



P Recovery in North America Ostara's PEARL® Process

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Agenda

Why | What | Who | How | Where

- Why Recover Nutrients?
- What is Struvite?
- Who is Ostara?
- How Does the PEARL™ Process Work?
- Where is it Operating?
- Available Services



Why Recover Nutrients?

Why | What | Who | How | Where

Benefits for the environment:

- Conserve phosphate reserves
- Improve river water quality
- Recycle materials locally
- Reduce greenhouse gas emissions



A More Sustainable WWTP

Why Recover Nutrients?

Why | What | Who | How | Where

Benefits for the treatment plant:

- Reduce recycled nutrient loads
- Prevent struvite scale
- Reduce phosphate in biosolids
- Reduce sludge volumes
- Produce a revenue generating product



Lower Costs & Improve Reliability

Process Performance

Why | What | Who | How | Where

- Phosphorus removal >85%
 - Reduced bio-P VFA demand
 - Improved process stability
 - Reduced struvite and/or chemical use
- Nitrogen removal up to 40%
 - Reduced aeration and alkalinity for nitrification
 - Reduced carbon demand for denitrification



Reduce Plant Load By ~30%

Process Financial Benefits

Why | What | Who | How | Where

- Reduced chemical consumption
 - Ferric/Alum (plus others)
- Reduced energy consumption
- Increased plant capacity
- Reduced sludge disposal
- Reduced maintenance (labor/parts)
- Fertilizer revenue creation



<5 Year Payback / Instant Net Saving

What is Struvite?

Why | **What** | Who | How | Where



- Increases O & M costs
- Impacts plant reliability



Sewer pipes from Ephesus (founded 300 B.C.)

Crystal Green®

Why | **What** | Who | How | Where

- Certified fertilizer - 5% N, 28% P, 0% K, + 15% MgO
- Premium quality product
 - Release rate, purity
- Environmentally-Friendly
- Independently tested
- Established sales and marketing
- Registered US and Canada



CrystalGreen®
All Ways Green.

Who is Ostara?

Why | What | **Who** | How | Where

- Incorporated May 2005
- Unique business model
 - PEARL™ Process systems/service
 - Crystal Green® fertilizer
- Proprietary, proven technology
 - Two full scale plants operating
 - Two additional plants under construction
 - Extensive municipal and industrial pilot testing
 - North America
 - International – (UK, Israel, China)



Creating Value from Waste

Why | What | Who | How | Where



• Licensed technology (PEARL™ Nutrient Recycling Process) from University of British Columbia

• 1st private financing round closed
• 1st pilot running in Canada, Edmonton

• Successful 1st pilot running in USA, Suffolk, Virginia
• Crystal Green™ leachate trial at Virginia Tech, Virginia Beach (USA)



• Successful 1st ethanol pilot in Fergus Falls, Minnesota (USA)



• 1st commercial sale of Crystal Green™
• Successful pilot in Reno, Nevada (USA)

• Successful pilot in Chicago suburb - Elgin, Illinois (USA)

• Successful pilot in Madison, Wisconsin (USA)
• Ongoing pilot in Israel, Haifa
• Robert F. Kennedy, Jr. Joins Ostara Board



• Ostara founded – seed funded



• 1st contract signed with City of Edmonton

• 1st Crystal Green™ trial at NC State Turf, North Carolina (USA)
• Crystal Green™ trial at Virginia Tech, Blacksburg (USA)
• Crystal Green™ fishery trial in British Columbia (Canada)

• Successful pilot in Portland, Oregon (USA)
• 1st full-scale installation in Edmonton (Canada)



• Successful pilot in York, Pennsylvania (USA)
• Edmonton demonstration plant accepted and purchased by Goldbar Treatment plant for \$500K
• National Bank becomes strategic advisor in obtaining treatment fee project financing



• Funding of \$10.5 million by Vantage Point Venture Partners and Foursome Investments
• 1st USA contract signed for full-scale facility in Portland, Durham
• Bonding insured by EDC
• Crystal Green™ leachate trial at University of Arkansas, Arkansas (USA)
• Crystal Green™ nursery trial at Oregon State University, Oregon (USA)

• Successful pilot in San Francisco, California (USA)



• 1st full-scale commercial plant operations in USA, Portland, Durham
• 1st truck-load sale of Crystal Green™

North American Experience

Why | What | **Who** | How | Where

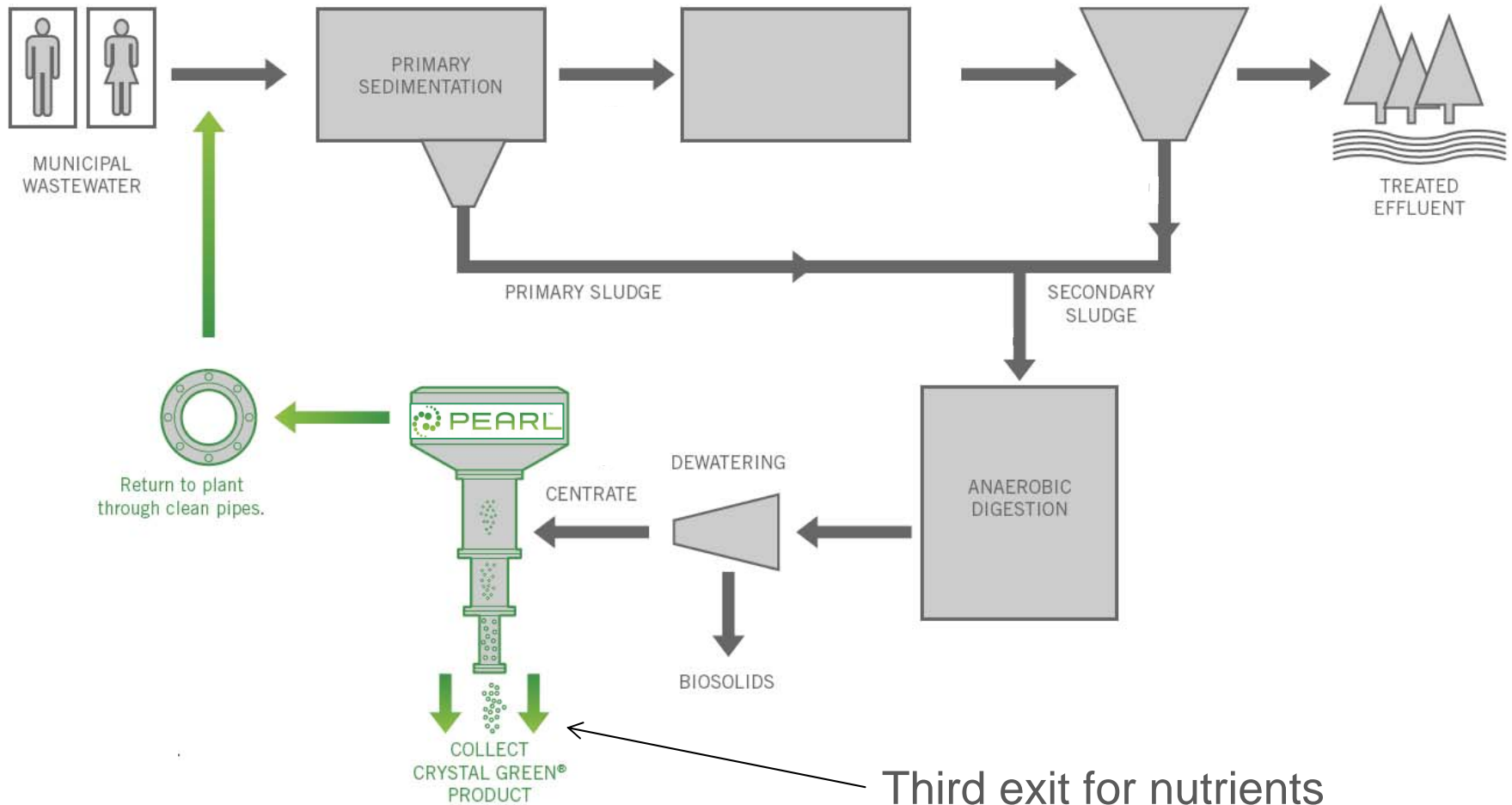


◆ Pilot

◆ Full Scale

Ostara's PEARL™ Process

Why | What | Who | How | Where



Third exit for nutrients

PEARL™ Process Details

Why | What | Who | **How** | Where

Precipitation chemistry

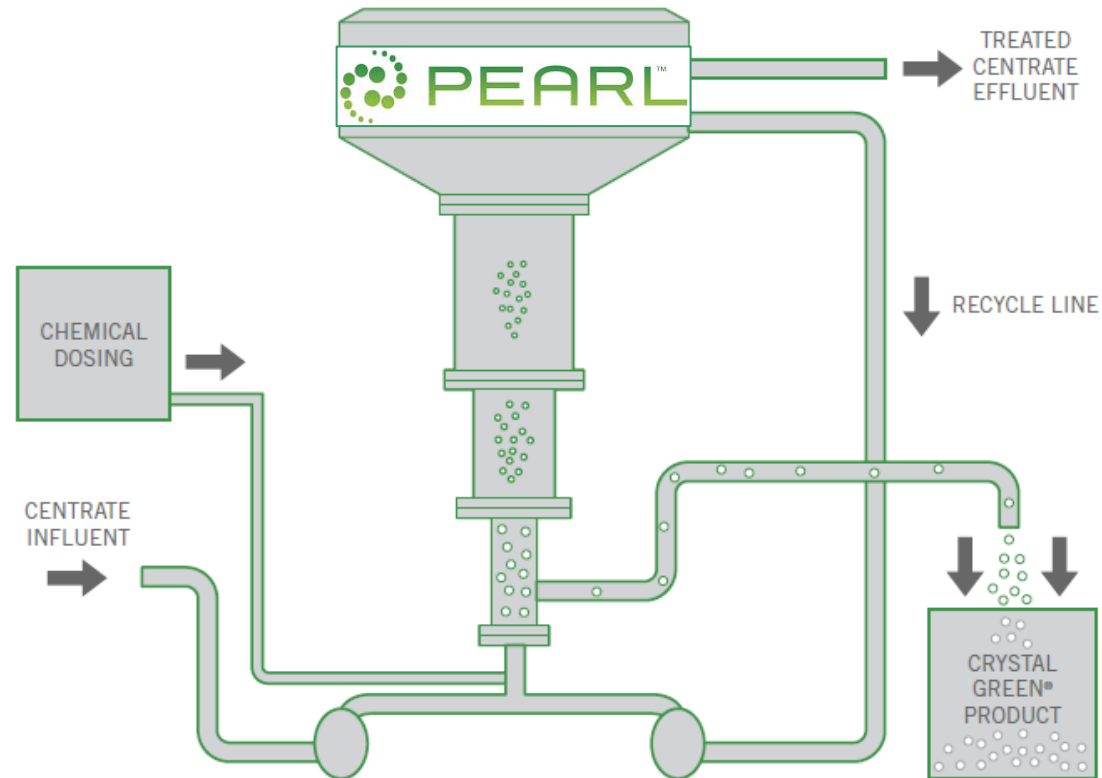


pH

Crystal growth

Simple operation

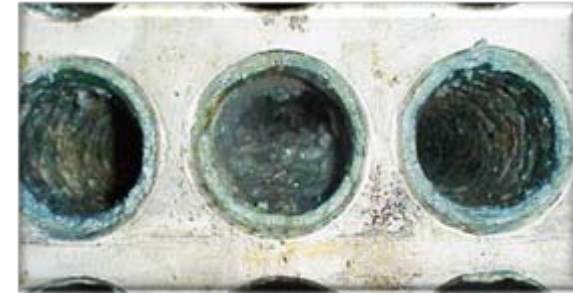
- Remote control
- Material handling
- Sampling/analysis/calibration



Preferred Application

Why | What | Who | **How** | Where

- Struvite/Vivianite challenges
- PEARL™ Process feed:
 - $\text{PO}_4 - \text{P}$: >75 mg/L, >65 kg P/day
 - TSS <1000 mg/L (up to 10,000)
- Plant size >20 MLD
- Plant processes:
 - Anaerobic zone (Bio – P)
 - Anaerobic digestion
 - Anoxic zone for denitrification/biological selection
 - Minimum chemical P removal



The Durham WWTP

Why | What | Who | How | Where

- Portland, OR
- 210,000 PE
- 80 MLD
- Since May 2009

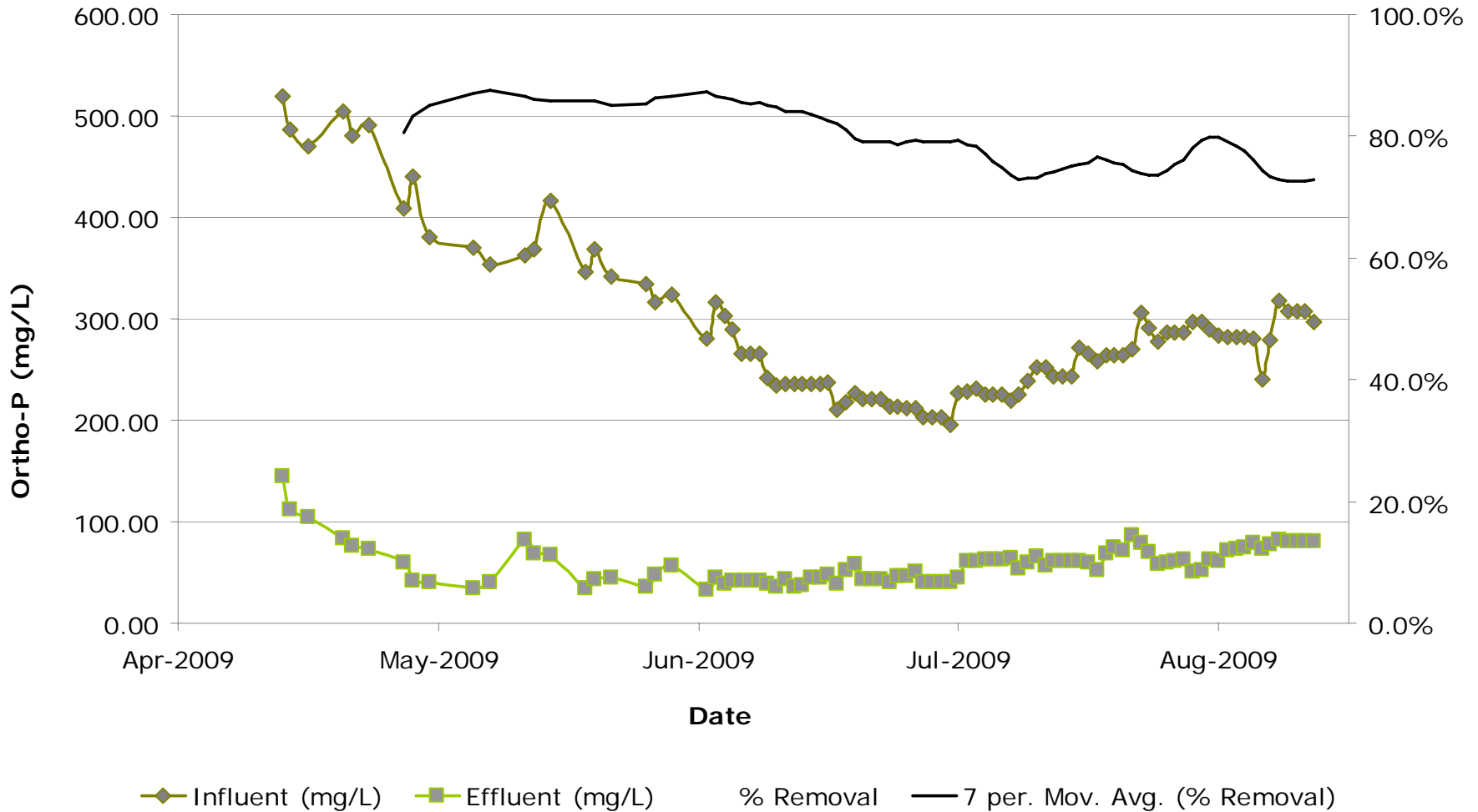


- Dewatering centrate
- Feed: 450,000 L/day
- 400 mg/L PO₄ – P
- 1200 mg/L NH₄-N

Durham Performance - PO₄

Why | What | Who | How | Where

100% of centrate treated since startup



The Gold Bar WWTP

Why | What | Who | How | Where

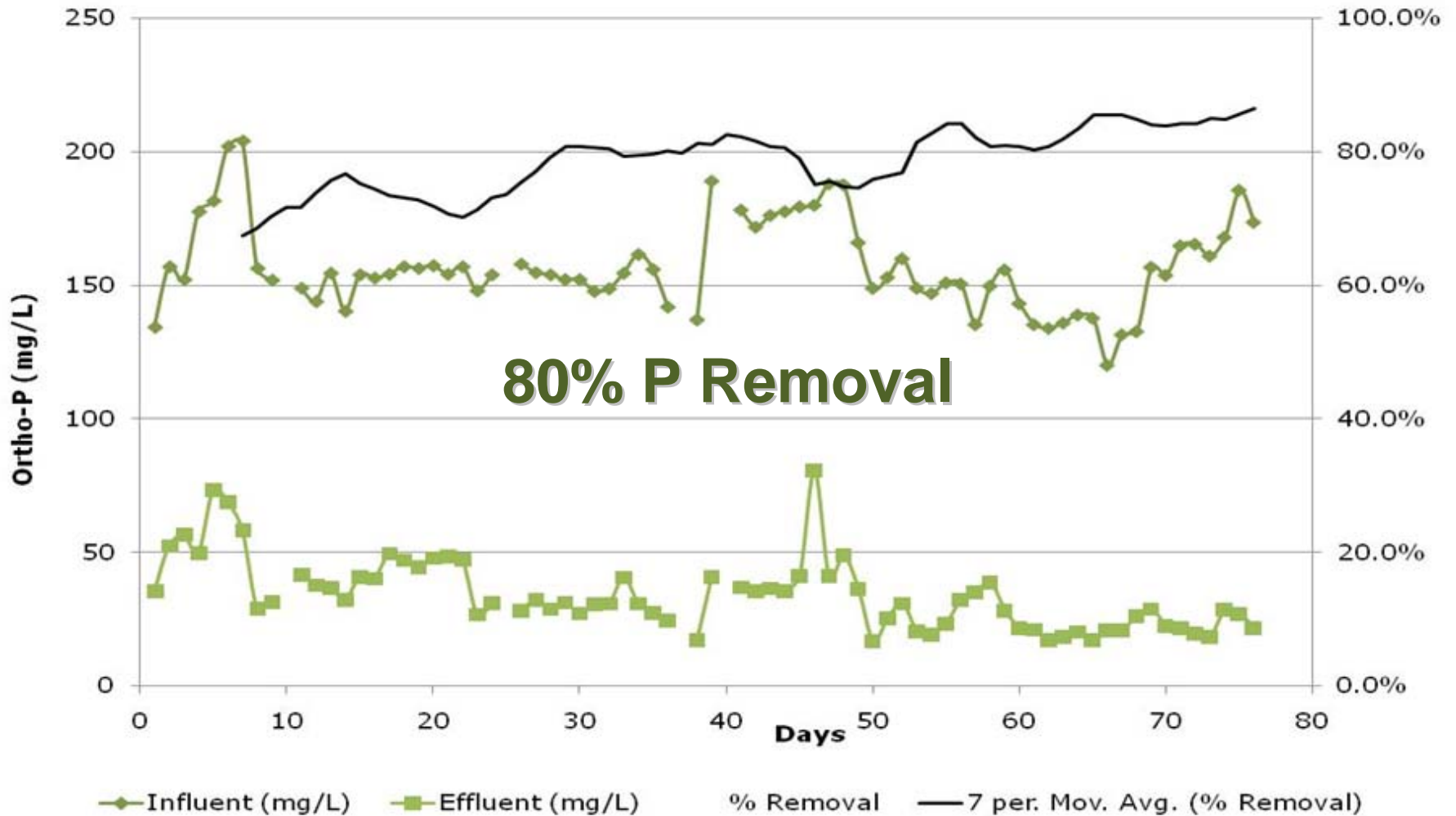
- Edmonton, AB
- 700,000 PE, 310 MLD
- Since May 2007



- Lagoon supernatant
- Feed: 500,000 LPD,
- 150 mg/L P, 700 mg/L N

Gold Bar Performance - PO₄

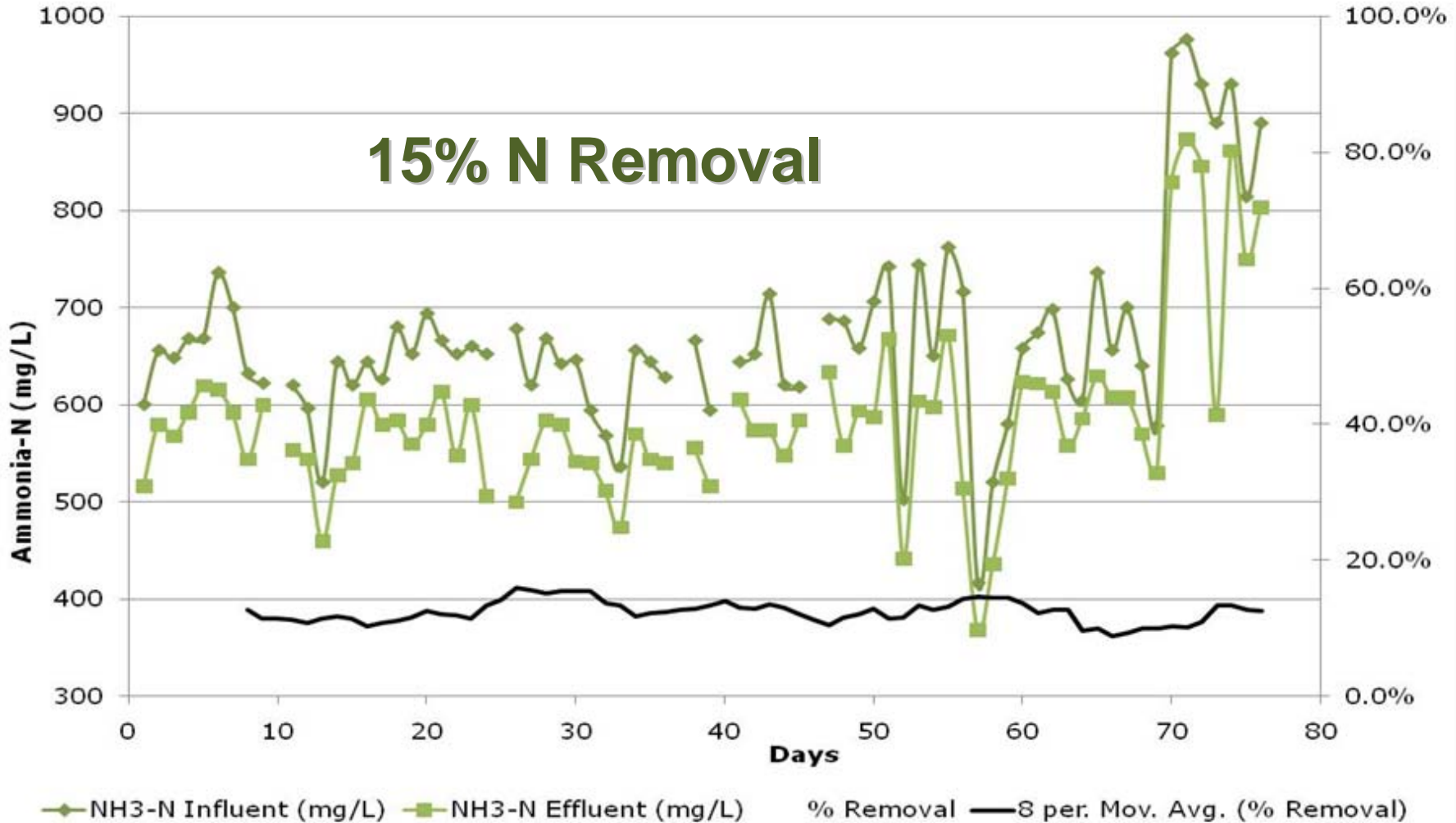
Why | What | Who | How | Where



Gold Bar Performance - NH₄

Why | What | Who | How | Where

15% N Removal



Services Offered

- Jar test
 - Quick verification of viability
 - Assess struvite solubility versus pH
- Pilot study
 - 3 to 4 week duration
 - Demonstrate performance
 - Optimize process design
 - Verify Crystal Green® quality



Thank You!

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