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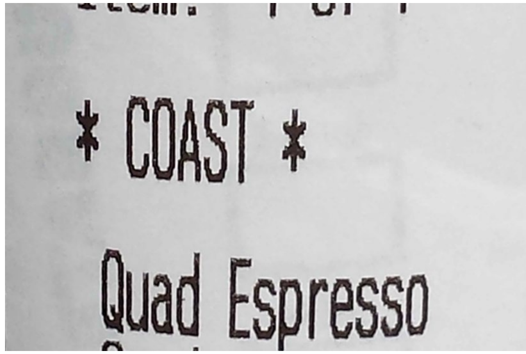
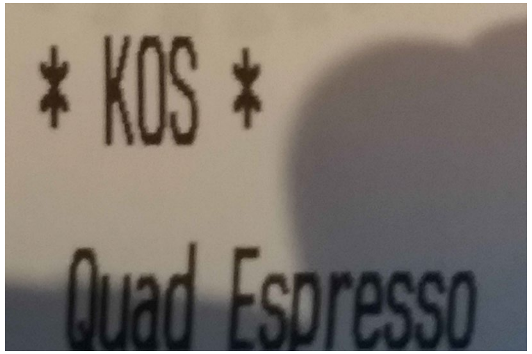
Phosphorus Recapture in Water

Koos J. Baas B.Sc.





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Innovation in Phosphorus Recapture

PENDING PATENTED PENDING

History

wetsus
european centre of excellence for sustainable water technology

Phosphate Limitation

IWW
IWW Zentrum Wasser

Biofouling Strategies

UNESCO-IHE
Institute for Water Education

Measuring low P

TU Delft
Delft University of Technology

P Adsorption w Ferritine

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History

AWWA 2007 Mon4-1
Tampa, Florida

Elucidation of membrane biofouling processes using bioassays for assessing the microbial growth potential of feed water

Dick van der Kooij, Wim Hijnen, Emile Cornelissen, Kiwa Water Research
Sjack van Agtmaal, Water Supply Company Evides
Koos Baas, Aquacare Europe BV
Gilbert Galjaard, NV PWN Water Supply Company North Holland

Introduction
Membrane fou
hampers the a
intended for l
microbial bior
rate and extent
elements, whi
the feed wat
compounds is
processes app
chemicals add
seawater and
originating fro
cyanobacteria
and in seawat
compounds t
ultrafiltration
including mic
activated carb
formation of e
and fulvic ac

WATER RESEARCH 44 (2010) 3454–3466

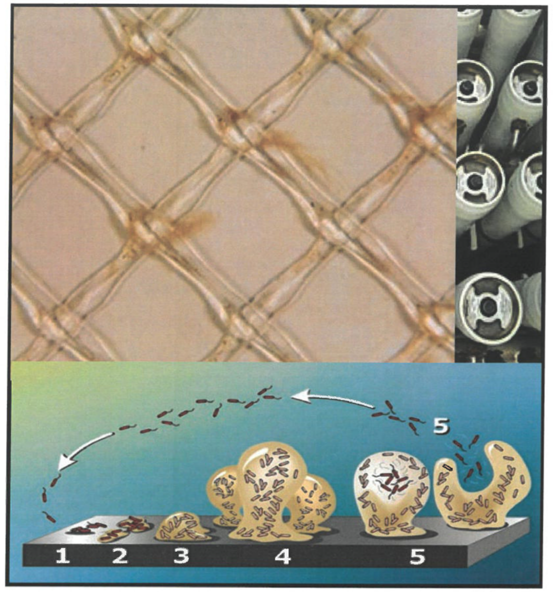
ELSEVIER
Available at www.sciencedirect.com
ScienceDirect
journal homepage: www.elsevier.com/locate/watres
WATER RESEARCH

Phosphate limitation to control biofouling

J.S. Vrouwenvelder[a,b,*], F. Beyer[a,c], K. Dahmani[d], N. Hasan[b], G. Galjaard[e], J.C. Kruithof[a,e], M.C.M. Van Loosdrecht[b]

[a] Wetsus, Centre of Excellence for Sustainable Water Technology, Agora 1, P.O. Box 1113, 8900 CC Leeuwarden, The Netherlands

UNESCO-IHE
INSTITUTE FOR WATER EDUCATION



Phosphate limitation in Reverse Osmosis (RO) systems:
An option in controlling biofouling?

Judith Diane Jacobson

MSc Thesis (MWI – 2008/34)
June 2008

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The Quest

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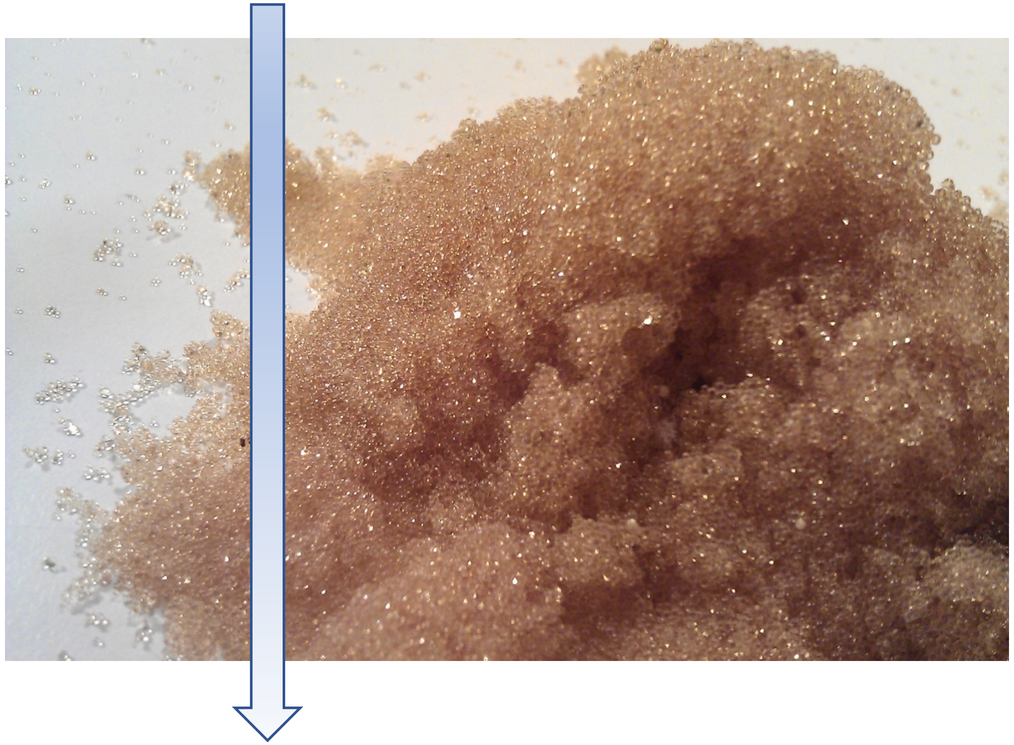
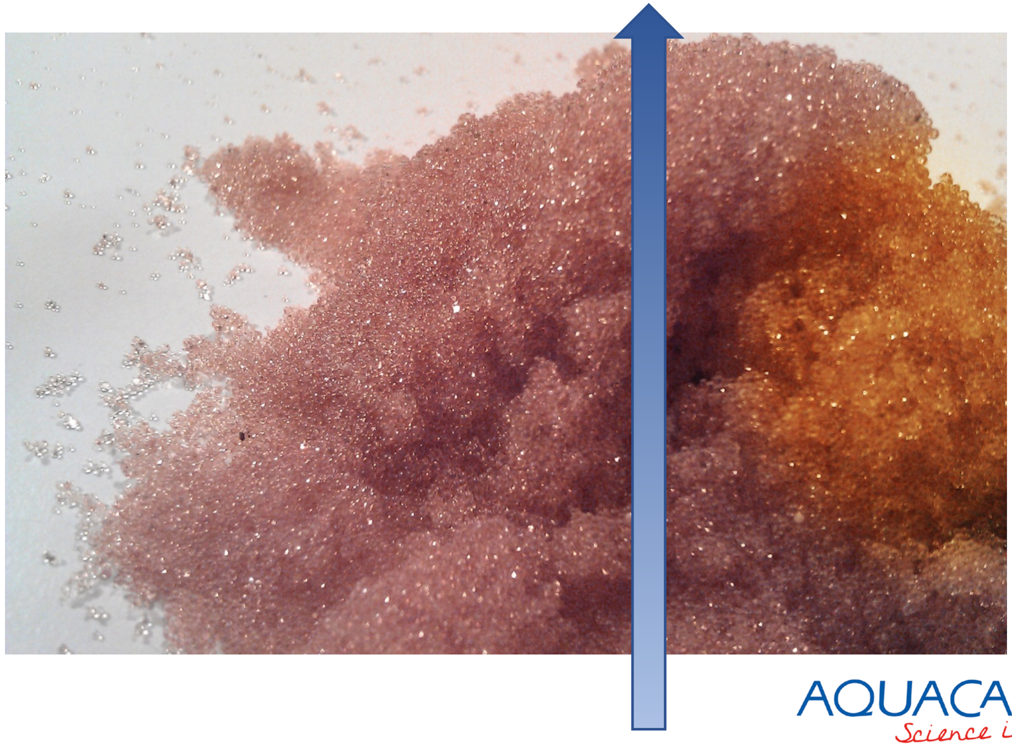
BIOPHREE® with P-affinity
Physical adsorption (no chemical reaction, no ion exchange ?)
Desorption from polymer (”regeneration”)
Recapture as aqueous, re-usable P.

P Adsorption



P Desorption



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2 Main Markets

Surface Water

Waste Water

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Surface water

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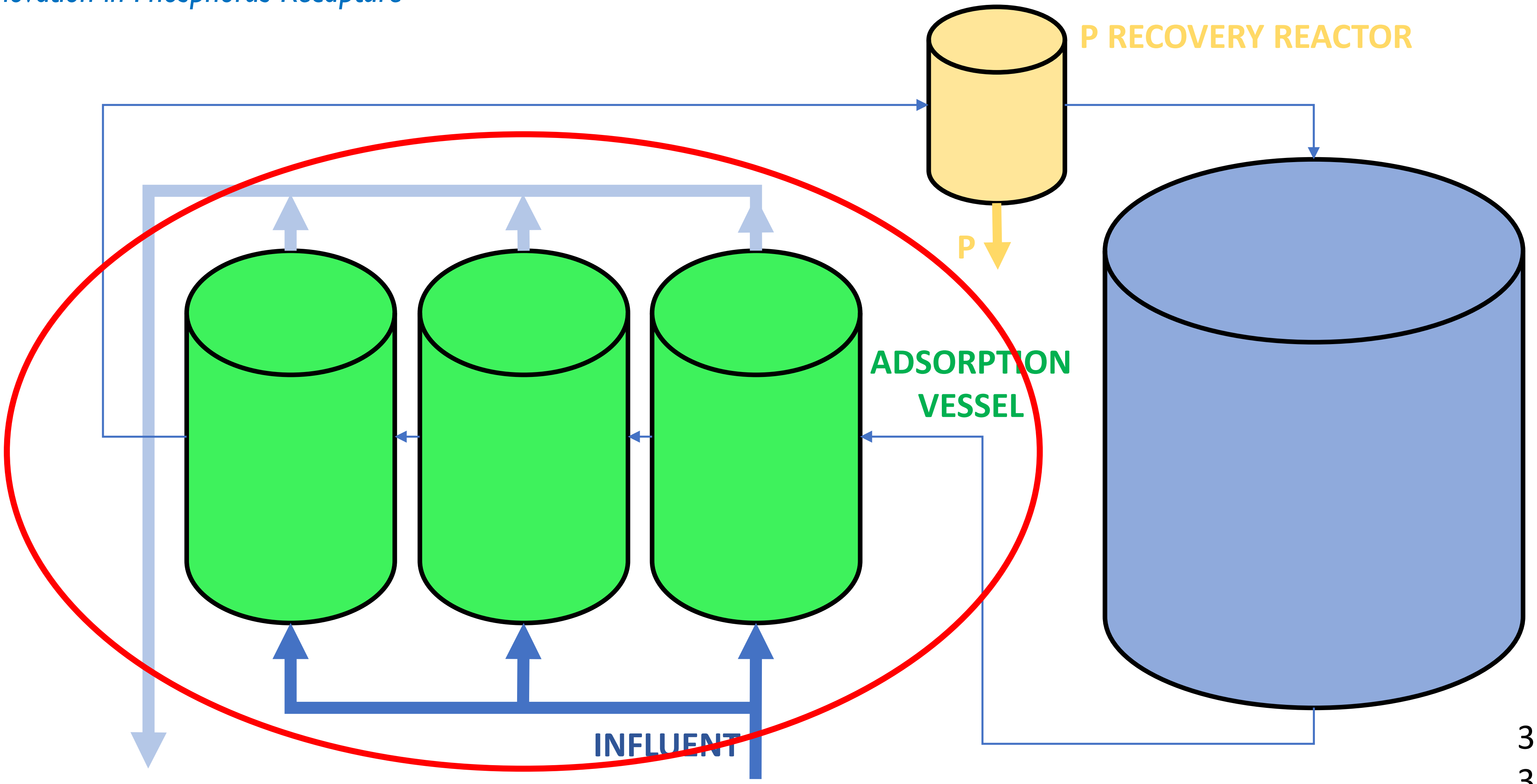

3 x 160 m³/hr
3 x 1 MGD

^

Many P adsorption columns serviced by 1 regeneration & recapture system
Continuous P removal treatment.
Regeneration fluid is continually re-used

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Surface water

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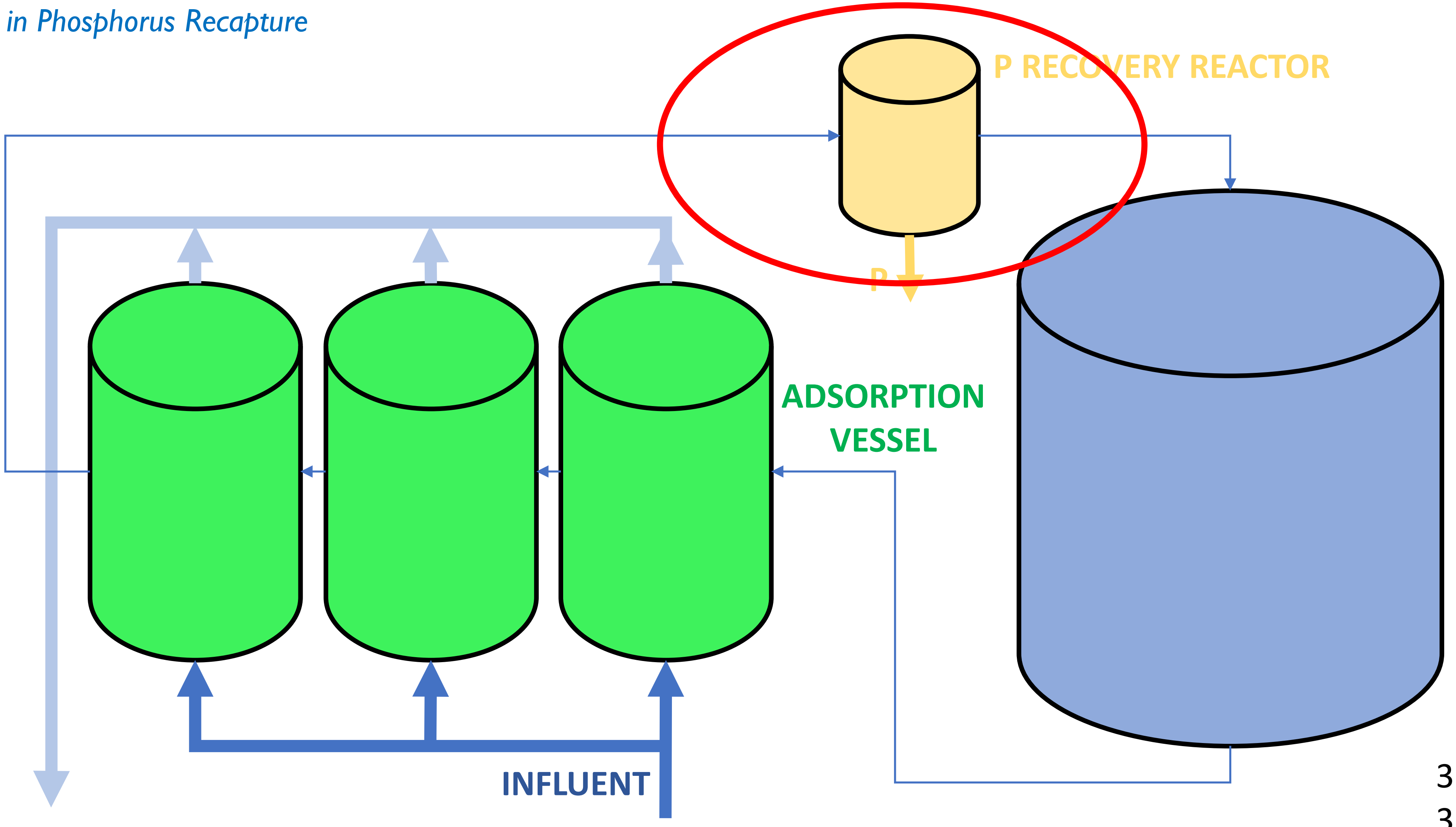

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Surface water

3500 m^3/hr
Courtesy Vitens

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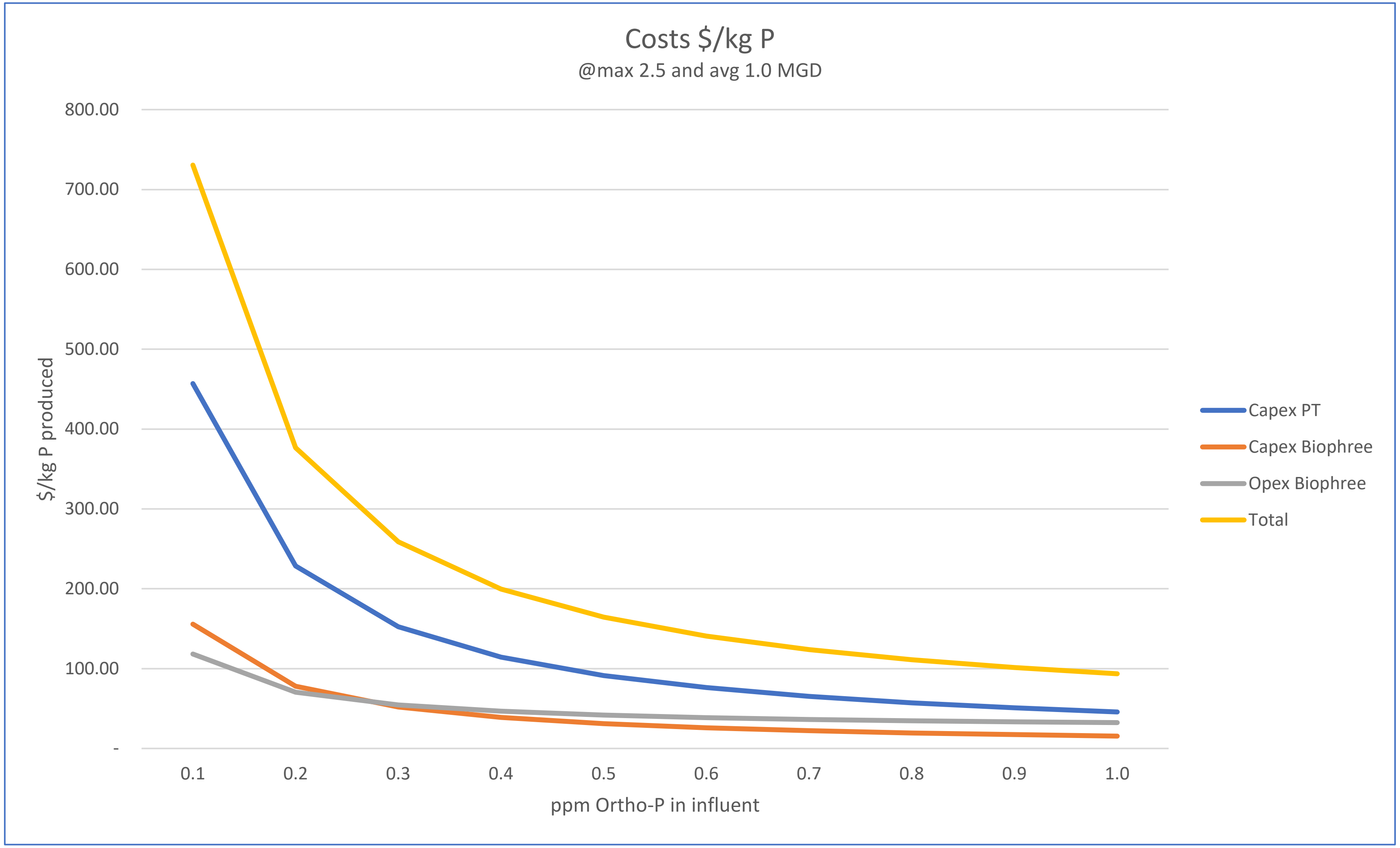

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Business case

Grand Lake St Marys Ohio USA

Economic Impact

$ 708/lb *(report KCI 2011)*

Opex

< $ 60/lb

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Business case = Footprint ?

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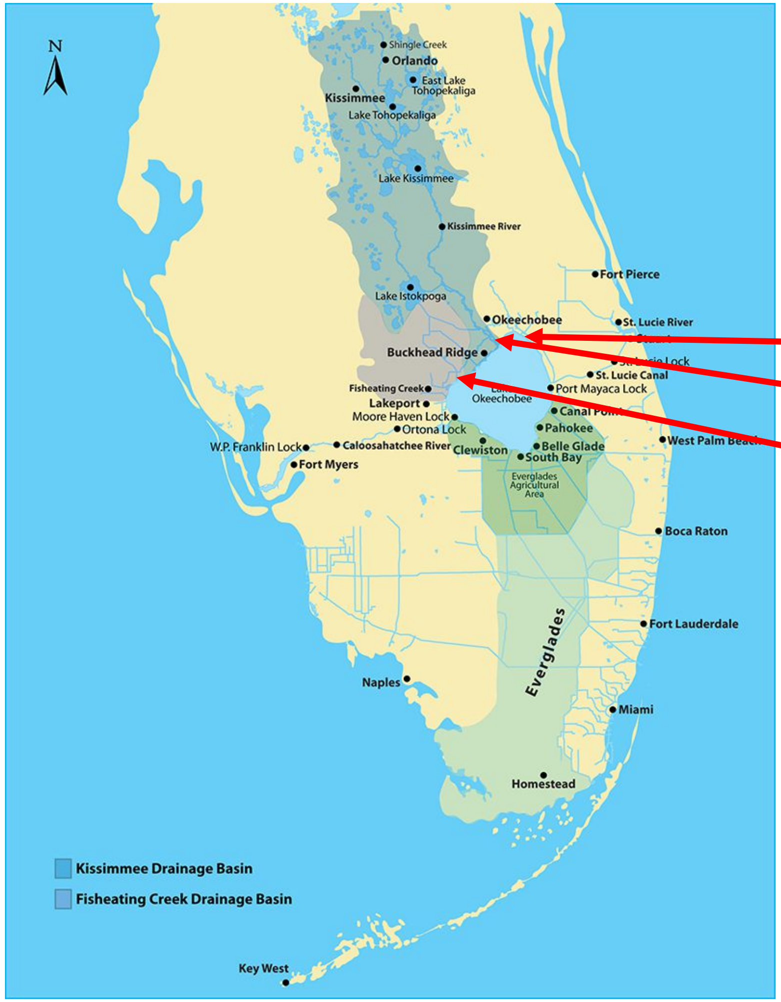
Strategy



Lake Okeechobee

Overload P is 120.7 MT/yr

Contribution 3 sources

TCNS	65.8 MT
S 154 Basin	17.0 MT
C41 Basin	19.4 MT
Total	102.2 MT

(Florida DEP 2001)

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Pilot & Competition

OBJECTIVES:
- Radical cheaper: <125 $/kg P removed
- Down to ultra low P levels (< 10 ppb P)
- Very small footprint

Stage 1
Idea generation

Stage 2
Lab verification

Stage 3
Pilot test

Stage 4
demonstration

Stage 1	Stage 2	Stage 3	Stage 4
> 200 participants Paper submission	Ca 80 participants 0,6 m³/day 2 weeks	10 participants 10 & 31 m³/day 3 months	4 participants 7.000 to 15.000 m³/day 1 year
Prize: 25 k$	Prize: 50 k$	Prize: 125 k$ (4x)	**Prize: 10 million $**

THE GEORGE BARLEY WATER PRIZE

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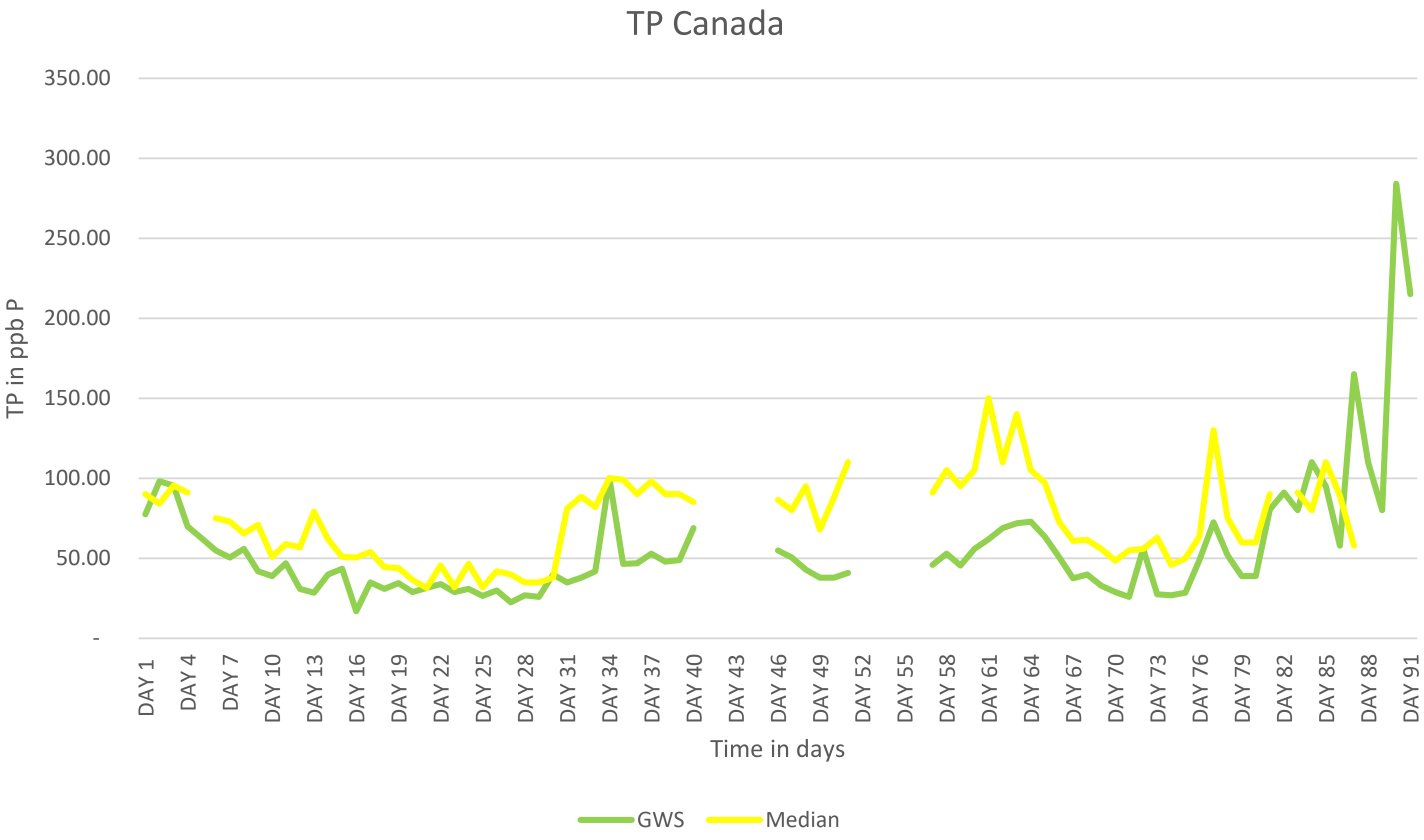
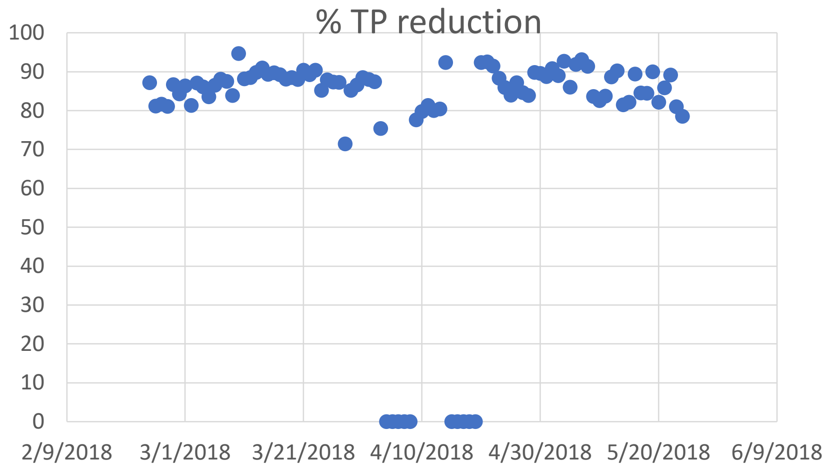
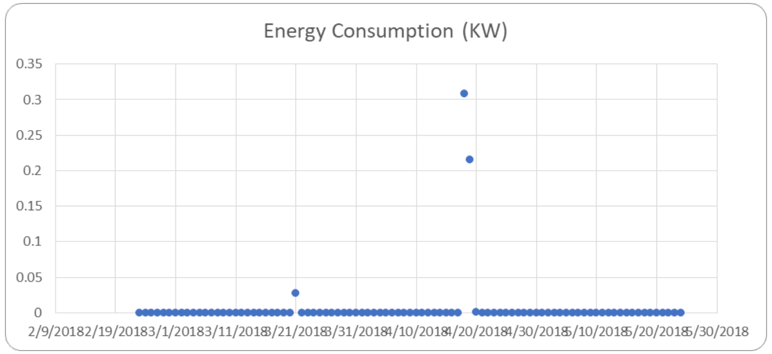
Pilot stage 3 Results







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BONUS RETURN
SCIENCE FOR A BETTER FUTURE OF THE BALTIC SEA REGION

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SO FAR

- Proven Technology to extreme low P-level (<10 ppb)
- Patent Europe granted
- Technical Readiness Level 7
- Successful re-usable regeneration fluid

CHALLENGES

- Entering new markets. Who owns the problem?
- Commercial feasibility recovered phosphorus
    - Phosphate Ore runs @ 0,80 $/kg P
    - Best recovery price is around 60,- $/kg P

ACKNOWLEDGEMENS

- 1st and 2nd place George Barley Prize Stage 2 (USA)
- 2 of 4 Finalists George Barley Prize Stage 3 (Canada)
- 1st place Baltic Sea Challenge
- ISLE utilities Sales pitch Frankfurt

ADVANTAGES

- Simple
    - Scalable from small domestic to large lakes or rivers
    - Flexible and easy to design
    - Cooling systems regenerate 1 to 2 x/yr (*Manual)*
- Eco Friendly
    - Small footprint on Carbon, Space and Environment
    - Durable operations
- Recovery of phosphorus to sellable product
    - Co-adsorption/desorption of TOC
    - Less depletion of existing P sources.

CONCLUSIONS

- From Idea to Market > 6 yrs
- New Markets = Different Business Case
- New Markets want to see Prove in Pilot
- Competition GBWP = Good Exposure & Validation

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