Sustainable Practices in Wastewater Treatment

Dr. Robert Simm

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One Team. Infinite Solutions.

Stantec

Presentation Outline

- The Evolution of Wastewater Treatment
- Some Sustainability Drivers
  - ✓ Climate Change
  - ✓ Rising Energy Costs
  - ✓ Increasing Resource Scarcity
  - ✓ Population Growth
- The Story of Phosphorus
  - ✓ Why phosphorus recovery from wastewater
  - ✓ Case study
- Heat Recovery from Wastewater Effluent
  - ✓ Why heat recovery
  - ✓ Case study

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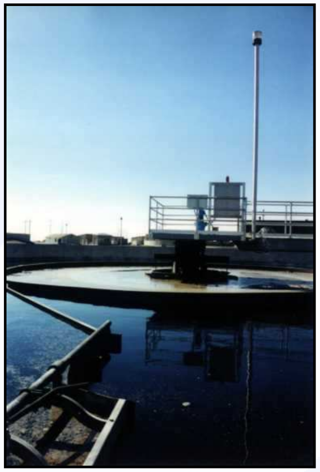
The Evolution of Wastewater Treatment



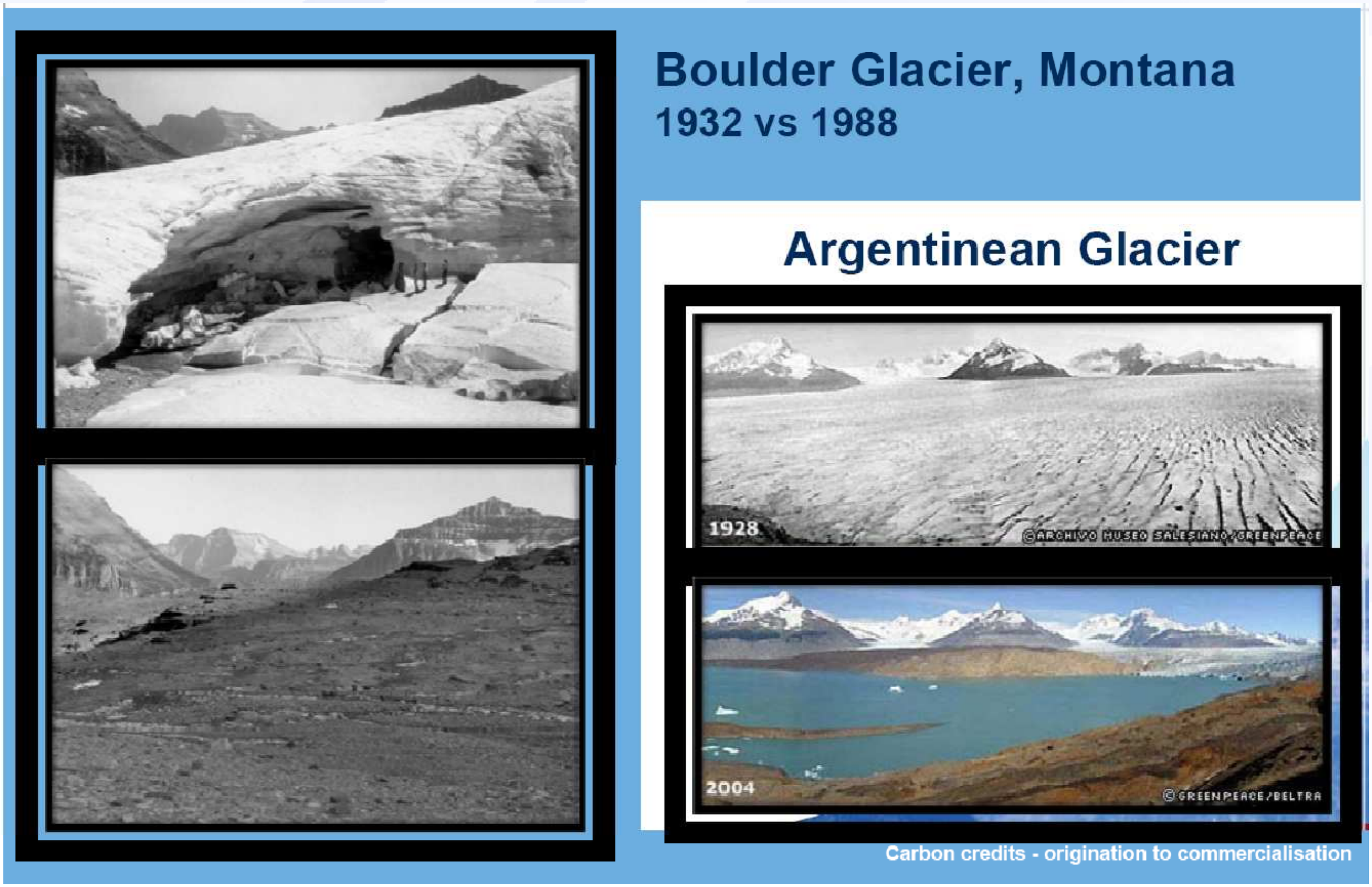
- Primary focus of WW treatment practice was initially public health protection

- Focus shifted to include aquatic environment protection in addition

- Current trend is towards sustainable practice in addition to public health and aquatic environment protection

WWTP – WPCC – WRF – Resource Recovery Center?

Some Current Drivers - Climate Change



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Some Current Drivers –
Dwindling Water Supplies

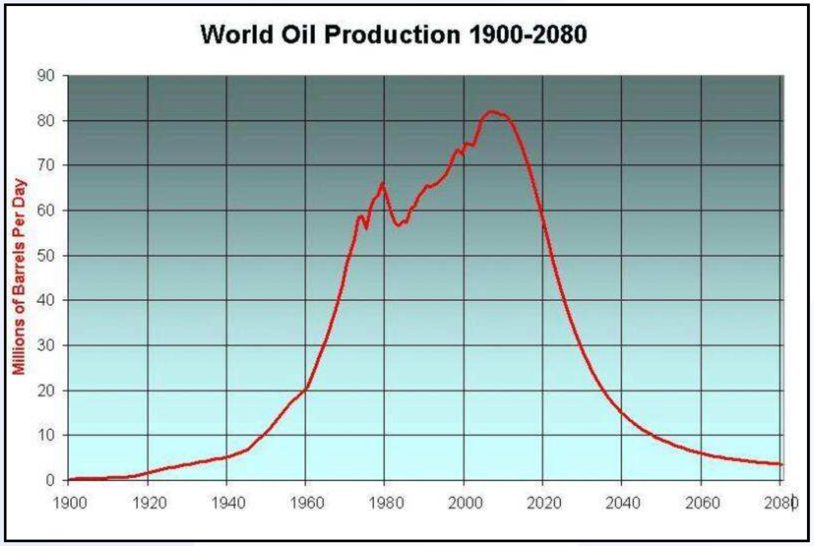
Some Current Drivers – Peak Oil

“Are we ‘running out'? I thought there Was 40 Years of the stuff left"

Oil will not just "run out" because all oil production follows a bell curve. This is true whether we're talking about an individual field, a country, or on the planet as a whole.

Oil is increasingly plentiful on the upslope of the bell curve, increasingly scarce and expensive on the down slope. The peak of the curve coincides with the point at which the endowment of oil has been 50 percent depleted. Once the peak is passed, oil production begins to go down while cost begins to go up.

In practical and considerably oversimplified terms, this means that if 2005 was the year of global Peak Oil, worldwide oil production in the year 2030 will be the same as it was in 1980. However, the world’s population in 2030 will be both much larger (approximately twice) and much more industrialized (oil-dependent) than it was in 1980. Consequently, worldwide demand for oil will outpace worldwide production of oil by a significant margin. As a result, the price will skyrocket, oil dependant economies will crumble, and resource wars will explode.



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Gasoline Prices and Wastewater Treatment

- ~ 70% of oil used in the US is used for transportation.
- Currently working with a large airport customer that is considering using digester gas from a near by WWTP to fuel airport vehicle fleet
- WWTP currently doing cogeneration, but this will be abandoned and replaced with gas cleanup and on-site filling station
- Cost of gas exclusive of vehicle conversions half the price of gasoline on an equivalent basis

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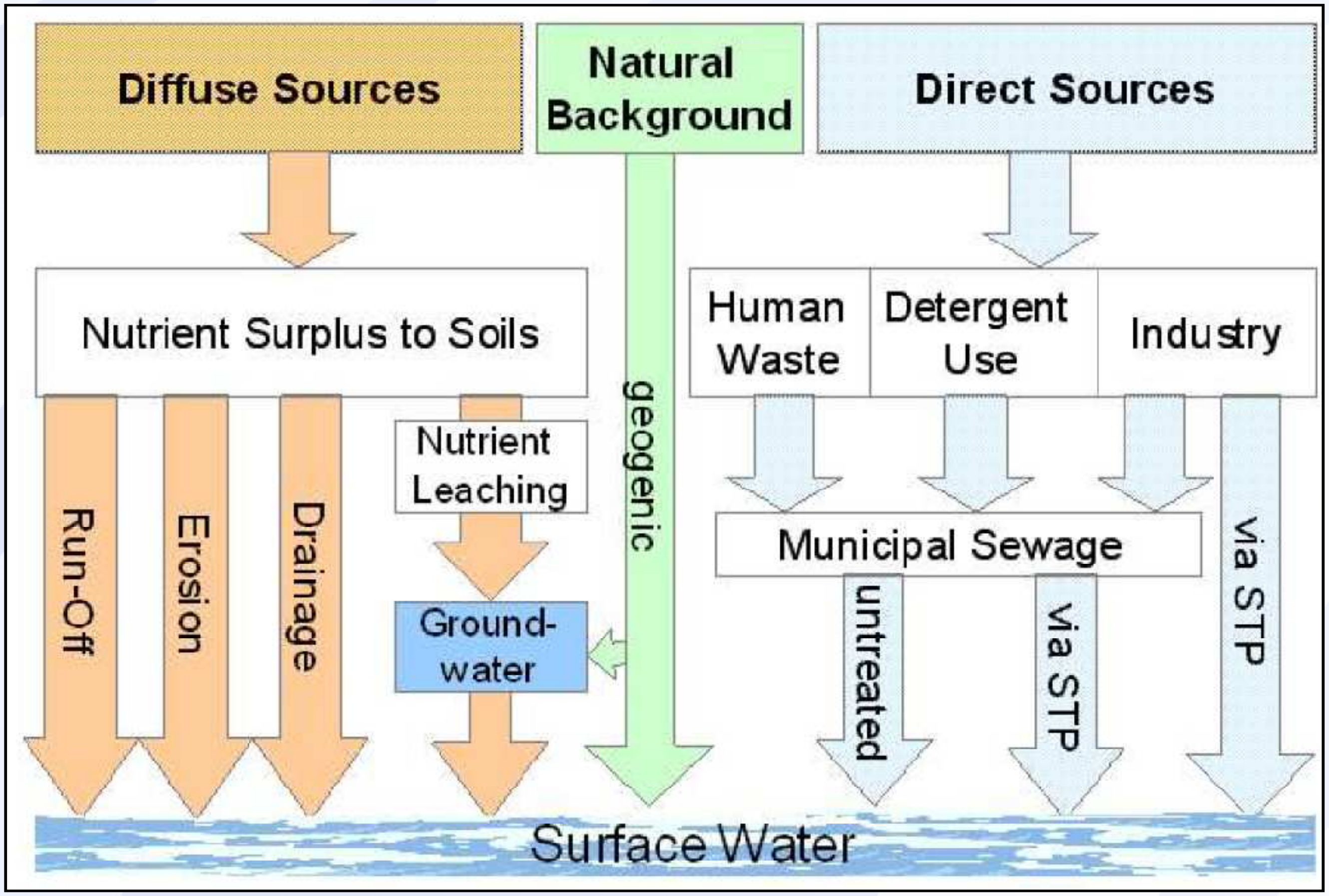
Phosphorus Discharges to the Aquatic Environment



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The Importance of Phosphorus

- Crucial component of DNA, RNA, ATP and other biologically active compounds (microbes, plants, and animals (including humans) – cannot exist without it)

- Current major use of phosphates is in fertilizers

- Unlike nitrogen that is present in large quantity in the atmosphere (78%), phosphate reserves are limited

- World population growth has been possible because of availability of phosphate reserves and cheap energy to extract, transform, and transport it to farms

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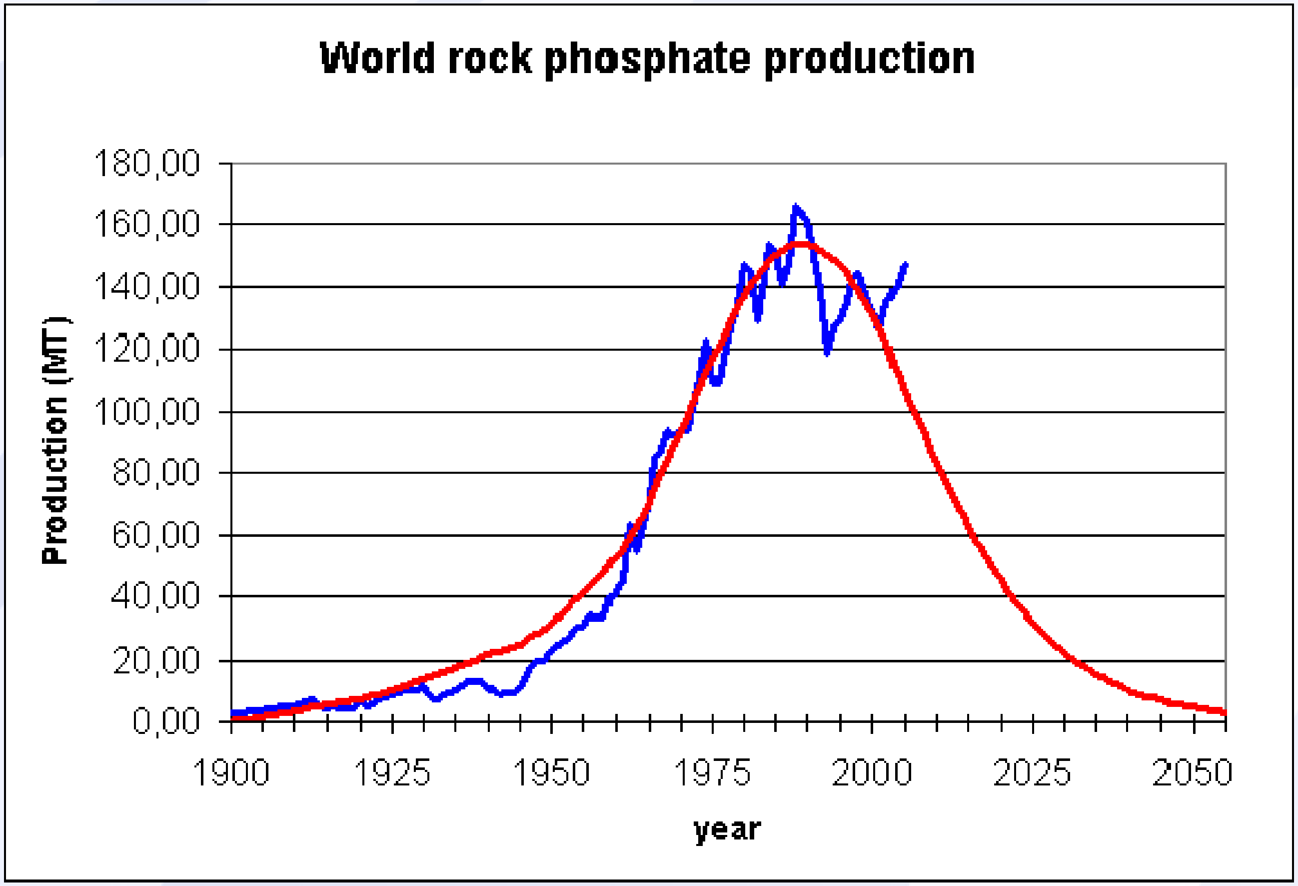
Peak Phosphorus?



Available Phosphate Reserves are Limited

- Phosphate reserves are projected to be depleted in the next 50 – 130 years depending upon source of predictions.

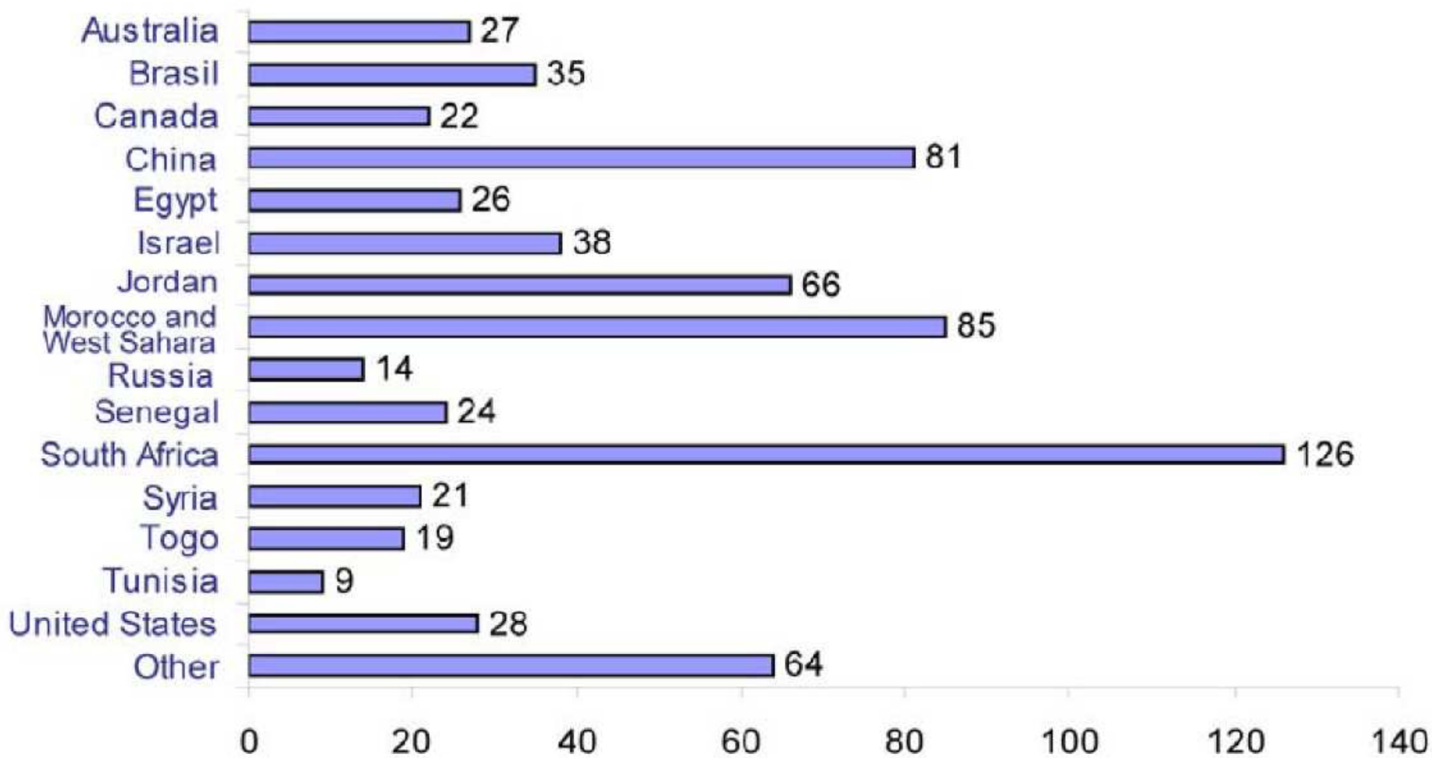


Figure 1: Phosphate rock – years of extraction remaining based on current reserves from 2006 using a 2% yearly increase (Source: USGS)

Drivers for P Recovery

- **Primary**
  - ✓ Phosphorus is critical to life on earth
  - ✓ Known phosphate reserves are finite
  - ✓ Fertilizer production takes a lot of energy
- **Secondary**
  - ✓ High P loading in return streams reduces process efficiency
  - ✓ Eliminate/reduce struvite precipitation in piping
  - ✓ Less P in biosolds can increase quantity for land spreading (situation specific)

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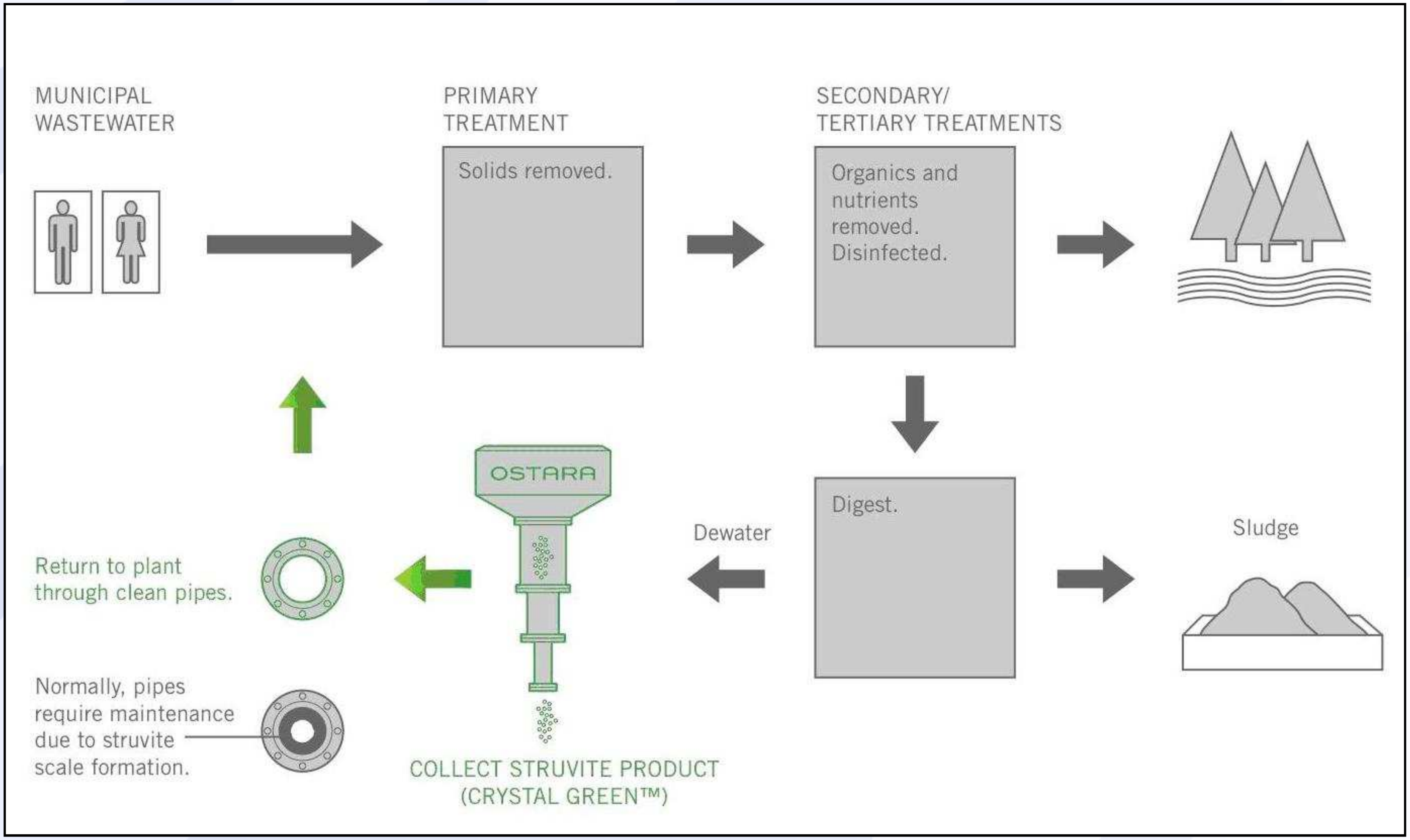
Nutrient Recovery Process



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What is Struvite?

- $Mg^{2+} + NH_4^+ + PO_4^{3-} \rightarrow MgNH_4PO_4.6H_2O$
- Magnesium Ammonium Phosphate (MAP)
- Slow Release Fertilizer
- Can be formed in struvite crystallizer

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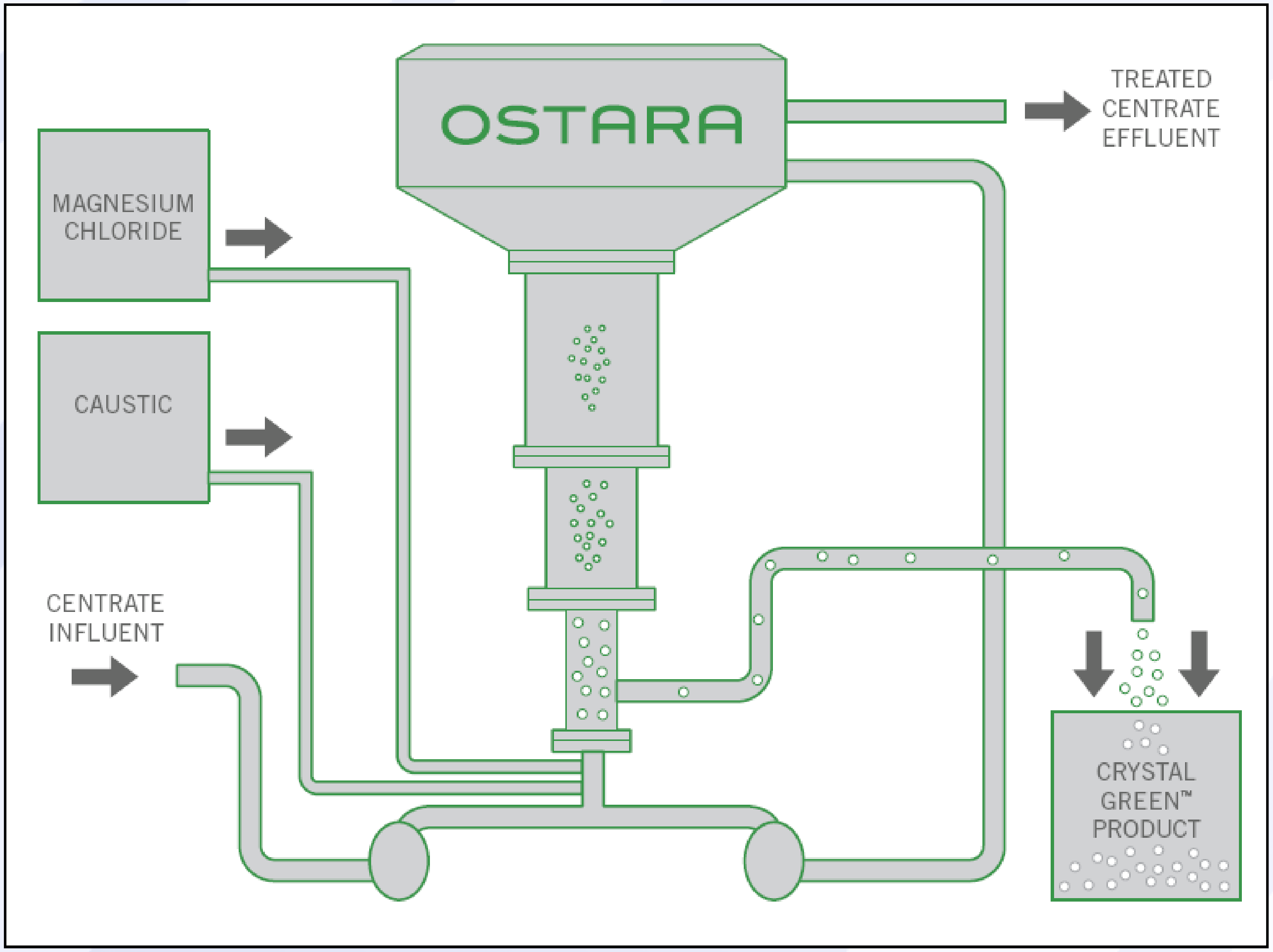

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Case Study - Gold Bar WWTP (First Commercial Scale Facility in NA)

- 84 MGD Biological Nutrient Removal (BNR) Facility
- Plant employs biological phosphorus removal
- Anaerobic digestion with offsite lagoons for supernating
- N & P released from sludges in lagoon
- Supernatant returned to plant

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Gold Bar – Demonstration Scale Unit

- First commercial scale struvite recovery unit in North America
- Began operation at Edmonton Gold Bar in May 2007
- Removes on average 81% soluble P and 13% ammonia from supernatant flow of 82 to 95 gal/min (310 to 360 l/min) representing 20% of sludge lagoon supernatant.
- Produces ~ 1,100 lbs/d (500 kg/d) of struvite slow release fertilizer

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Struvite Crystals from Reactor

- Struvite crystals can be used as "slow" release fertilizer for:
  - ✓ Commercial green houses
  - ✓ Golf courses
  - ✓ Home use
  - ✓ Stream/Lake restoration

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Emission Impacts Calculated Using EIO-LCA

Scenario	Clean Air			GHG	Clean Soil		
	SO_2 (MT)	CO (MT)	NO_2 (MT)	CO_2 Equ. (MT)	Cd (kg)	Cr (kg)	As (kg)
Conventional Fertilizer Production	4.3	3.0	5.2	2,492	7.2	64.3	0.9
Ostara Process	1.8	0.7	1.3	430	0.1	0.4	0.2
Emission Reduction per unit	2.5	2.2	3.9	2,062	7.1	63.9	0.7

Source: Britton et al, 2008

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Heat Recovery from Sewage

- For a conventional building ~ 15% of thermal energy lost, unused, via the sewage system.
- Heat can and is being recovered from both raw sewage and treated effluent
- Recovered heat saves on energy & reduces GHG emissions.

Heat Pump with Raw Sewage, 7 MWe motor, 20 MWth at 90C

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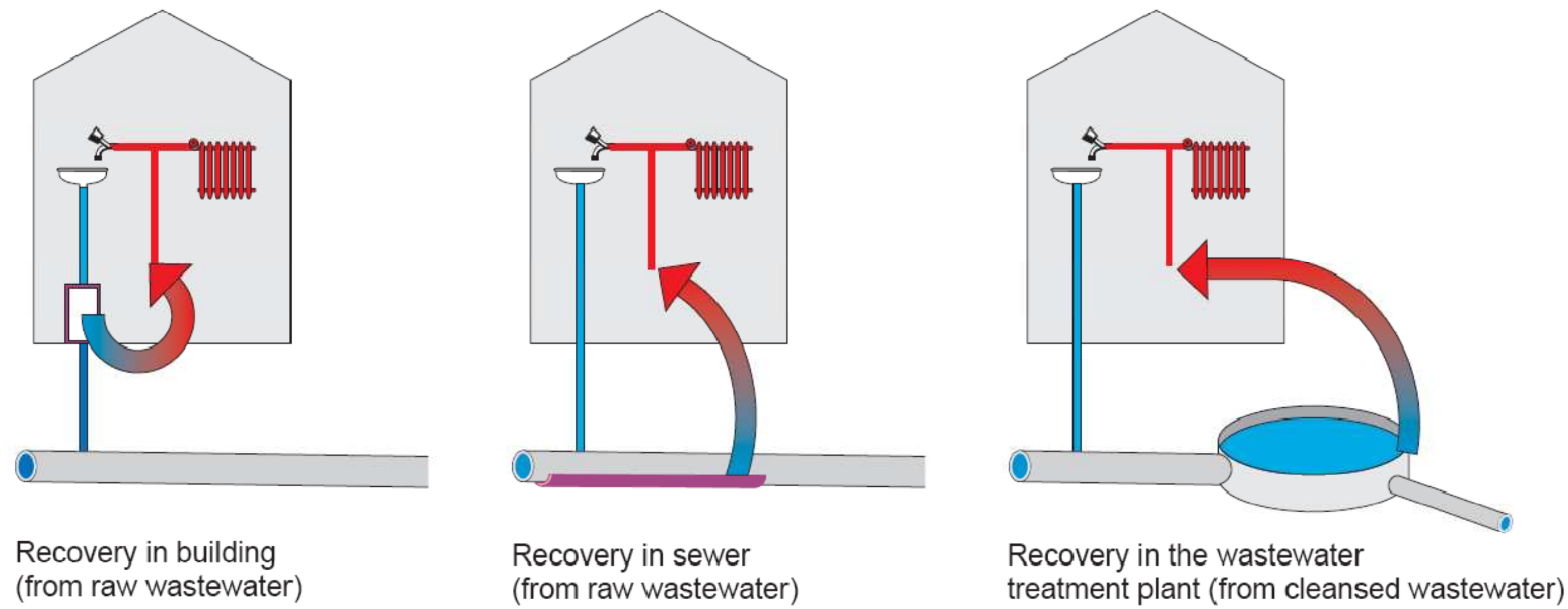
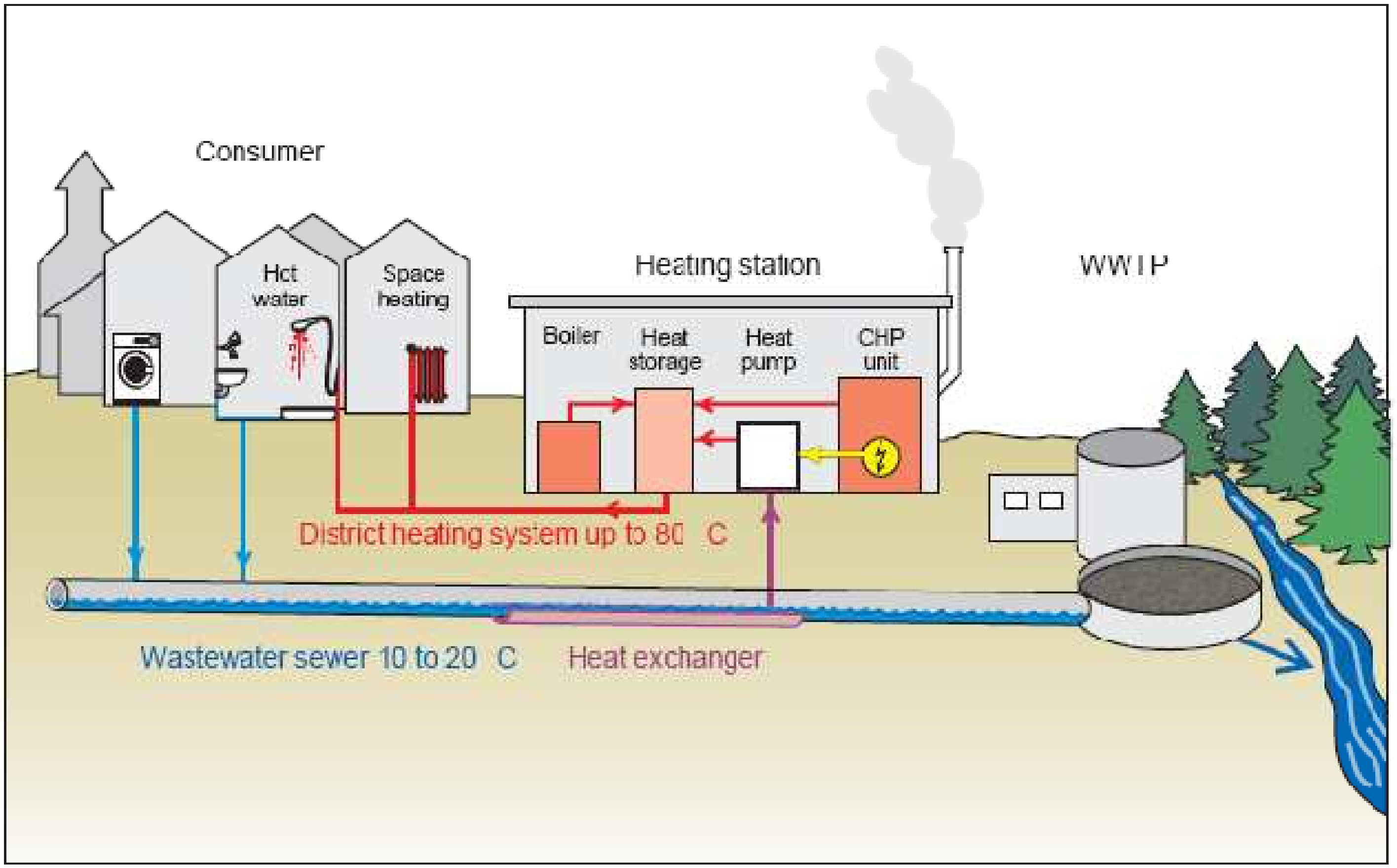
Heat Recovery Options



Typical Set Up for Raw Wastewater Heat Recovery




Tragkraft 6000 kg

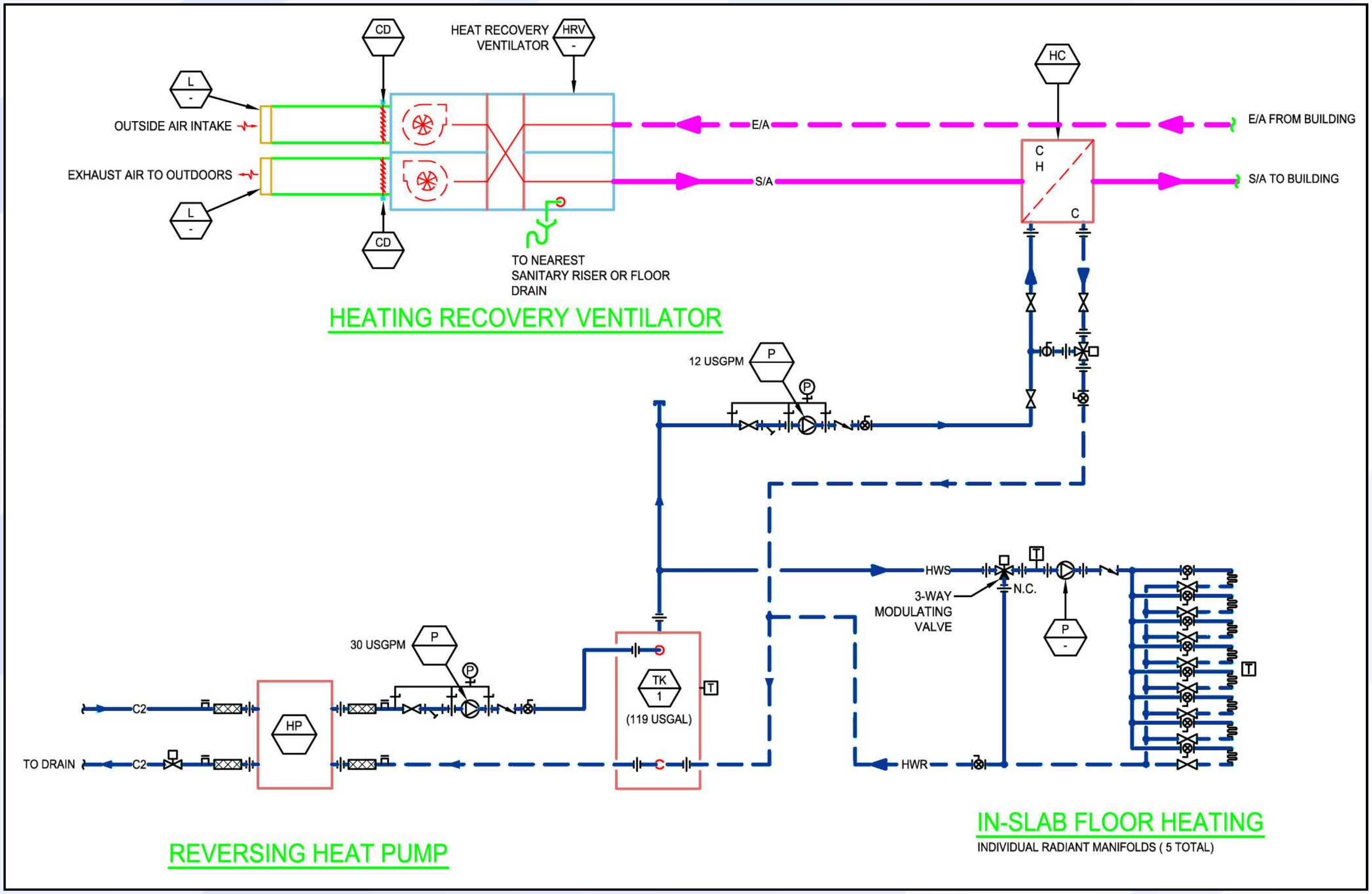
Heat Recovery Examples

Kelowna WWTP

Whistler WWTP

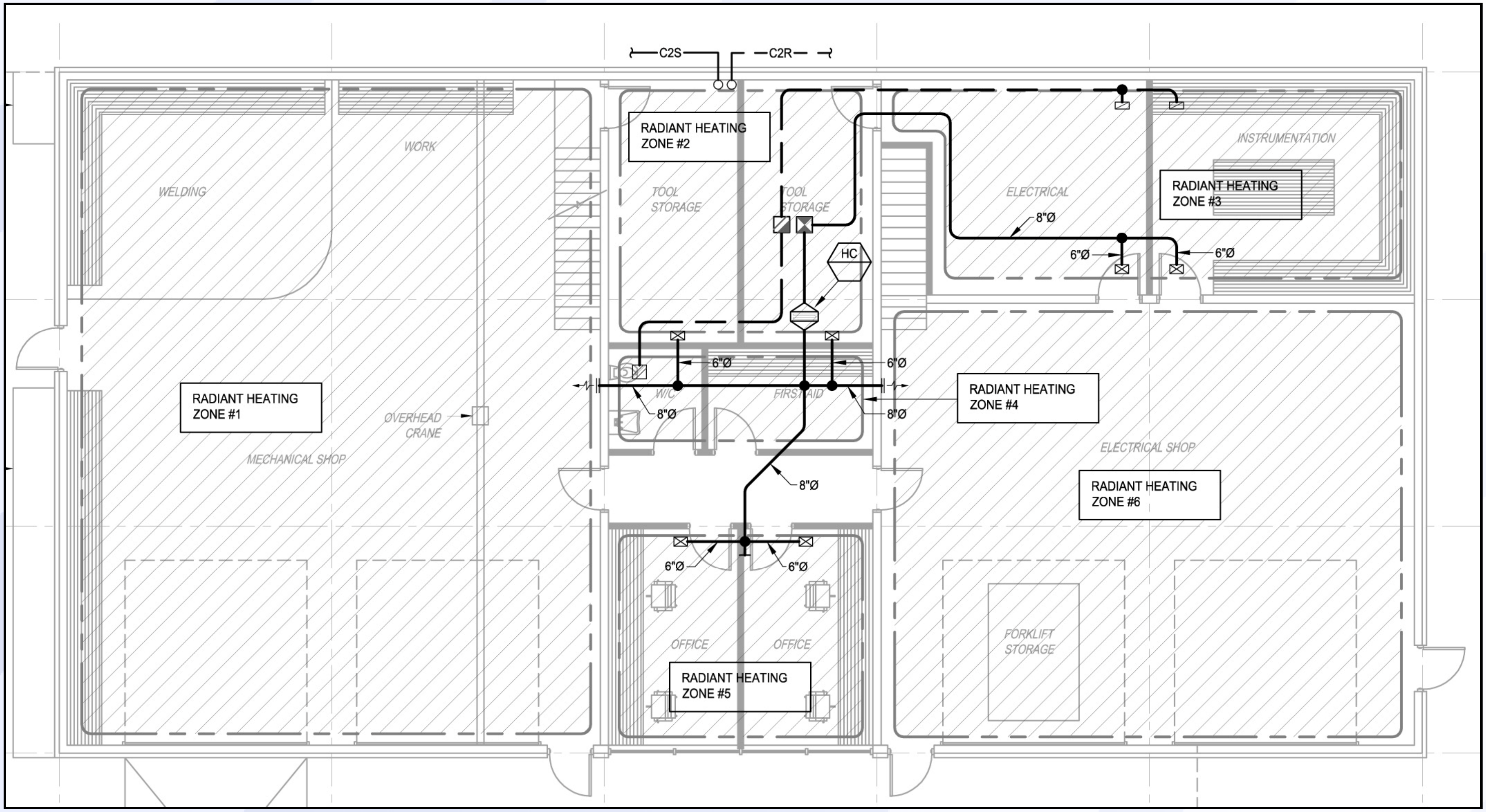
Maintenance Building

- Suggested HVAC System Simplified Diagram



Maintenance Building

- Suggested LEED HVAC System Floor Plan 1



Maintenance Building

- LEED HVAC System Economic Analysis
- An opinion of probable cost analysis was performed to determine the incremental cost of implementing the LEED HVAC energy system
  - ✓ Cost premium: $23,000
  - ✓ Annual Energy Cost Savings: $2,800
  - ✓ Simple Payback: 8 years
- Advantages of heat pump / radiant floor type HVAC system:
  - ✓ The LEED® HVAC system offers 5 temperature control zones as opposed to a single zone
  - ✓ Radiant heat is a much more comfortable heating system
- The LEED HVAC system would provide approximately 4-6 LEED Energy & Atmosphere LEED credits

Conclusions

- Many believe key global resource supplies are in decline.
- Raw wastewater contains many recoverable resources in addition to water including phosphorus & heat.
- Concerns associated with GHG emissions and dwindling resource supplies will likely bring future pressure for resource recovery.

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Questions & Answers

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Options for P Recovery

- Urine separation and application to farmland
- Biosolids application
- Struvite recovery
- Recovery of P from incinerator ash

Impact of Municipal WW P Recovery

Potential P loading from sewered population:

190 M people X 0.0065 lbs/c-d X 365 days/yr = 450,775,000 lbs/yr
(225,387 tons-P/yr)

Potential struvite recovery = 225,387 tons-P/yr/0.127 = 1,774,704 tons-struvite/yr.

Potential phosphate recovery = 1,774,704 tons/yr X 0.28 = 496,917 tons P_2O_5/yr.

Actual recovery efficiency = 40% therefore potential = 198,767 tons P_2O_5/yr

Percent of Annual domestic consumption = (198,767 tons/yr/4.4 M tons/yr) X 100% = 4.5% (Recovery from industrial and animal wastes could increase total by 5 to 10 times)

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The Edmonton Plant

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NUTRIENT RECOVERY TECHNOLOGIES INC.

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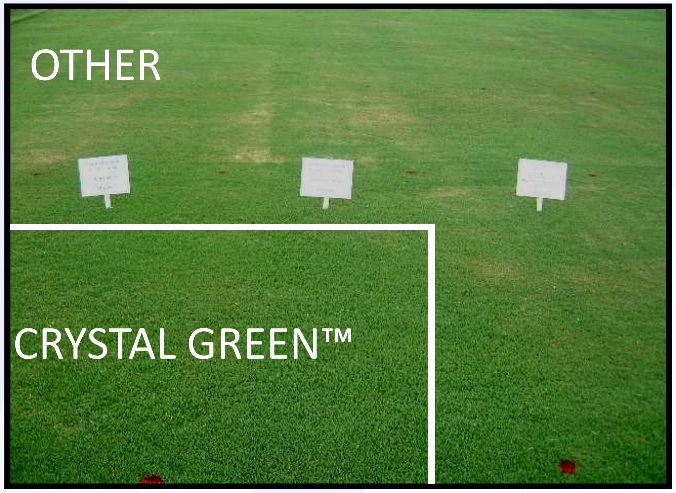
CRYSTAL GREEN™

- High purity, slow release fertilizer
  - ✓ >8 months release profile
- Environmentally friendly – less nutrient runoff
- 5% N | 28% P | 0% K | + 10% Mg
- Extensive Trialing
  - ✓ Turf
  - ✓ Horticulture
  - ✓ Silviculture



Trends in Europe

- Application of sewage sludge to land starting to decrease in Europe due to concerns with:
  - ✓EDC's
  - ✓PPCP's
  - ✓Persistent Organics
  - ✓Metals (cadmium, chromium, copper, nickel, mercury and zinc)

- European's (particularly the Germans) are looking at sludge incineration followed by phosphorus recovery.

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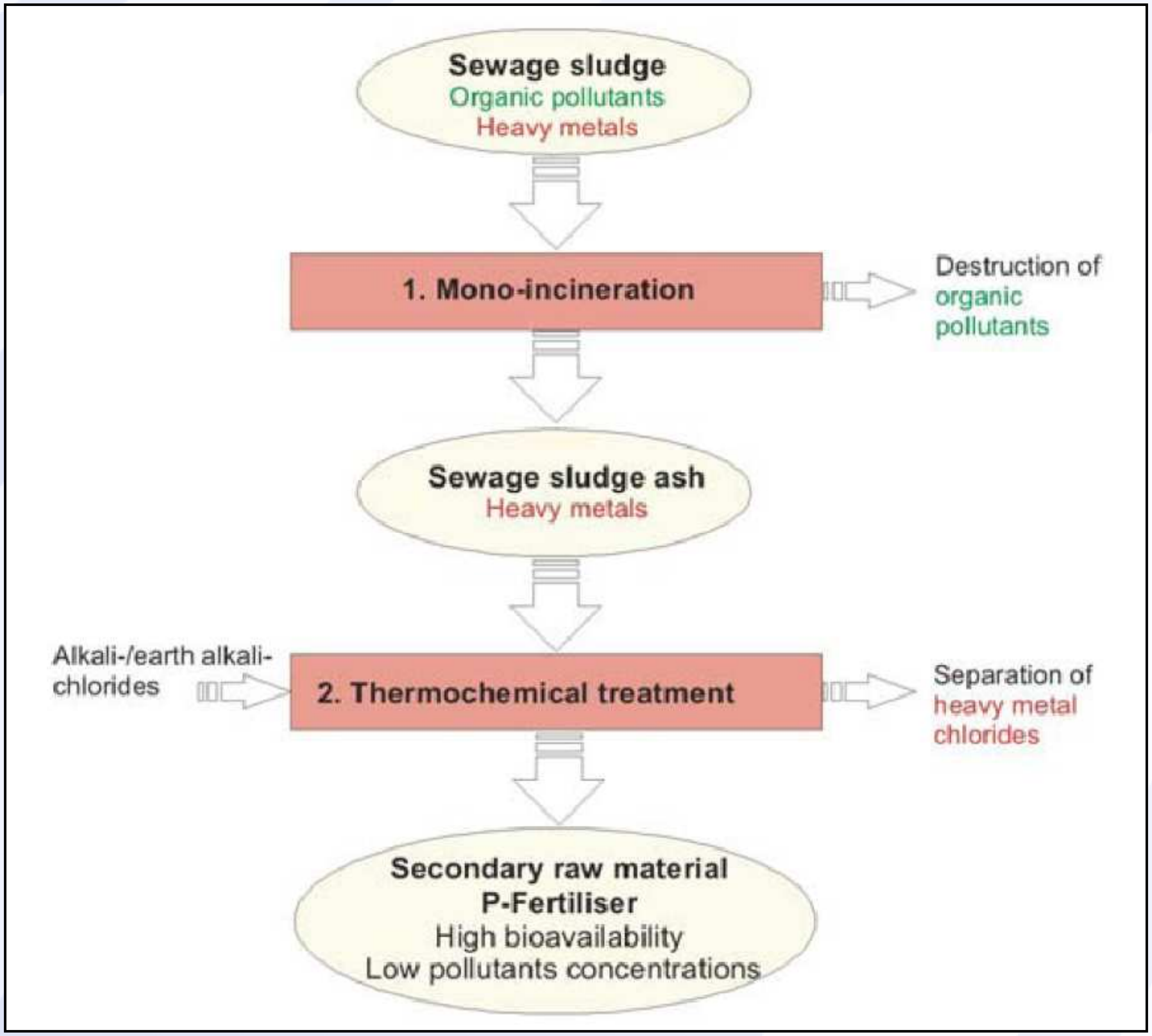
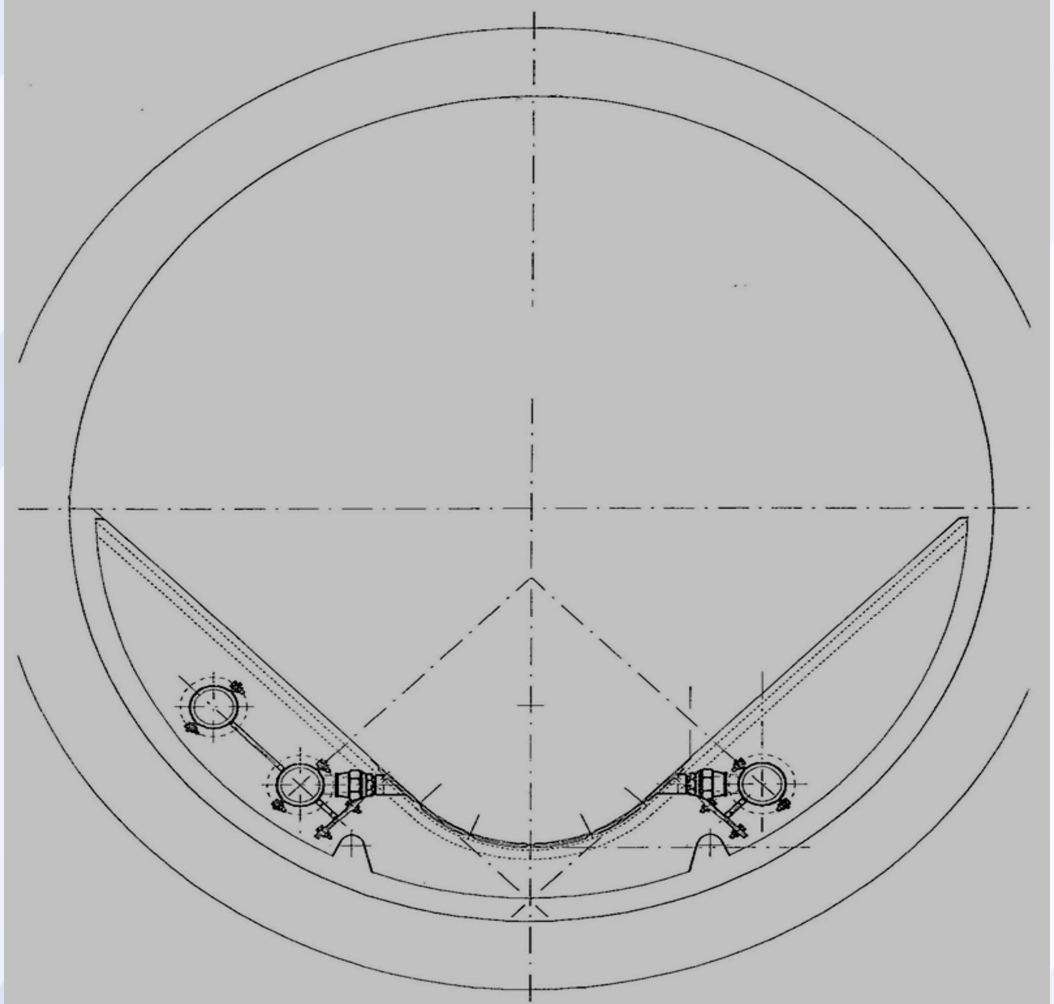
Trends in Europe (Continued)



Sewage pipe



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Creating Value From Waste

From Problems

To Solutions

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