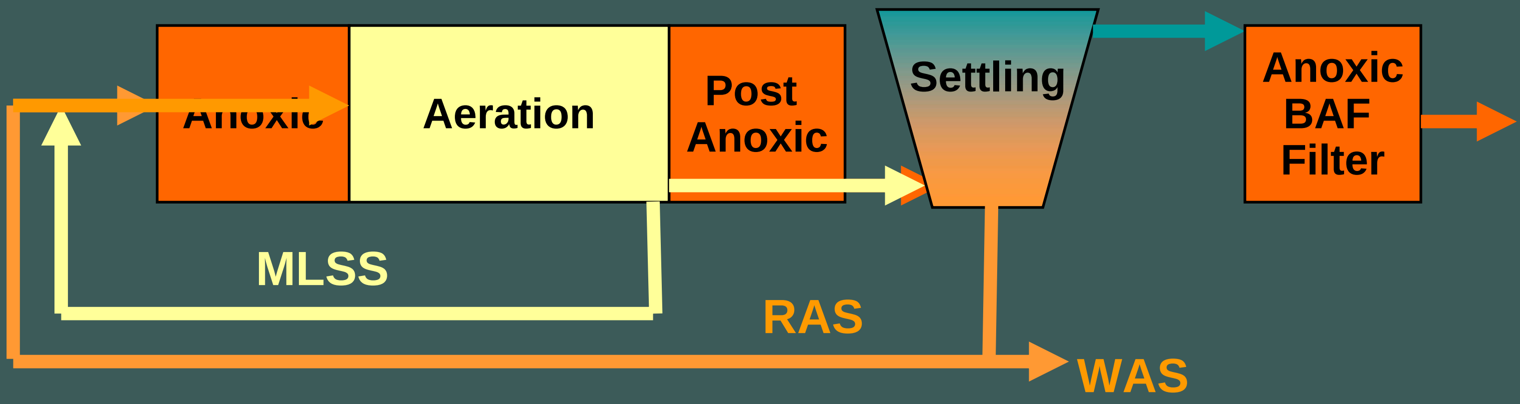
- WPCP's removing more TN than required can sell nitrogen credits

$$\text{Credit Cost} = \frac{\text{Total Annual Project Costs}}{\text{Total Annual Reduction of Nitrogen}}$$

2004 Credit Cost = \$2.14 / lb TN (expected to increase)

Alternatives Evaluation

- Do nothing and pay annual credit cost ($115 K in 2003)
- In tank modifications to remove some nitrogen (and pay annual credit cost for remainder)
- In tank modifications plus post DN using conventional anoxic tank
- In tank modification plus post DN using BAF
- BAF with no in tank modifications



Alternatives Evaluation

- BAF Recommended Over Alternatives
  - No reduction in current plant capacity
  - Minimal impact on existing facilities during construction
  - Ability to meet 1.5 mg/l NOx-N limit
  - Most cost effective based on life-cycle cost analysis
    - Buying/ selling credits
    - Methanol use

Biological Processes - Nitrification

Oxygen (O_2)

Ammonia Oxidizers

(Nitrosomonas)

Autotrophic

Ammonia (NH_3/ NH_4^+)

Alkalinity (HCO_3^-)

Nitrite (NO_2^-)

(H^+)

Alkalinity Destruction

Oxygen (O_2)

Nitrite Oxidizers

(Nitrobacter)

Autotrophic

Grow Faster than Ammonia Oxidizers

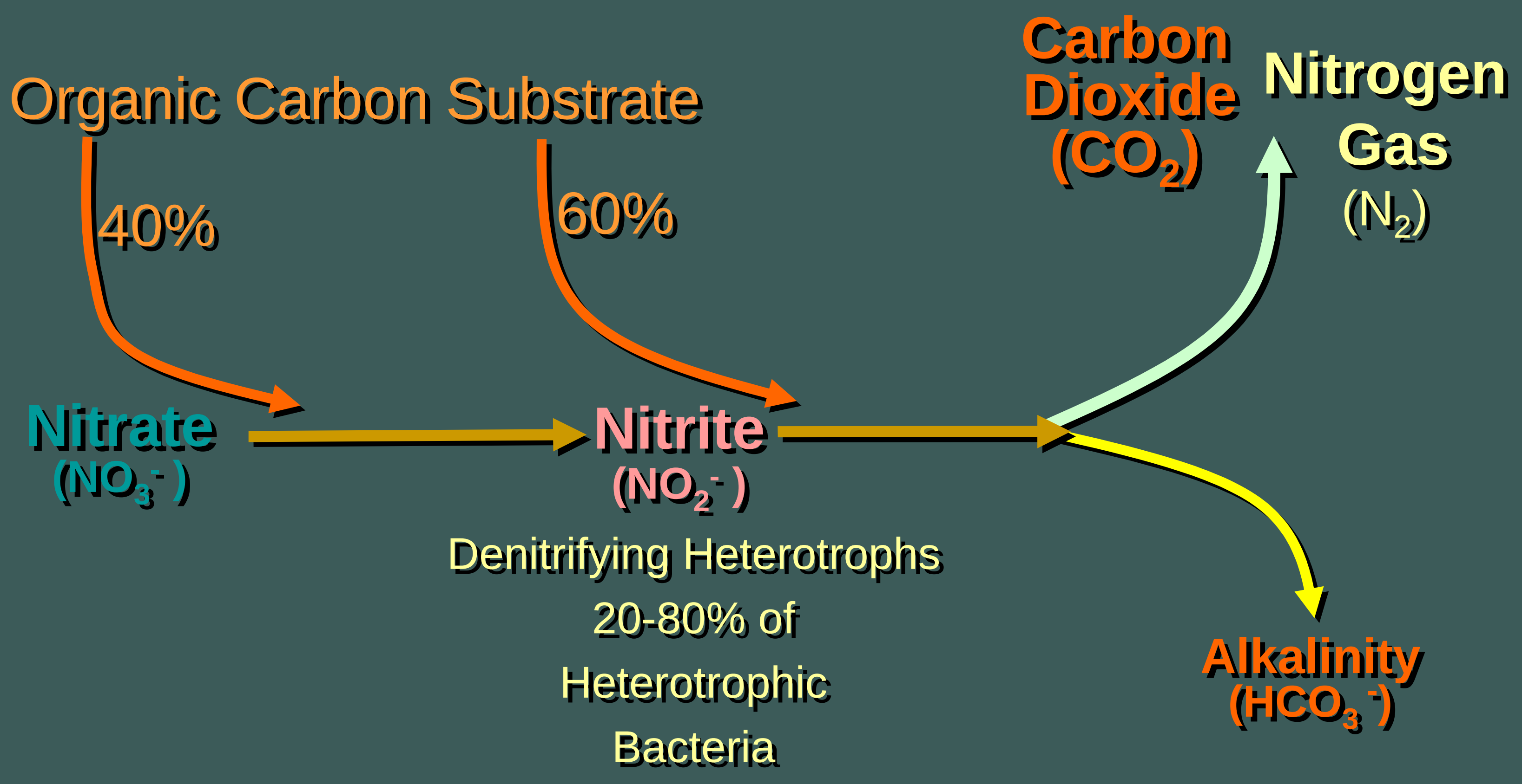
Die Out Faster

More Sensitive to Inhibition

Nitrate (NO_3^-)

At least two different species of autotrophic bacteria are responsible for the conversion of ammonia to nitrate

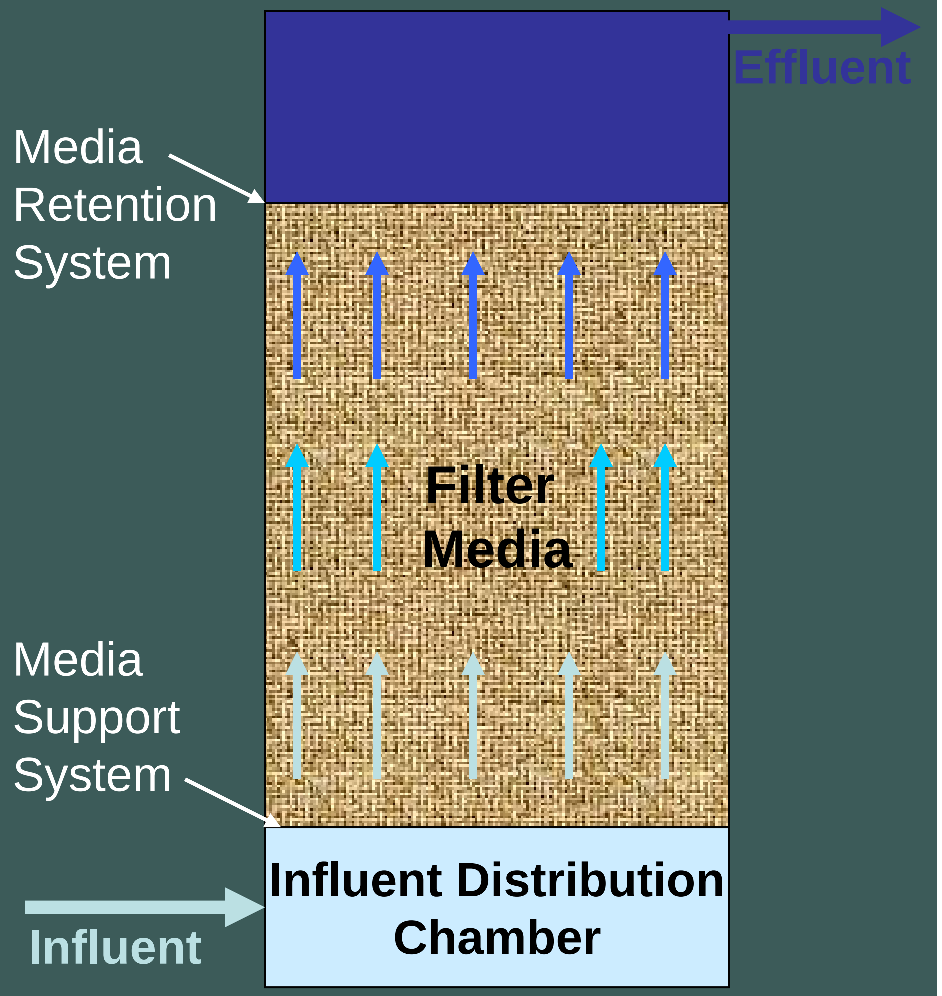
Biological Processes - Denitrification



The denitrification process was believed to be the "easier" part of the equation
- not quite true when low TN levels are required

Alternatives Evaluation

- Attached Growth Biological Processes
- Upward Flow Through a Granular Media
  - Media - Surface for denitrifying organisms
  - Media - Solids removal



Typical BAF

Project Delivery

- Equipment Pre-Selection
- Design Based on Pre-Selected Vendors Equipment
- Conventional Bid with Line Item for DN Filter
- Contractor Purchased DN Filters
- Single Construction Contract with Owner

Project Delivery – Vendor Selection

- Pre-Selection via a Request for Proposal (RFP)
  - Meet 1.5 mg/l NOx-N Limit
  - RFP Defined Scope of Supply
    - Flow Control Equipment
    - Filter Media and Media Retention Systems
    - Instrumentation
    - Control Logic for Filter and MeOH Dose Control
    - Ancillary equipment for complete system
- RFP Required all Information Necessary for PW Cost Evaluation

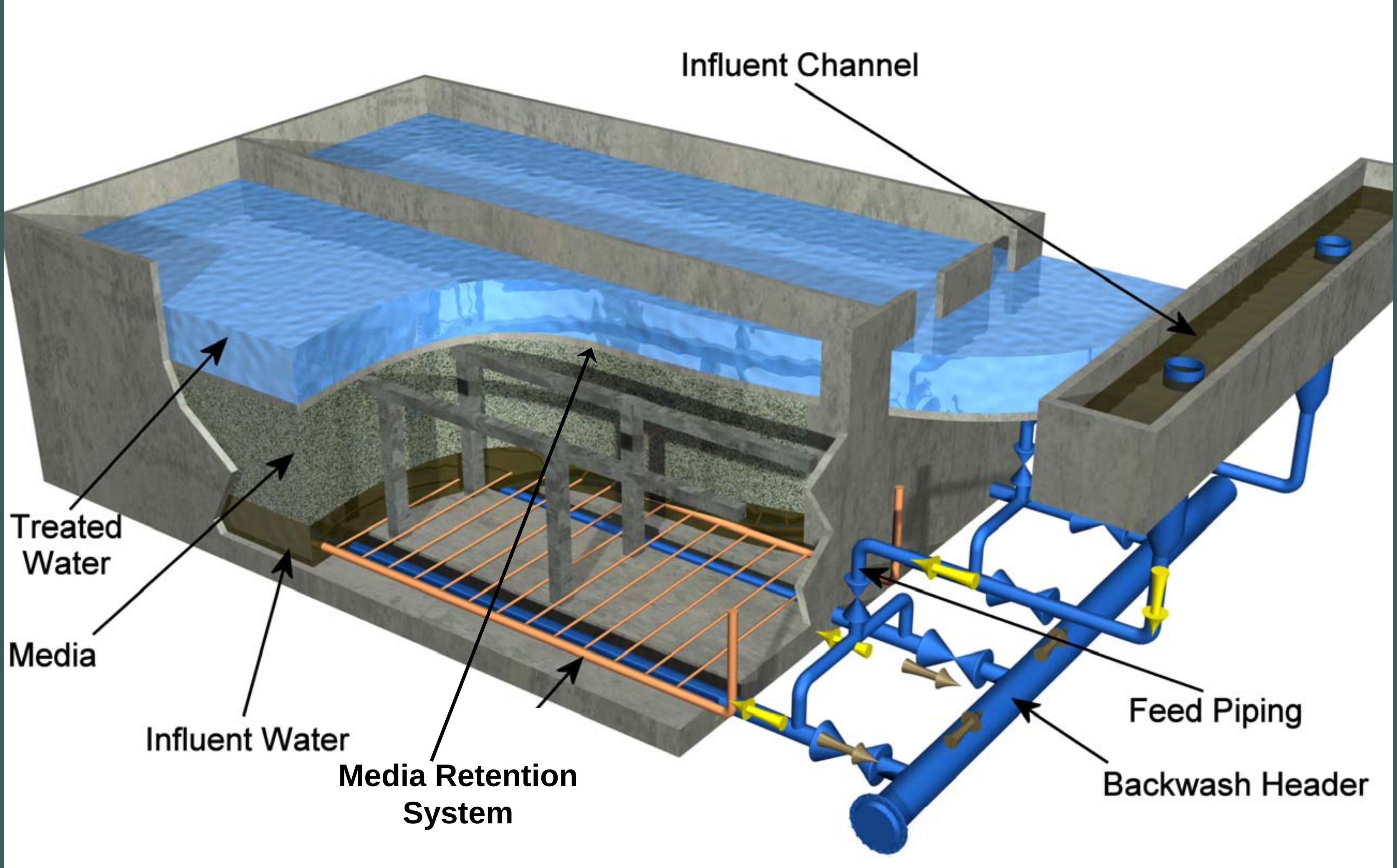
Project Delivery – Vendor Selection

- Two Manufactures Known at the Time of the Study
  - Kruger (Veolia Water)
  - Ondeo Degremont (now Infilco Degremont)
- Differences Between Manufactures
  - Media (polystyrene balls vs. granular biolite)
  - Media Retention Systems
  - Backwash Direction
  - Backwash Storage

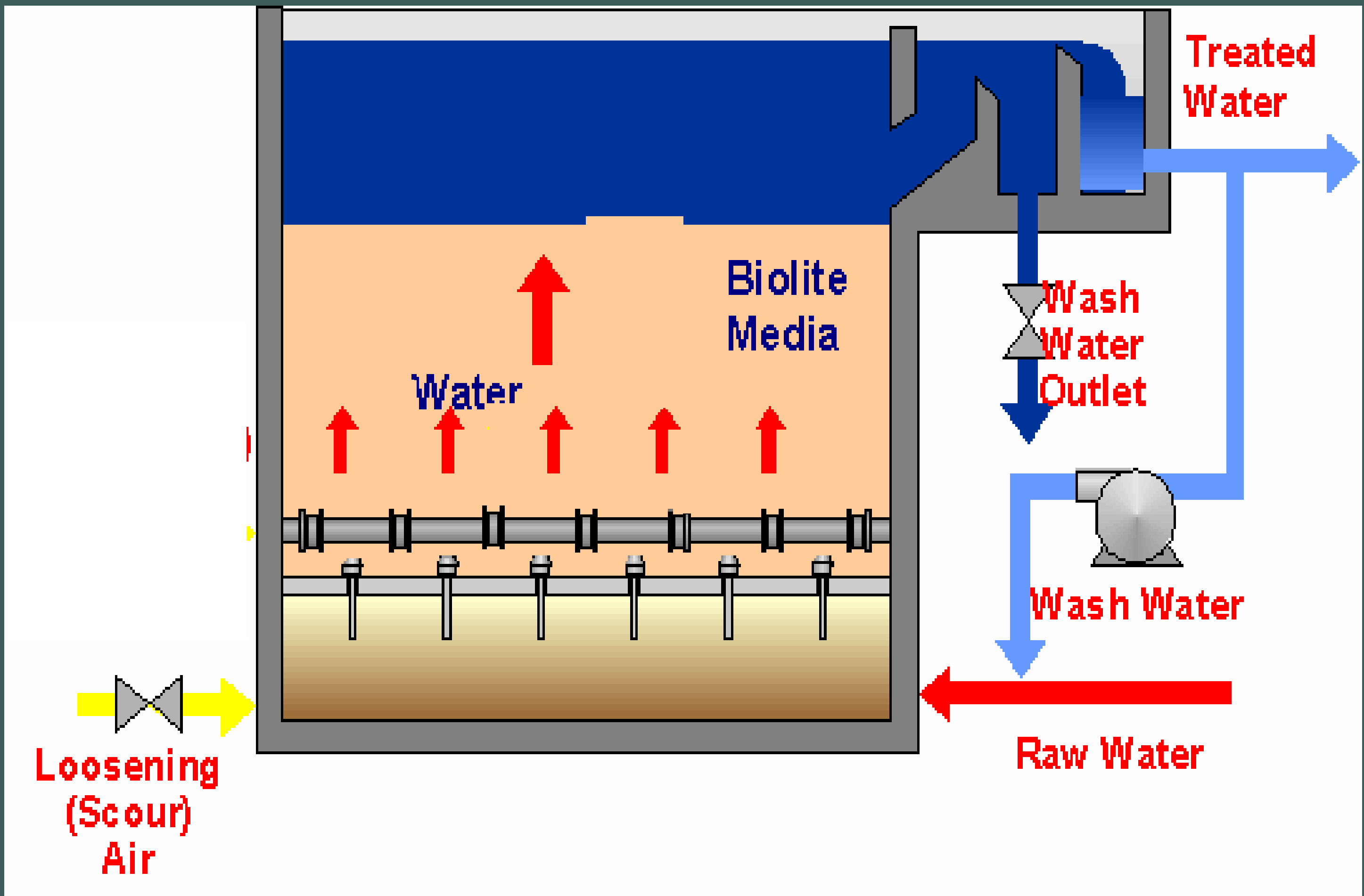
DN Filter Differences

Parameter	Kruger Biostyr	IDI Biofor
Filter Cells	5 cells 755 sf total filter area 9.18 ft media depth	4 cells 583 sf total filter area 10 ft media depth
Operation at AD Conditions	3 cells in operation **176 lbs/d/1,000 cf** **5.4gpm/sf**	3 cells in operation **167 lbs/d/1,000 cf** **5.6 gpm/sf**
Operation at Peak Hydraulic Conditions	4 cells in operation **9 gpm/sf**	3 cells in operation **12.3 gpm/sf**
Backwash Operation	**Gravity** 1 every 18 hours **15 minute downtime**	**Pumped** 1 every 18 hours **38 minute downtime**

Kruger BioStyr



Infilco-Degroment BioFor



Kruger BioStyr

Biostyr Media Retention Platform

Biofor Media Retention Fence

Kruger BioStyr

Nyborg, Denmark

Hobro, Denmark

Infilco-Degroment BioFor

Frankfurt Main Plant, Germany

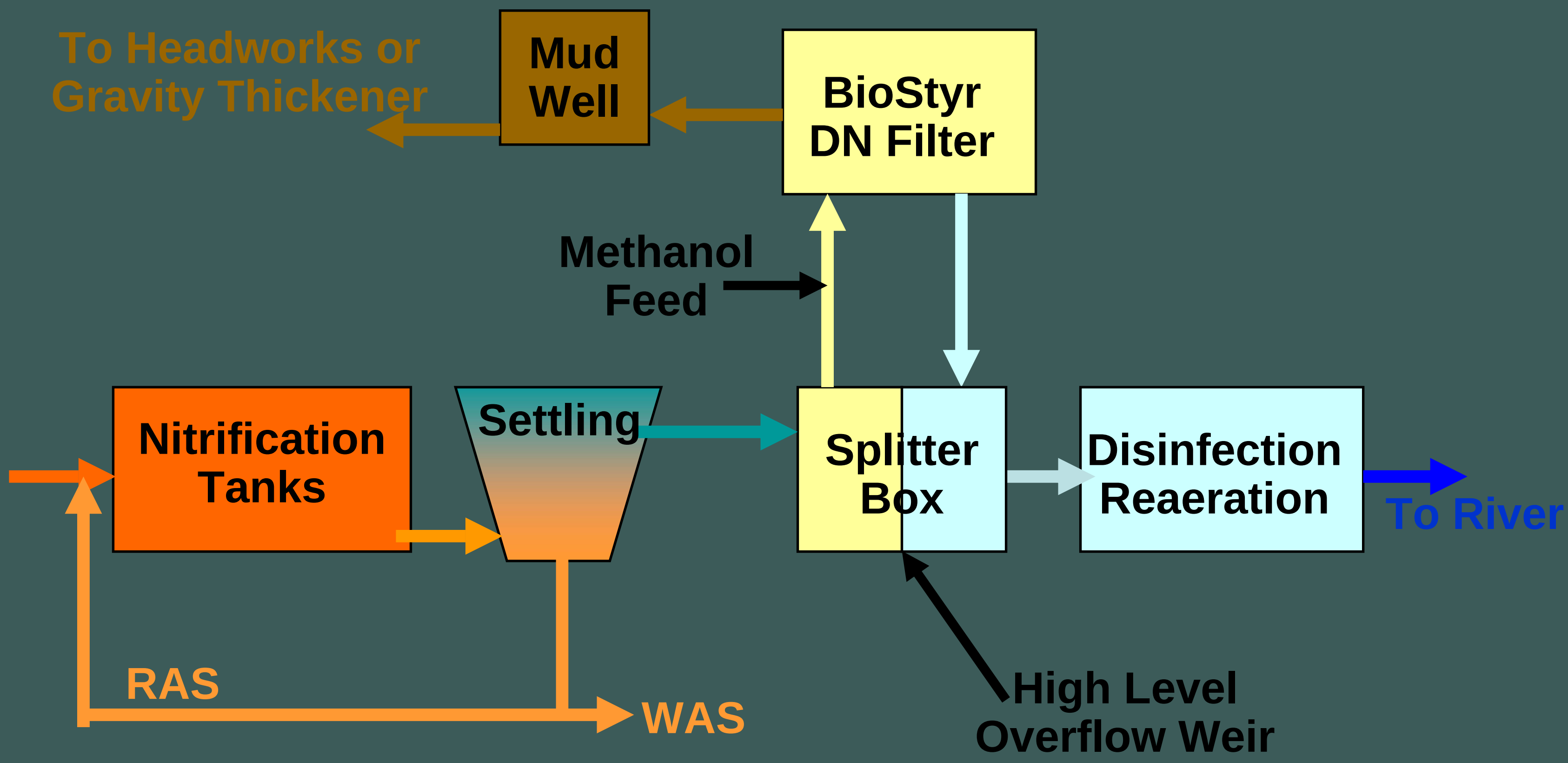
Project Delivery – Vendor Selection

- Capital cost for DN filter equipment, concrete tanks, building and all ancillary equipment
- O&M cost for power, media replacement, etc.
- Present worth costs for two systems almost identical
- Selection came down to
  - Bid exceptions
  - Owner preferences
  - Demonstrated performance (both systems provided data demonstrating past performance)

Influent and Effluent Requirements

Parameter	Influent Conditions	Effluent Requirements
Annual Average flow	3.50 mgd	NA
Minimum Flow	0.50 mgd	NA
Peak Hourly Flow	7.75 mgd	NA
Temperature	13 Degrees C (minimum)	NA
Dissolved Oxygen	Less than 7.0 mg/l	NA
Total Nitrogen	27.5 mg/L (annual ave.)	NA
Total Kjeldahl Nitrogen	2.0 mg/L (annual ave.)	NA
Ammonia Nitrogen	0.5 mg/L (annual ave.)	NA
Nitrate/Nitrite (NO_X – N)	25.1 mg/L (annual ave.) varying from 41.5 mg/l to 11.5 mg/l	1.5 mg/l (annual ave.)
BOD_5	6.0 mg/L (annual ave.) varying from 24.0 mg/l to 1.0 mg/l	Influent BOD_5 + 5.0 mg/l
TSS	6.0 mg/L (annual ave.) varying from 19.0 mg/l to 1.0 mg/l	10 mg/l (monthly ave.) 20 mg/l (max. day)

Implementation

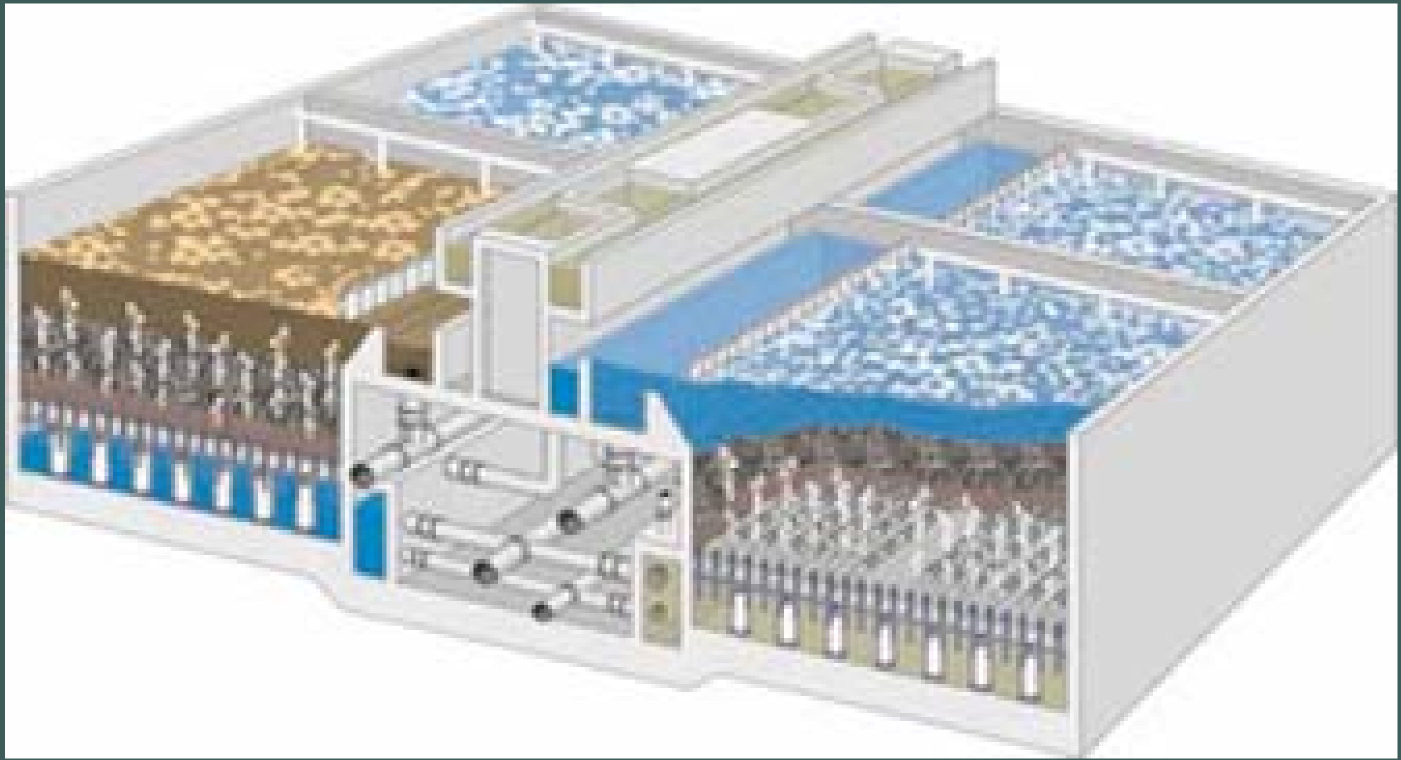



09/30/2005
ALLIED


10/21/2005

Questions?

Infilco-Degroment BioFor



Kruger BioStyr