



CAPE COD  
COMMISSION

# Alternative Strategies for Improving Water Quality

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Section 208 Plan Update, September 26, 2013

Precedent Studies & Alternatives



**offshoots**  
PRODUCTIVE LANDSCAPES

# STRATEGIES:

## Site Scale

"Panel on Technologies Agenda, September 26, 2013"

## Neighborhood

## Watershed

## Cape-Wide

**WASTE WATER**  
80%

**WATER BODYS**  
8%

**IMPERVIOUS**  
6%

**FERTILIZER**  
5%

**NATURAL**  
1%

Septic System Title 5

Innovative Septic Title 5

Toilets: Urine Diversion

Toilets: Composting

Toilets: Packaging

Low Flow Fixtures

Grey Water Reuse

Eco-Machines

DISCHARGE

Wetlands: Vertical S

Phyto-buffer: S

Permeable React Bar.

Biofiltration Strips

Green Roofs

SECONDARY, TERTIARY & DISCHARGE

Sewers

Satelite Treatment

Cluster Treatment

Eco-Machines

Wetlands: Surface Flow

Wetlands: Vertical LG

Phyto-irrigation

Wetlands: Surface Flow

Wetlands: Vertical LG

Sewers

Centralized Treatment

Culvert Widening

Dredging

Phyto-buffer: LG

Permeable React Bar

Shellfish Aquaculture

Seaweed Farming

Eco-Restorer/  
Floating Wetland

Nutrient Harvesting Gabion

Septic: Regulation

Toilets: Regulation

H2O Reuse: Regulation

Low-Flow Fixtures: Regs

Growth Management

Alt. Discharge Options

Landscape Guidelines

Fertilizer Policies

Mun. Maintenance Regs

# Traditional Approaches

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SECONDARY, TERTIARY & DISCHARGE

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NITROGEN POLLUTION

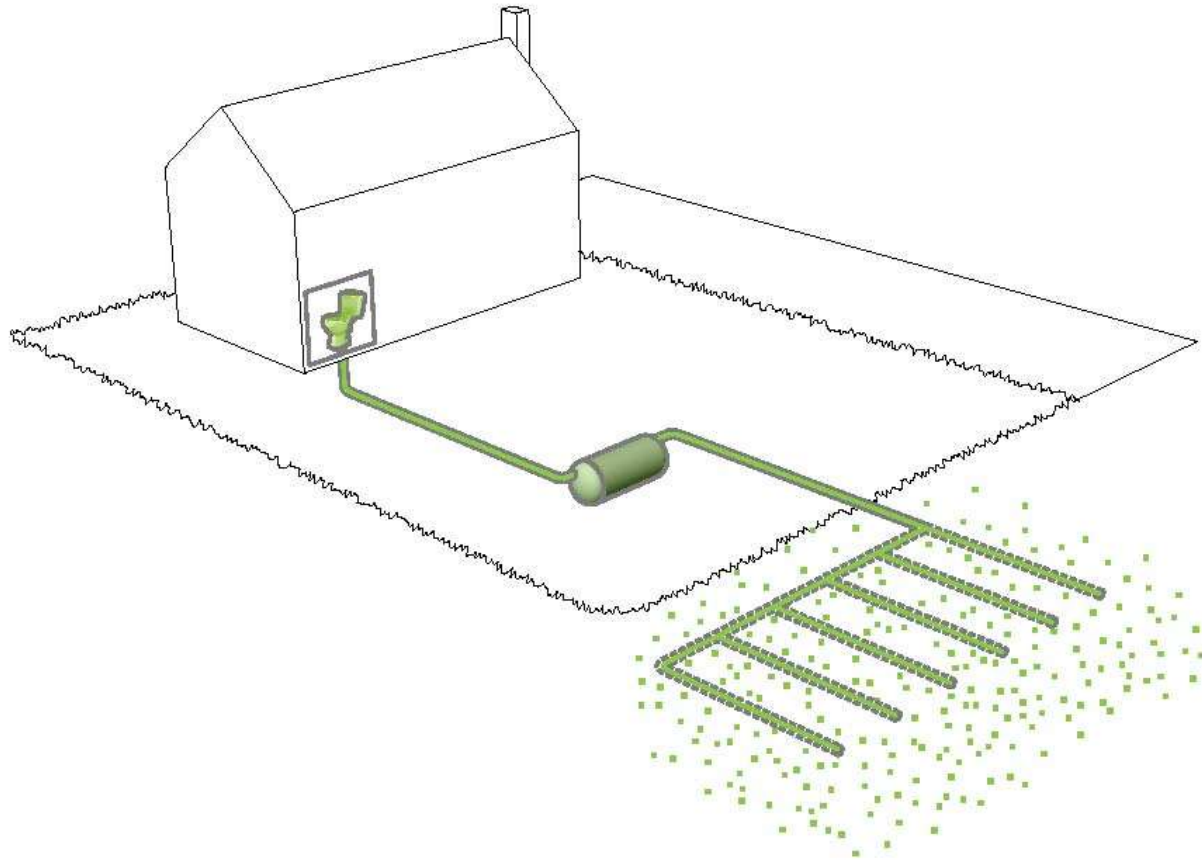
WASTE WATER

WATER BODYS

IMPERVIOUS

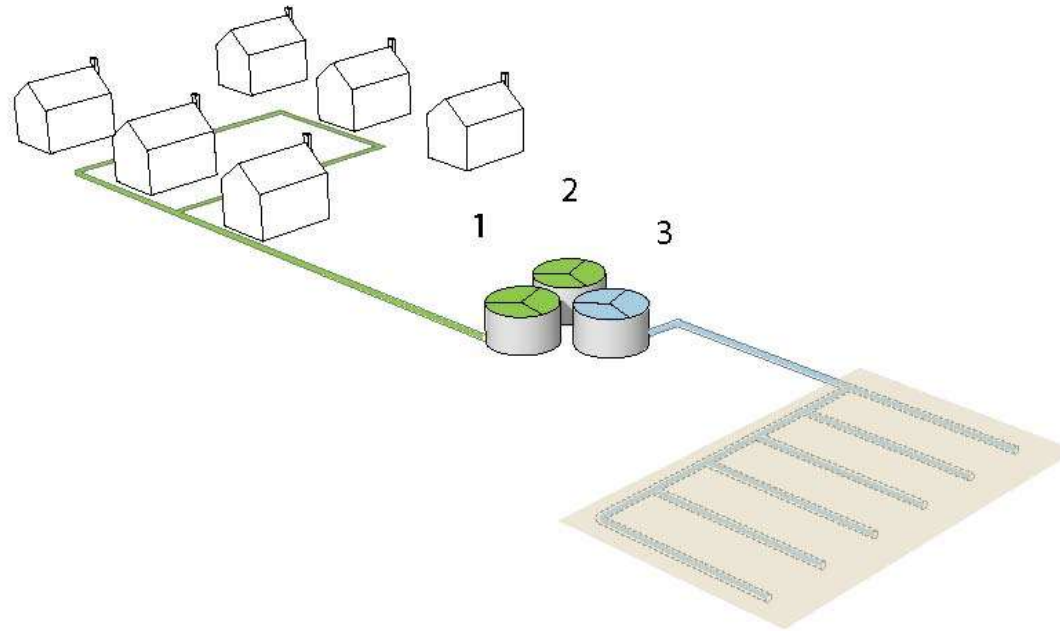
FERTILIZER

NATURAL



# Septic Systems

NITROGEN POLLUTION



**Cluster (3-30 Homes) & Satellite (30-1000) with offsite disposal**

NITROGEN POLLUTION

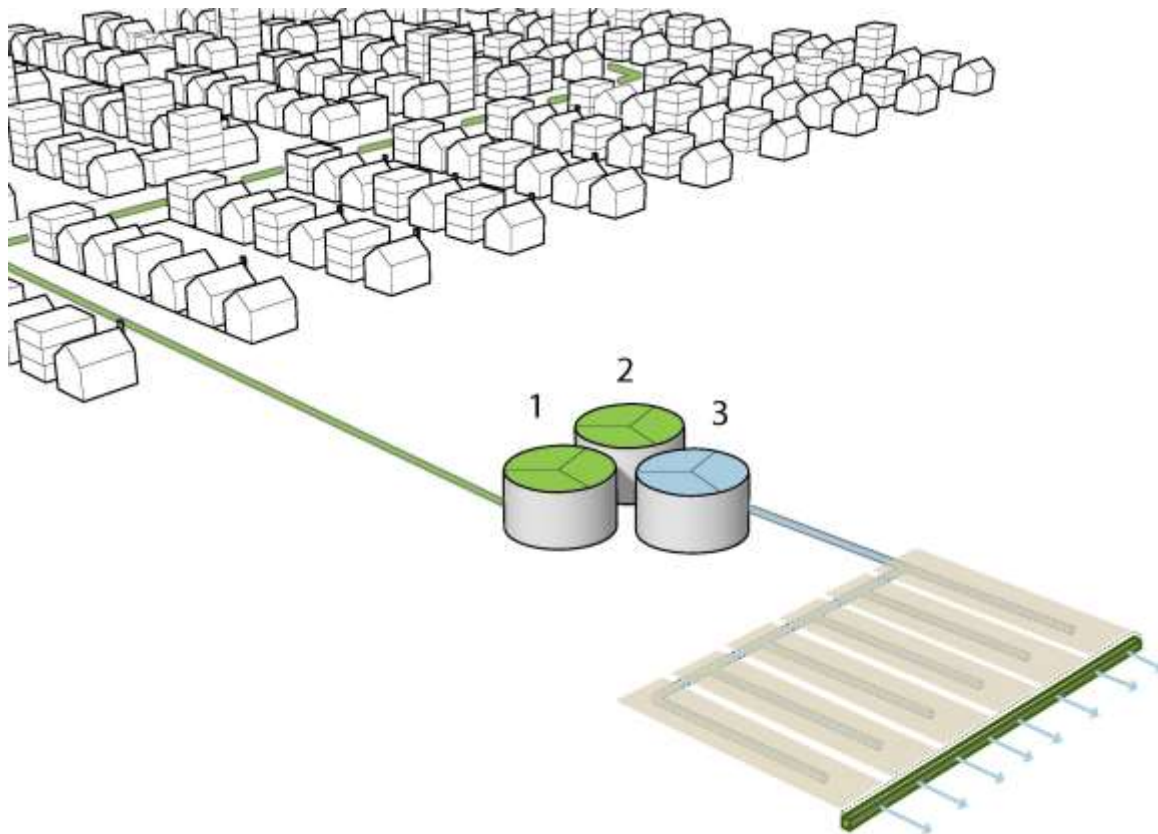
WASTE WATER

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# Centralized Treatment

# Alternative Approaches

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DISCHARGE

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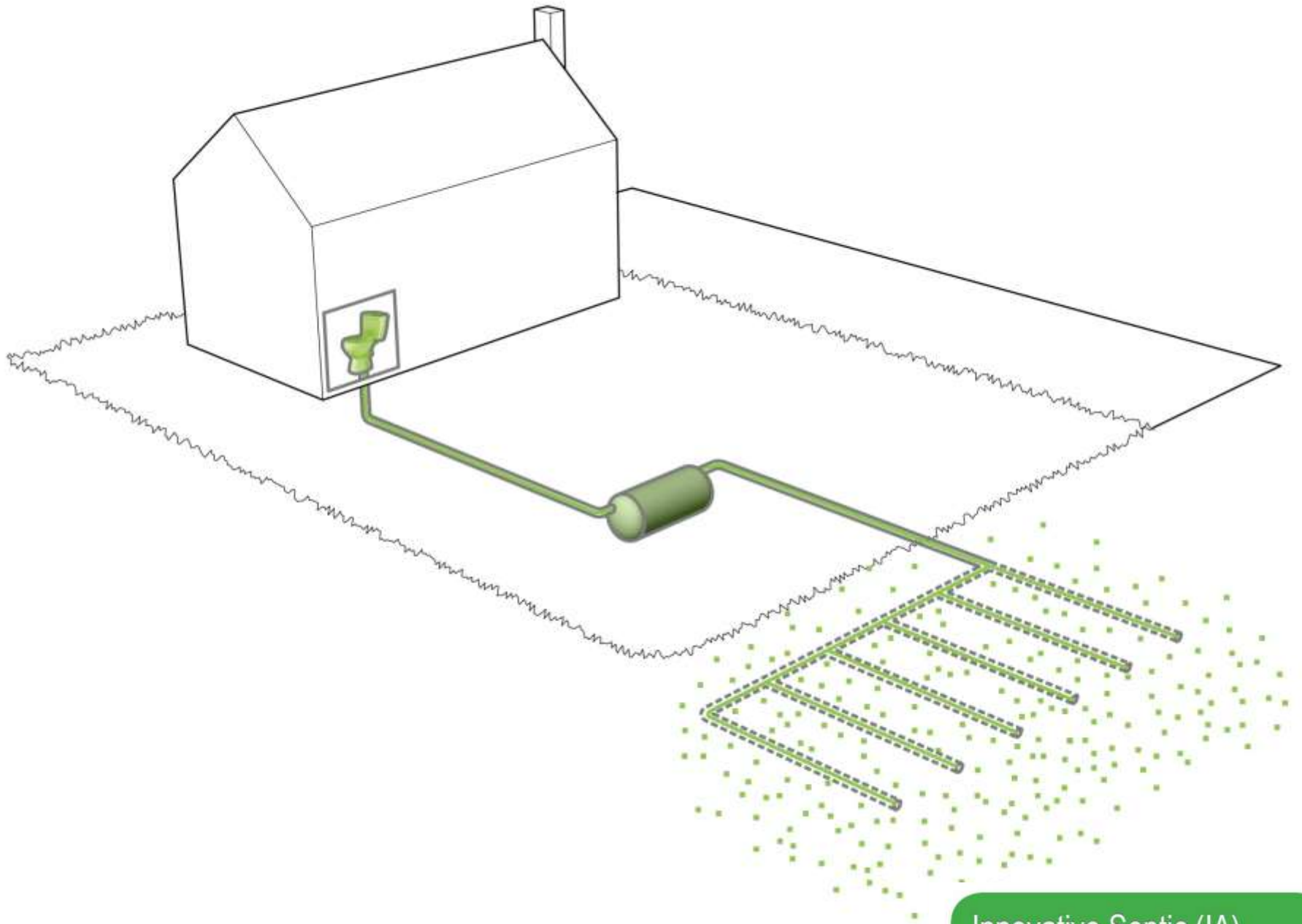
Growth Management

Alt. Discharge Options

Landscape Guidelines

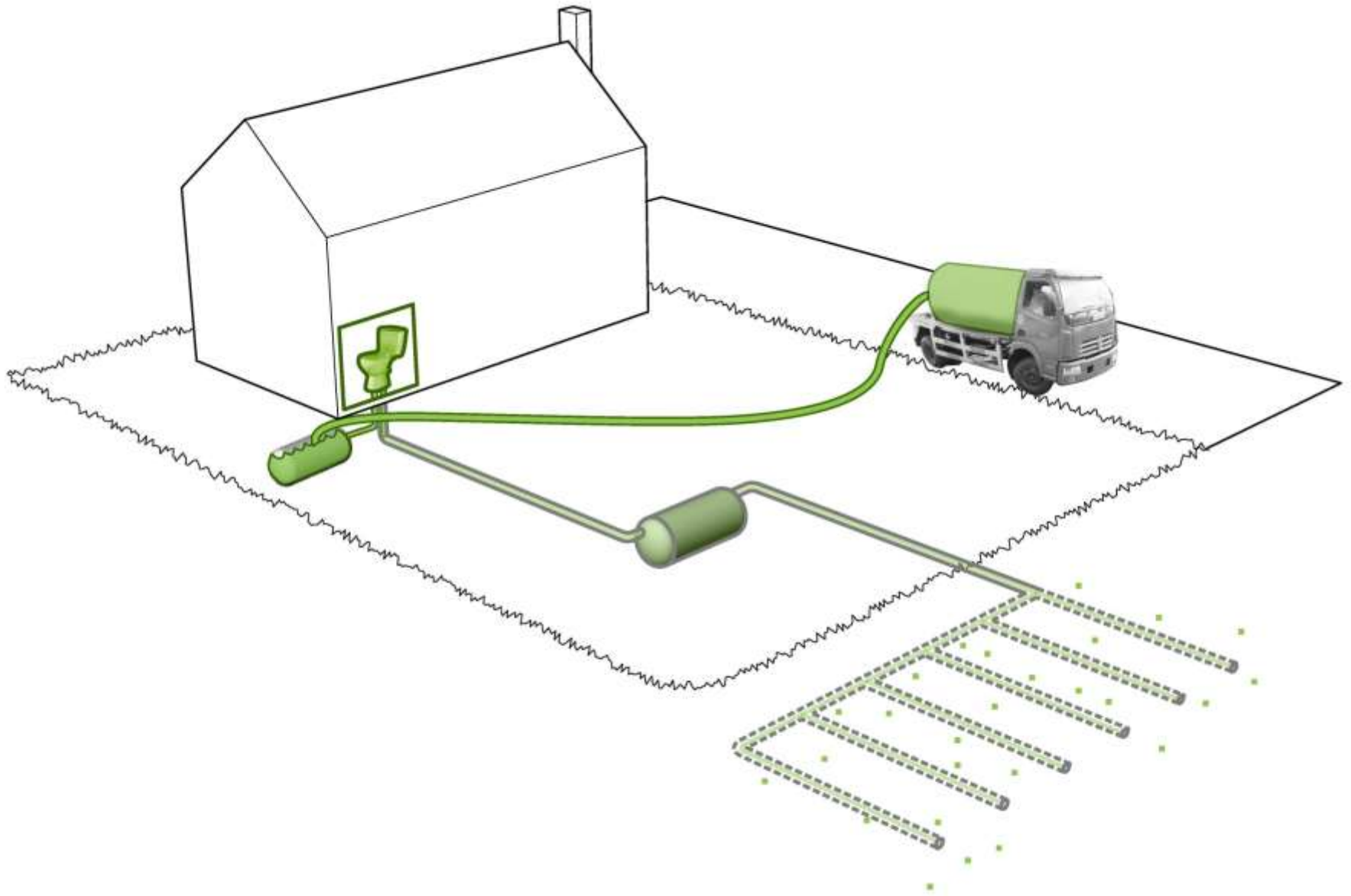
Fertilizer Policies

Mun. Maintenance Regs

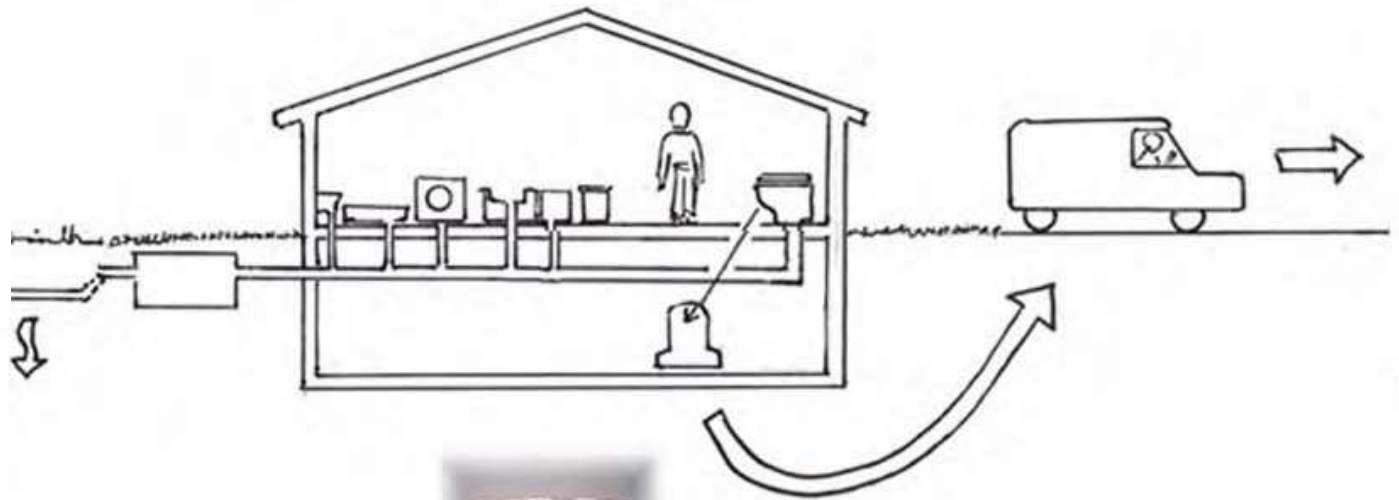


Innovative Septic (IA)





Toilets: Urine Diversion



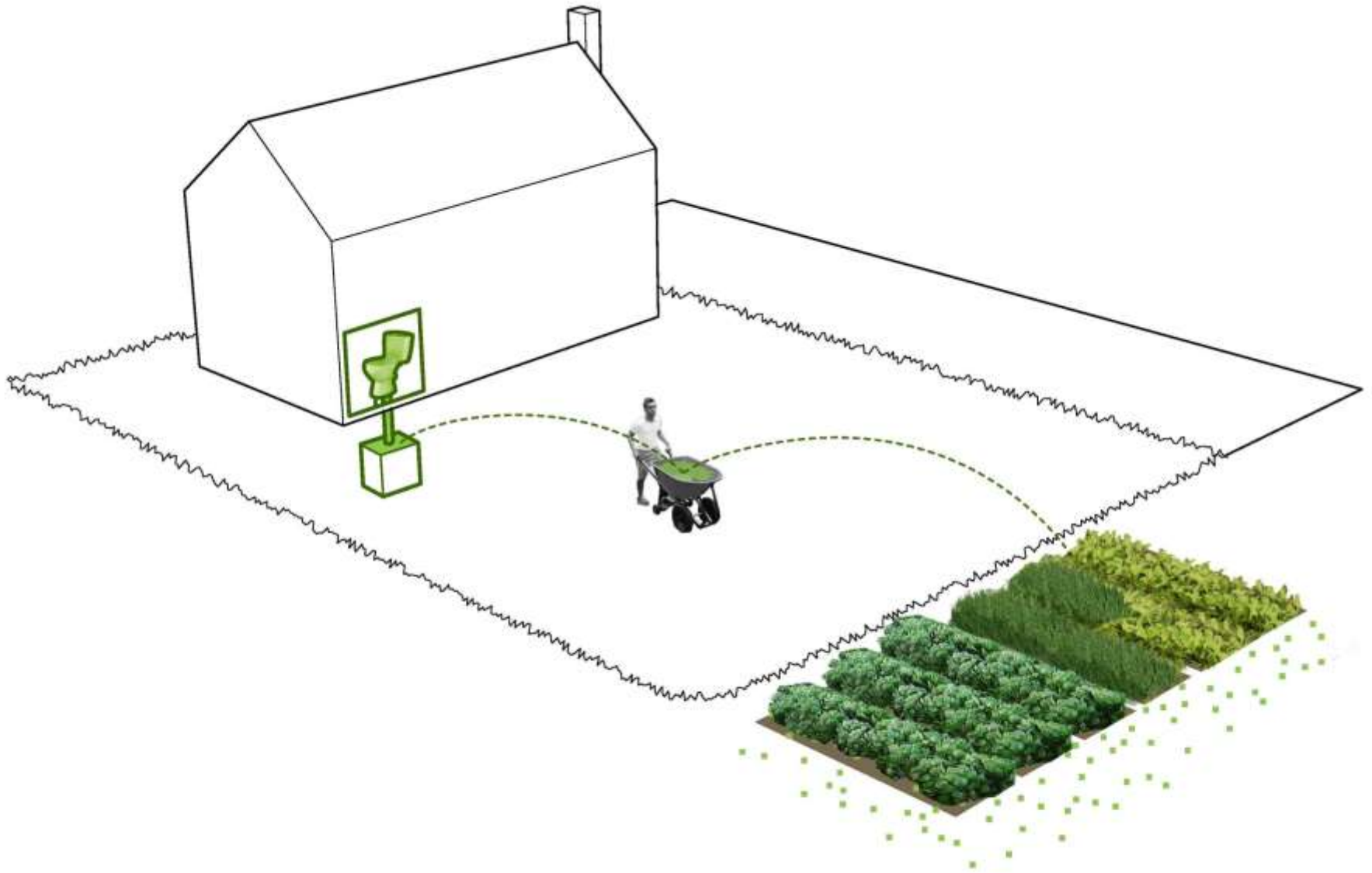
**Waterless  
Urinal**

**IBC container  
(220 gallons)**

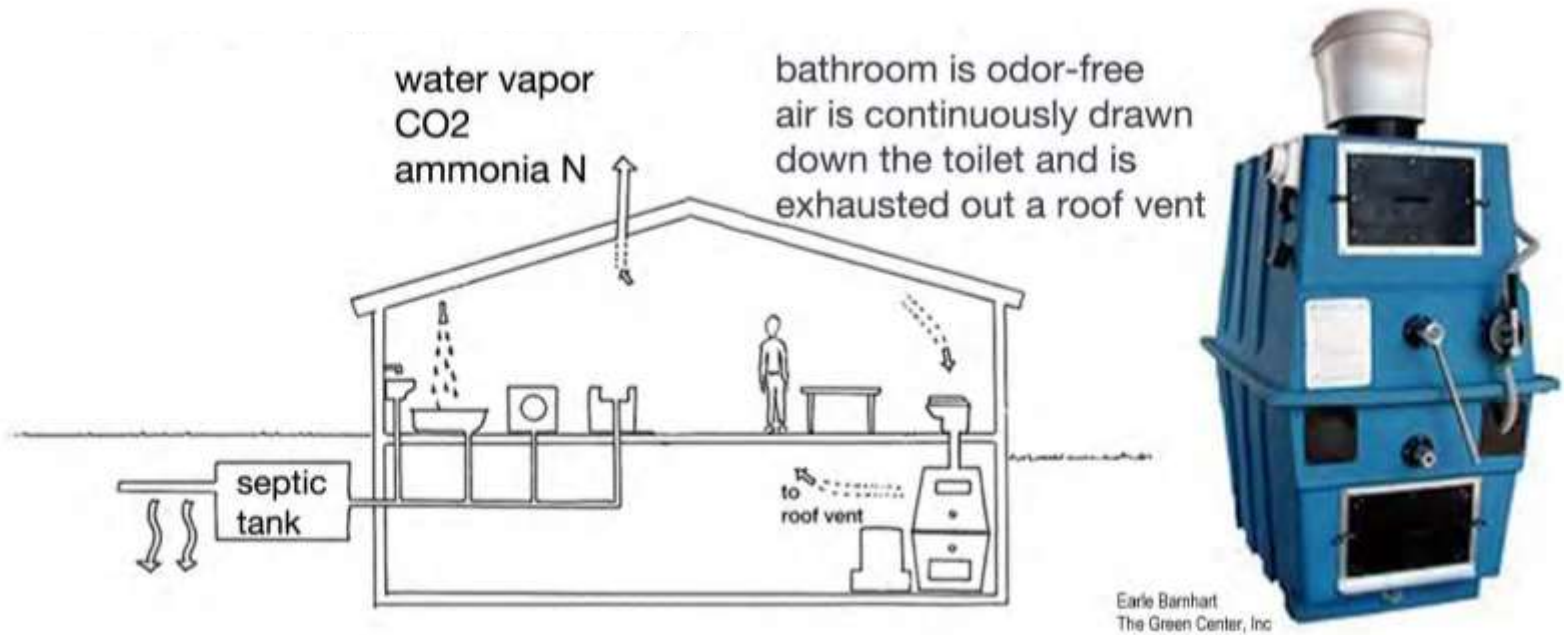


**40" x 40" x 48"**

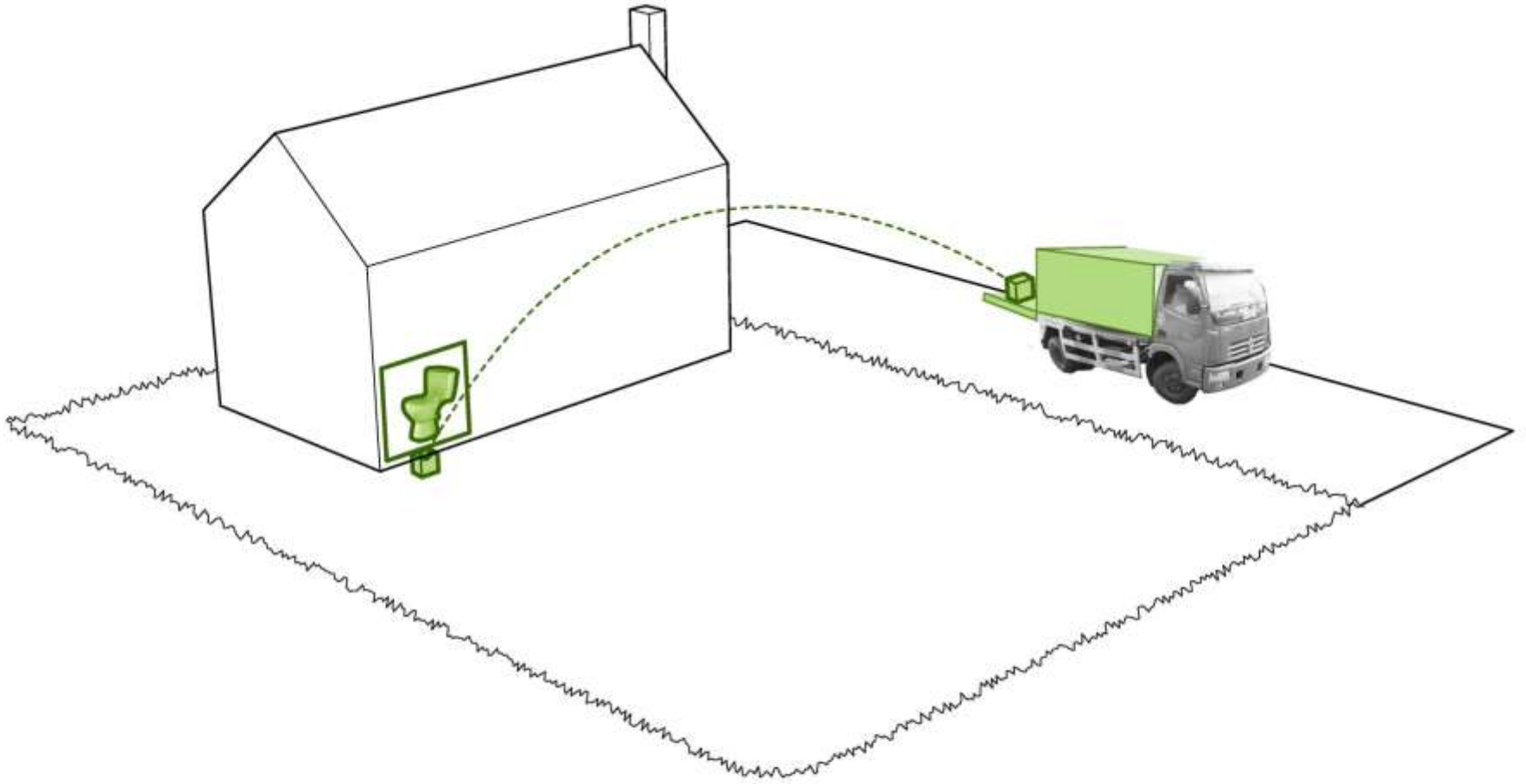
**Toilets: Urine Diversion**



Toilets: Composting



Toilets: Composting



**PACTO<sup>®</sup>**



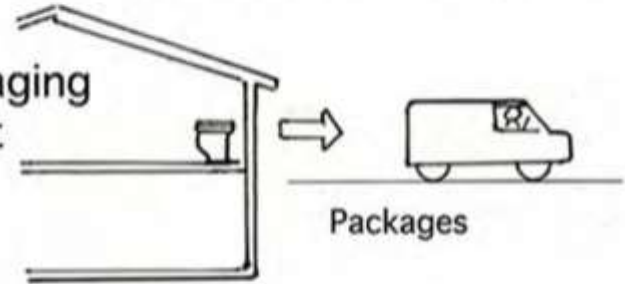
A packaging toilet directs human wastes into a biodegradable package, that is sealed after each use and stored at the base of the toilet.

- No water
- No plumbing
- No electricity
- Movable
- Installs immediately, anywhere
- Water use in house is reduced 30-40%



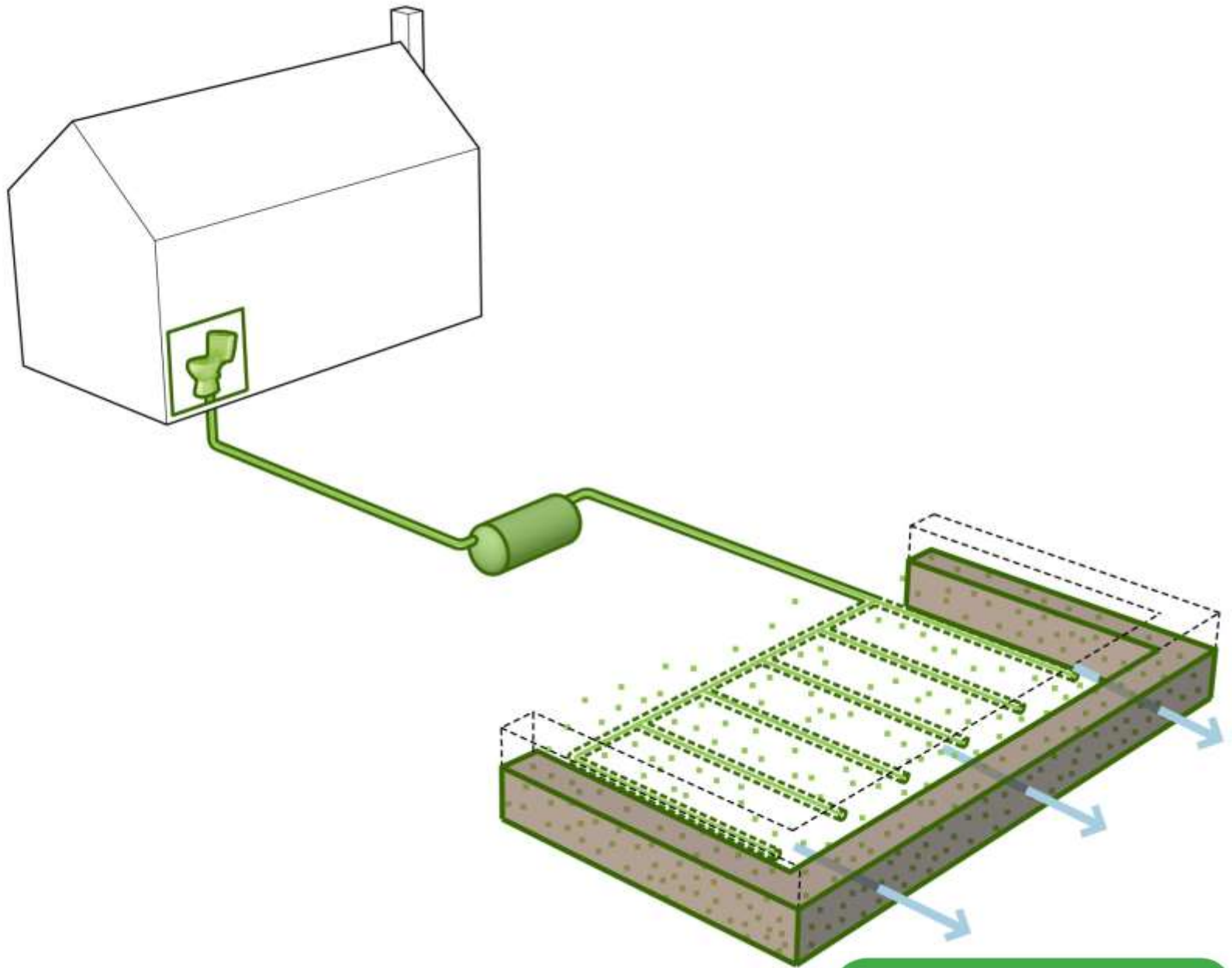
**LOOWATT**

Packaging Toilet



Earle Barnhart  
The Green Center, Inc

Toilets: Packaging



Permeable React Bar.

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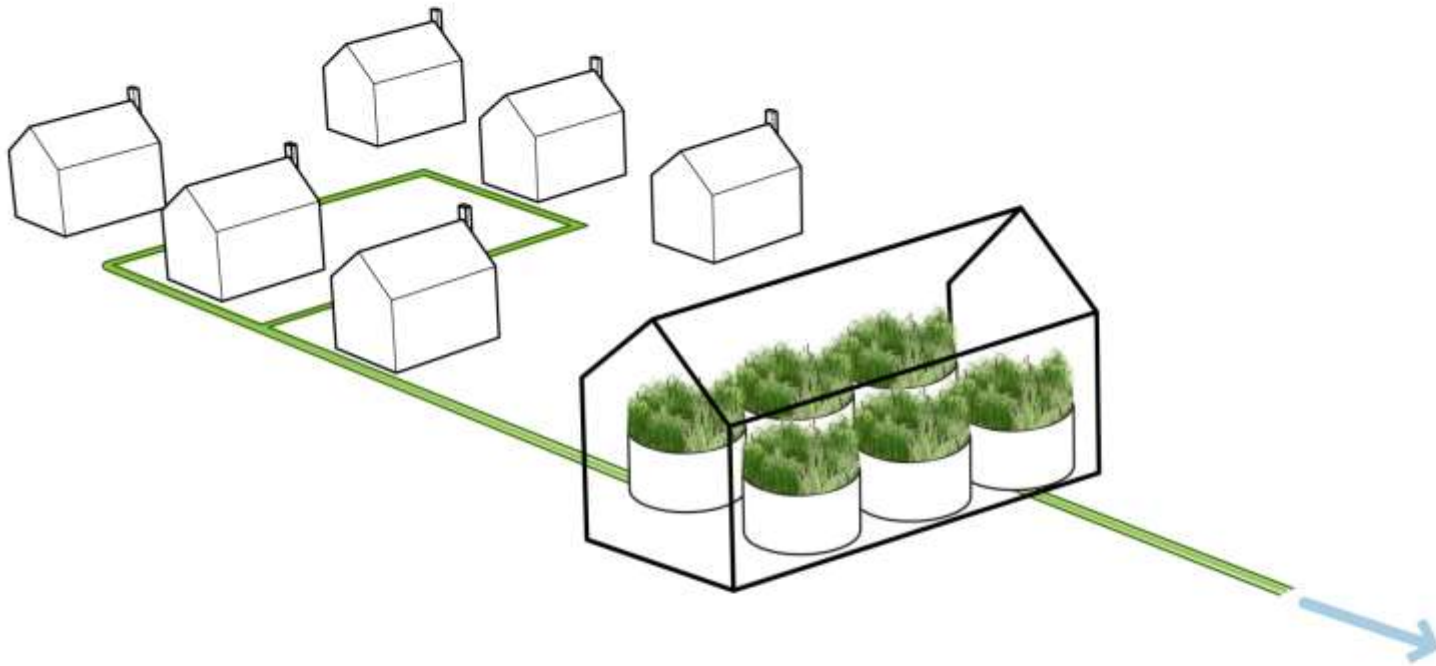
SECONDARY, TERTIARY & DISCHARGE

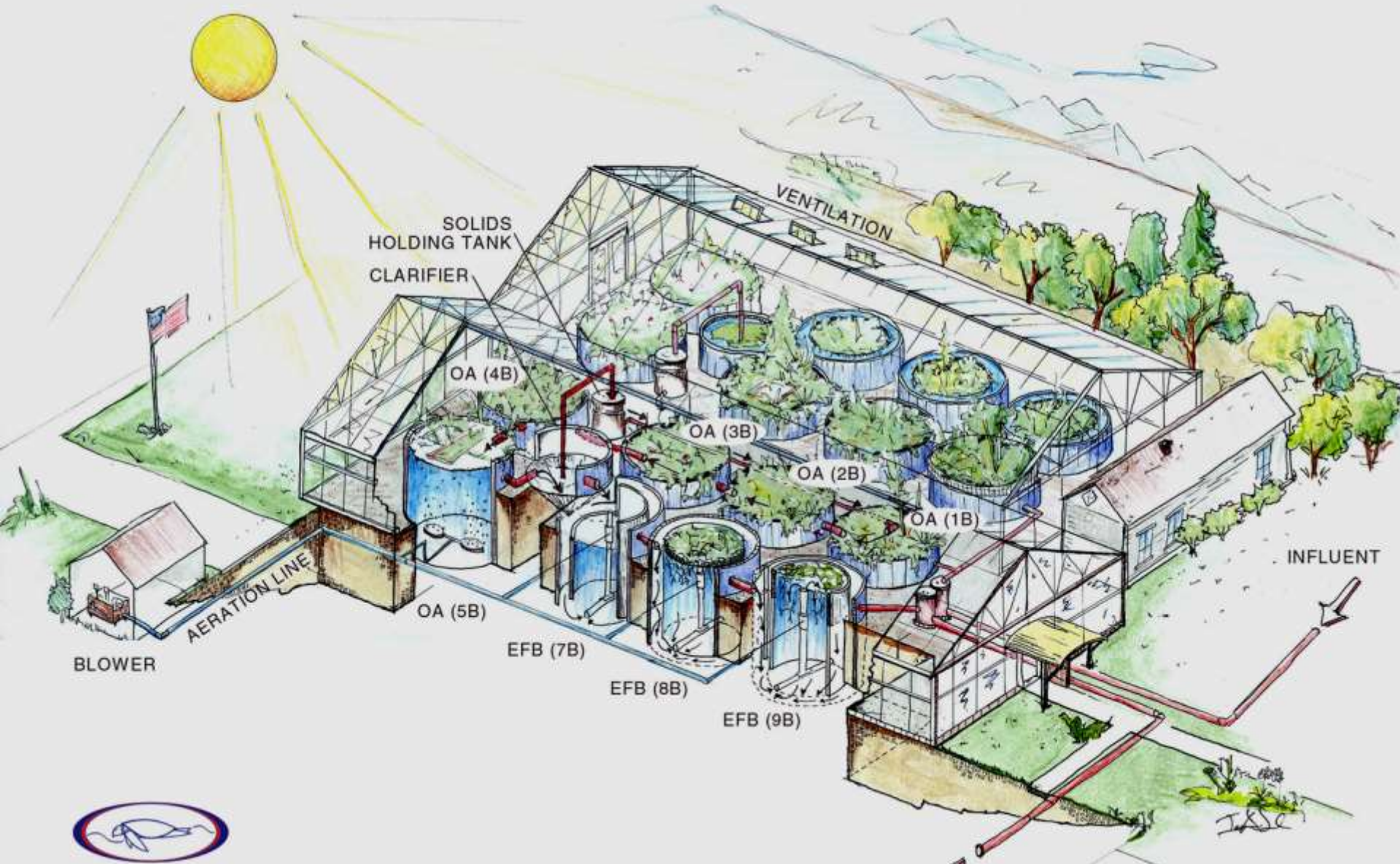
- Sewers
- Satelite Treatment
- Cluster Treatment
- Eco-Machines & Living Machines
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- Wetlands: Vertical LG
- Phyto-irrigation
- Phyto-buffer: LG
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John Todd Ecological Design, 2000

80,000 gpd wastewater treatment

**PRECEDENT: South Burlington, VT WWTF**



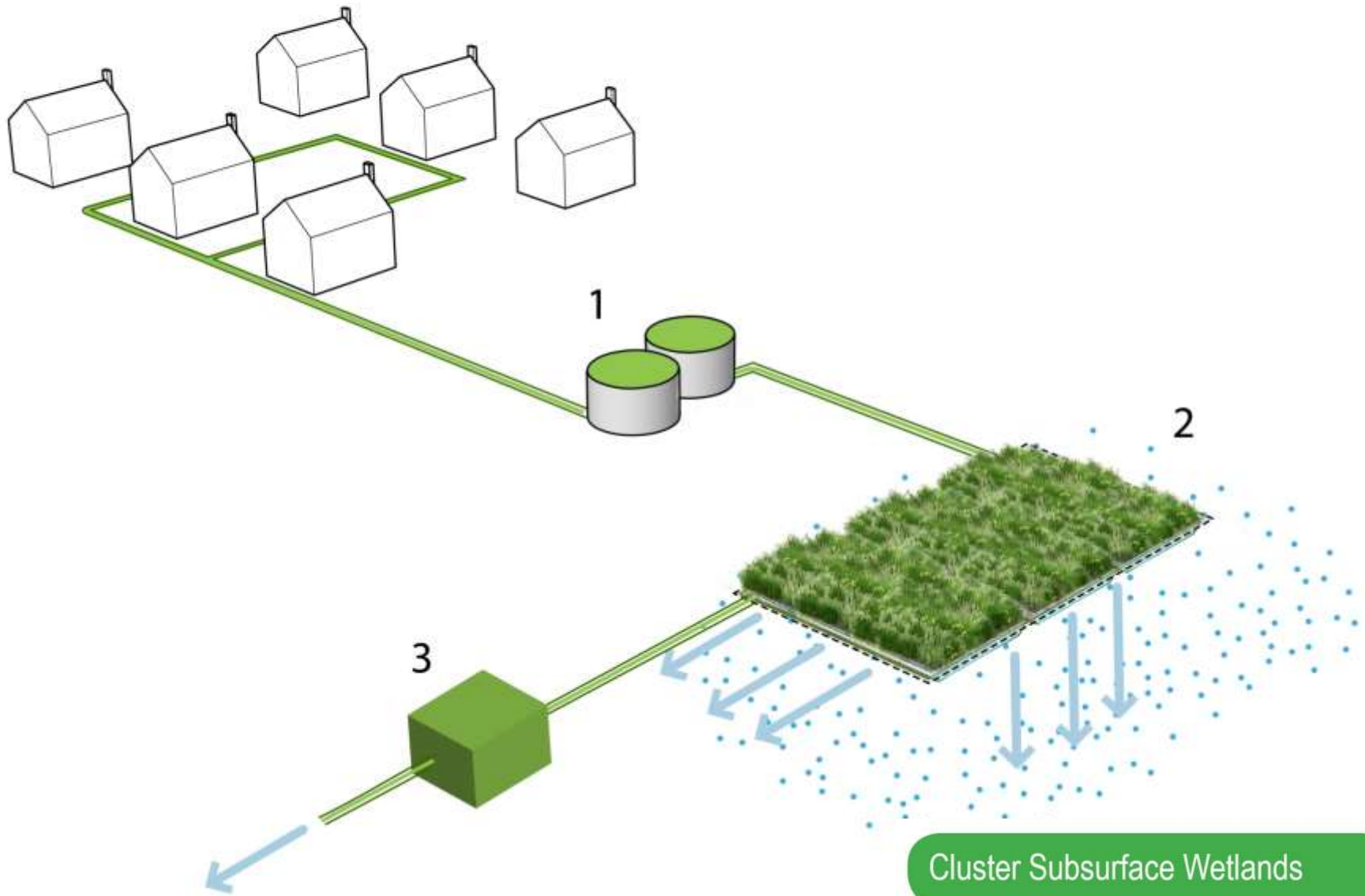
## South Burlington:

-System was designed to deal with organic nitrogen loading from municipal sewage.

-Denitrification was later targeted through the uses of pulsed aerobic/non aerobic reactors and the addition of carbon.

-Consistent achievement of an 86.4 % denitrification rate over a continuous 960 day data collection period.







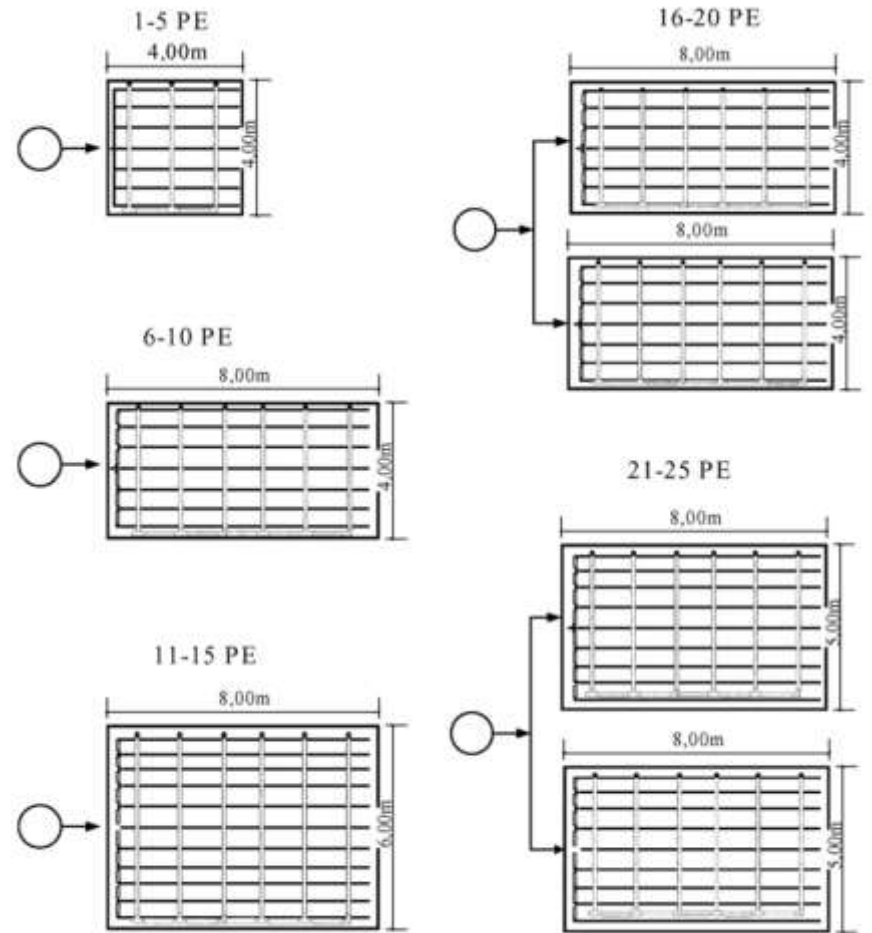
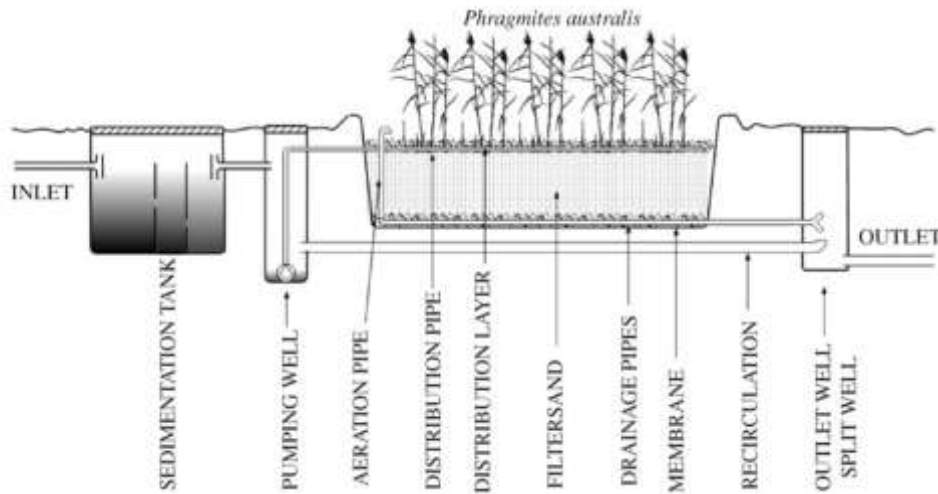
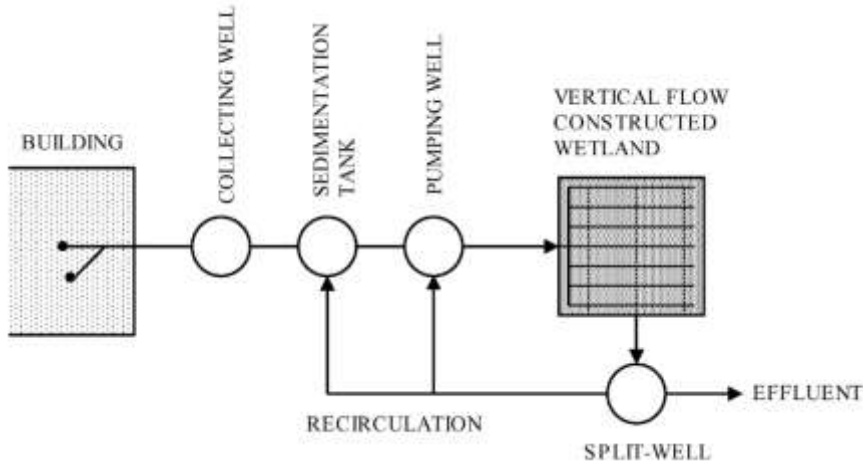
Site Area Needed: 22 Square Feet per person  
Provides both secondary and tertiary treatment:  
BOD, TSS, Pathogenic Bacteria and Nitrogen, even in winter

Cluster Subsurface Wetlands

Jan Vyzamal

**PRECEDENT:** Kamen, Czech Republic

# Cluster Subsurface Wetlands



Hans Brix, Ecological Engineering 2005

**PRECEDENT: Denmark Standard Vertical Wetland Details: SF House**

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- Wetlands: Subsurface Flow
- Phyto-irrigation

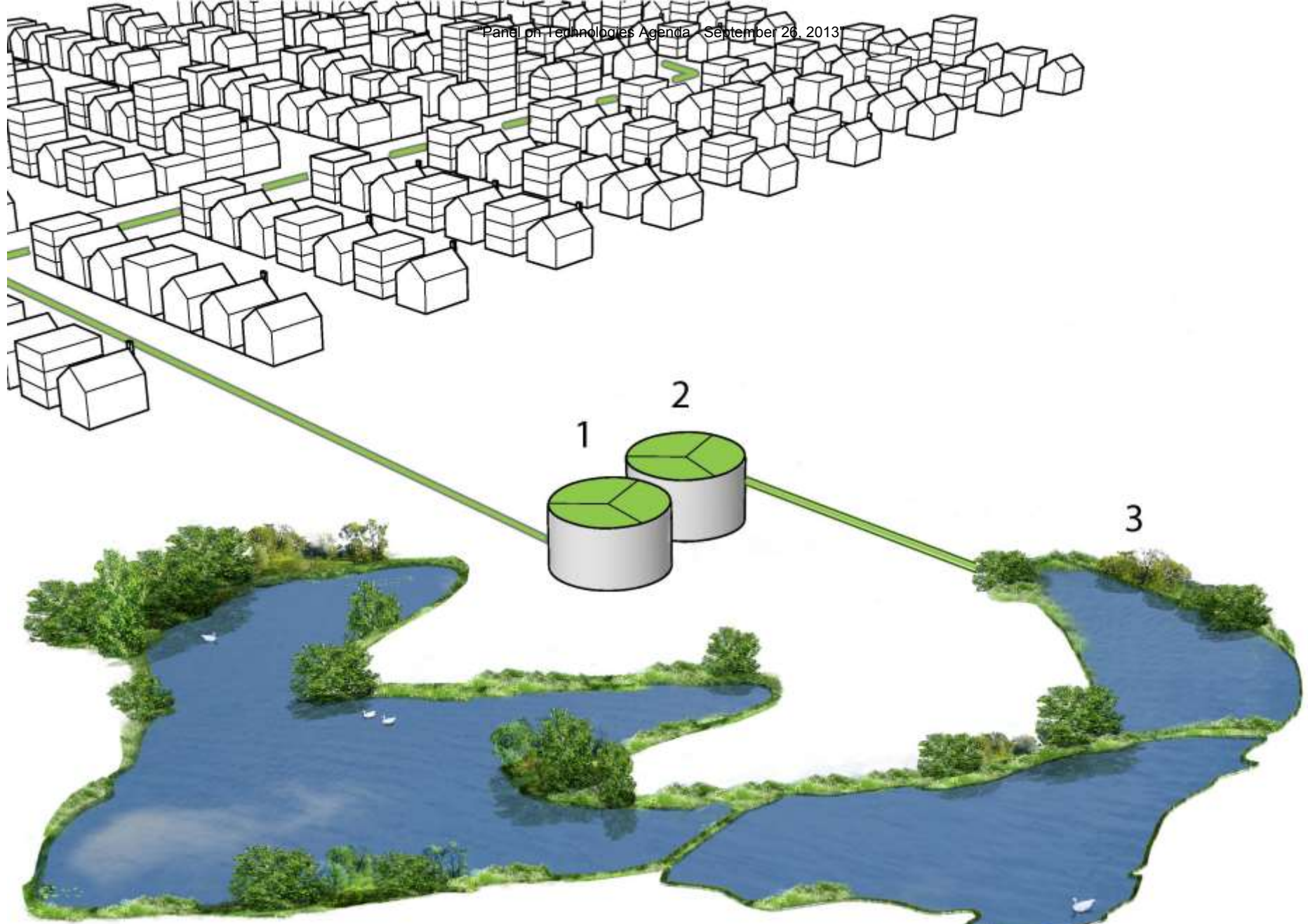
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Wetlands: Surface Flow



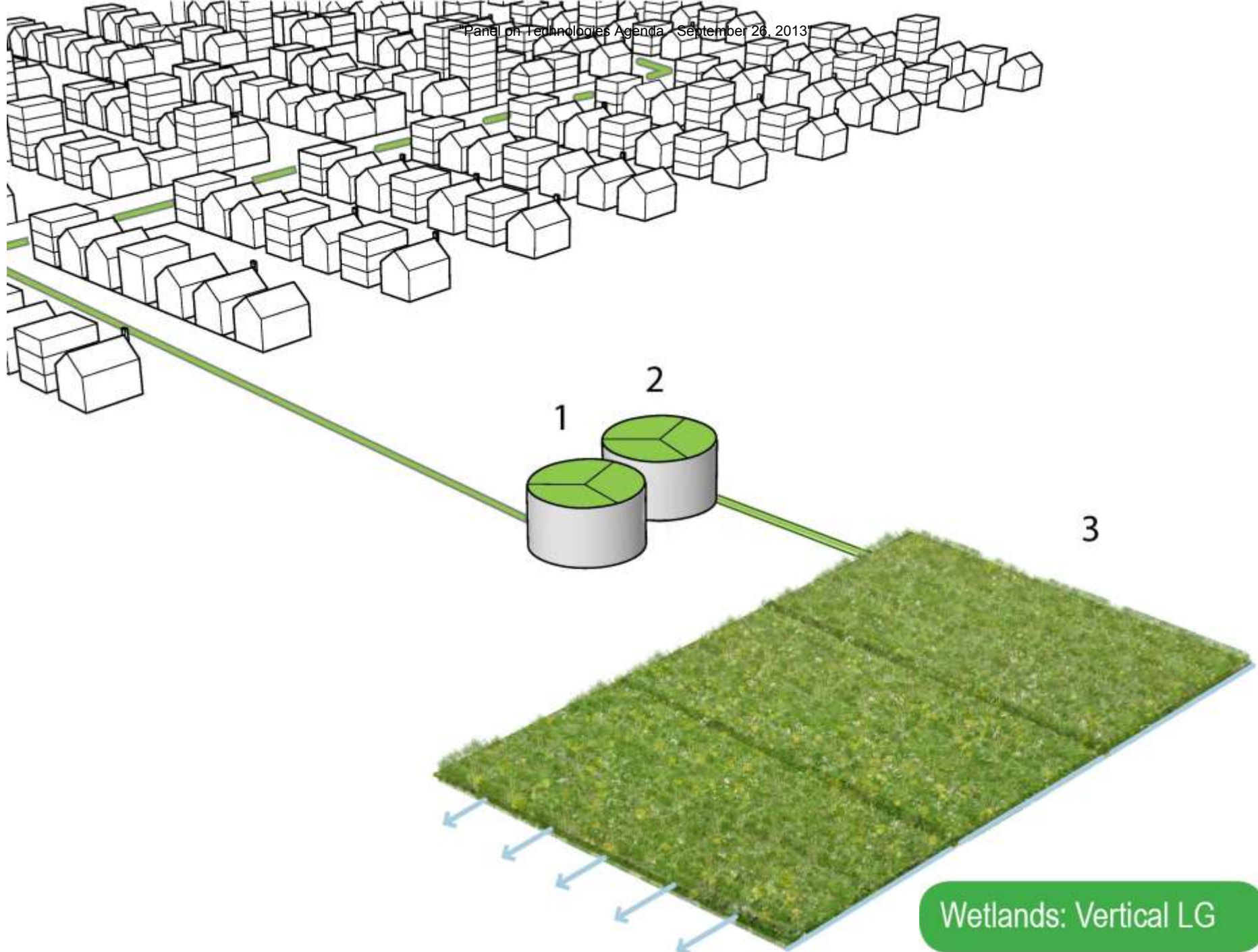


Photograph by Kate Kennen, 2011

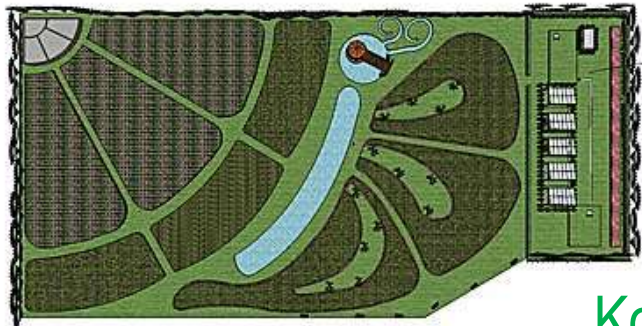
Mark Madison, CH2MHill, Portland, OR

**PRECEDENT:** Talking Water Gardens, Albany, -Millersburg OR





Wetlands: Vertical LG



Hans Brix, 2006 and CWI Website

## Koh Phi Phi, Thailand Vertical Wetland Treatment Plant



Site Area: 1000 sq m

Treats: 500 PE

Pre-treatment: sedimentation tank

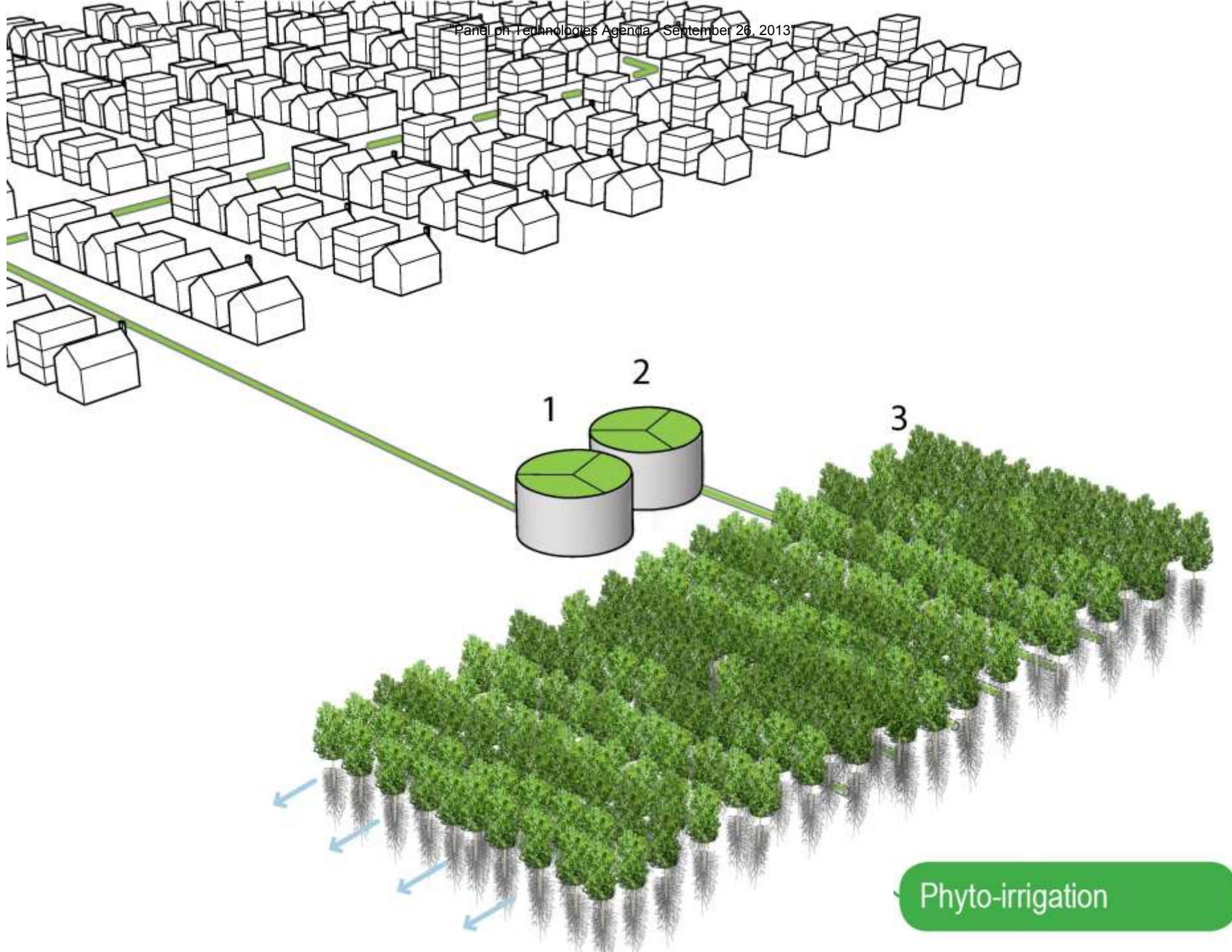
2 vertical subsurface flow wetlands

1 horizontal subsurface flow wetland

1 Free water surface wetland

Blumberg Engineers

Shuangshan Island (Zhangjiagang, Jiangsu Province, China)



Phyto-irrigation



Jason Smeasrod & Mark Madison, CH2MHill, Portland, OR

**PRECEDENT: Woodburn, OR Treatment Facility**

# Excess Nutrient Capacity within the Poplar Tree Plantation Utilized for Biosolids Reuse



**215 lb/ac/yr N Limit**  
(average across tree age classes)

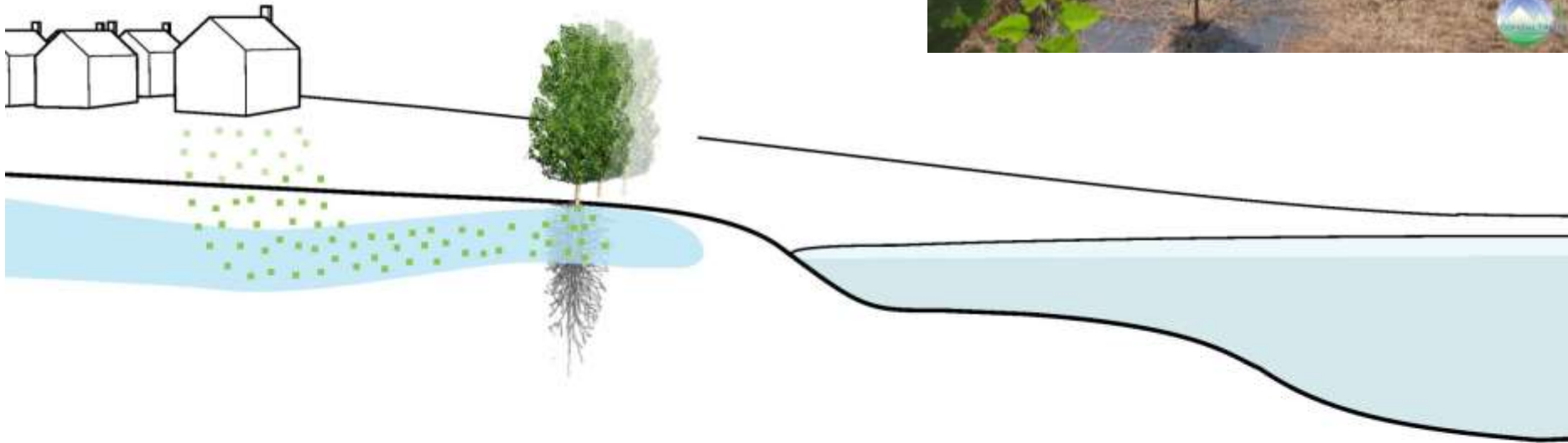
Annual lbs of Nitrogen per acre



Effluent  
28 in/yr  
@10 mg/L N

Biosolids  
2.9 dT/ac/yr  
@52 lbs  
PAN/dT





Phyto-buffer: LG

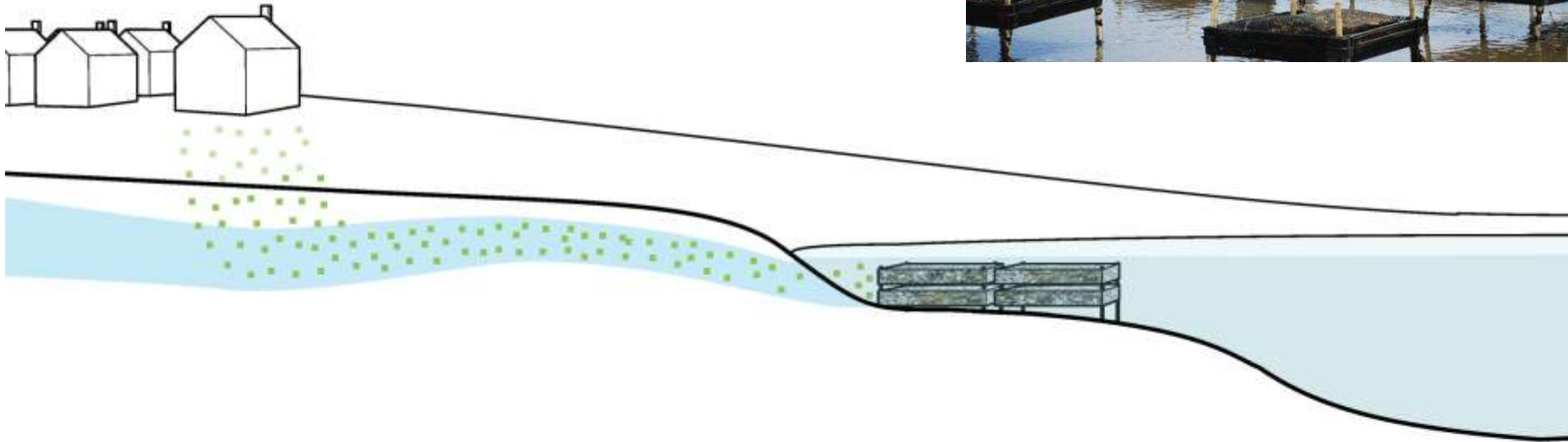


Poplars reach up to 20' Ground Water Depths



Ecolotree and Sand Creek Engineers

**PRECEDENT: Fertilizer Factory, North Carolina- Deep Rooting Poplars**

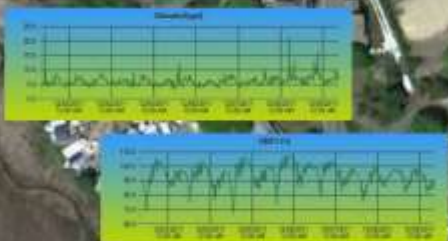


Shellfish Aquaculture

# Measuring Oysters' Improvements on Water Quality



Real Time Water Quality



[www.capecodextension.org/Marine-Programs/YSI-Water-Quality-Monitoring.html](http://www.capecodextension.org/Marine-Programs/YSI-Water-Quality-Monitoring.html)



Overall project area with new catch

- > already 2-3 million additional oysters
- > goal: 8,800 pounds of nitrogen removed per year
- > likely increase in commercial shellfish value of \$1 million/year
- > increased water filtration approximately 100 million gallons/day
- > erosion control
- > sediment reduction
- > increased turtle, eel, juvenile fish habitat



New spat on seaclam catch (small black patches)



YSI Meter

Recycled OysterFest Shells

Oyster Spawning Study Area (2.04 acres)

Blueberry Wells

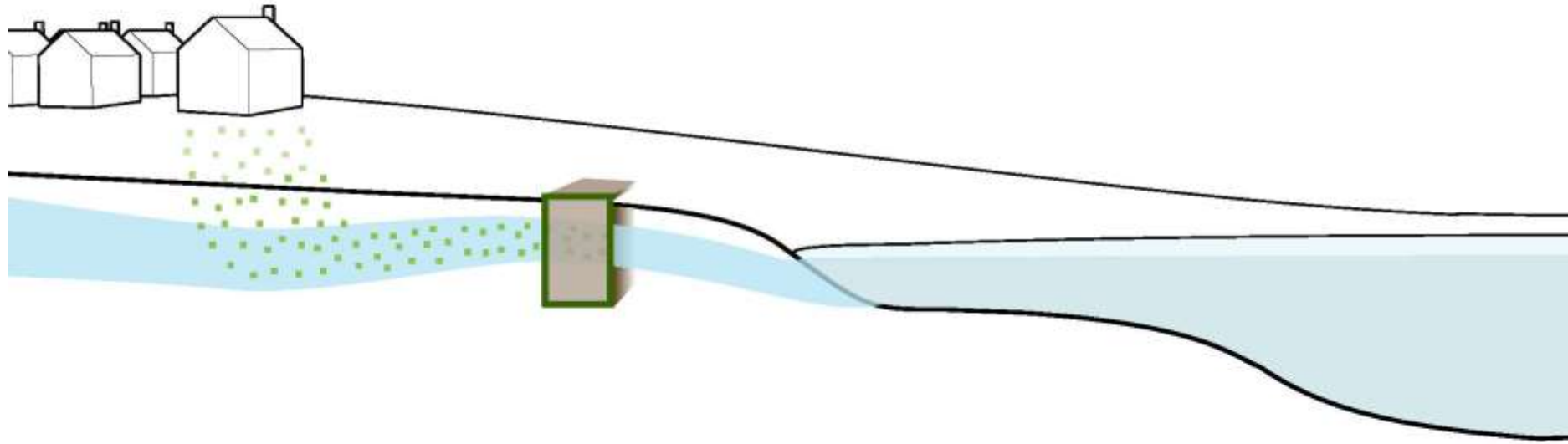


Anamarija Frankic (Umass)

PRECEDENT: Wellfleet Harbor, Cape Cod

"Panel on Technologies Agenda - September 26, 2013"





Permeable React Bar.



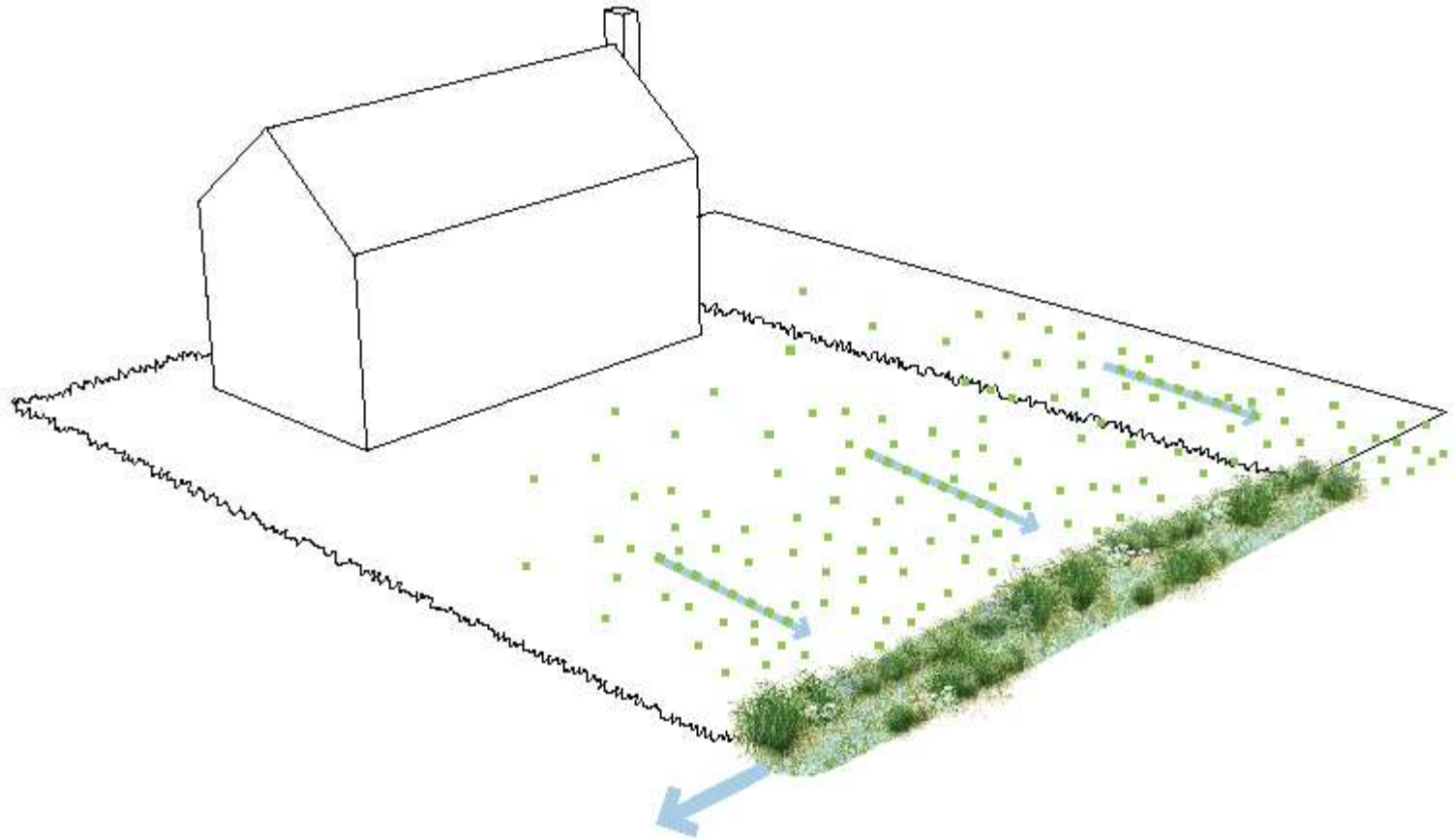
Chips



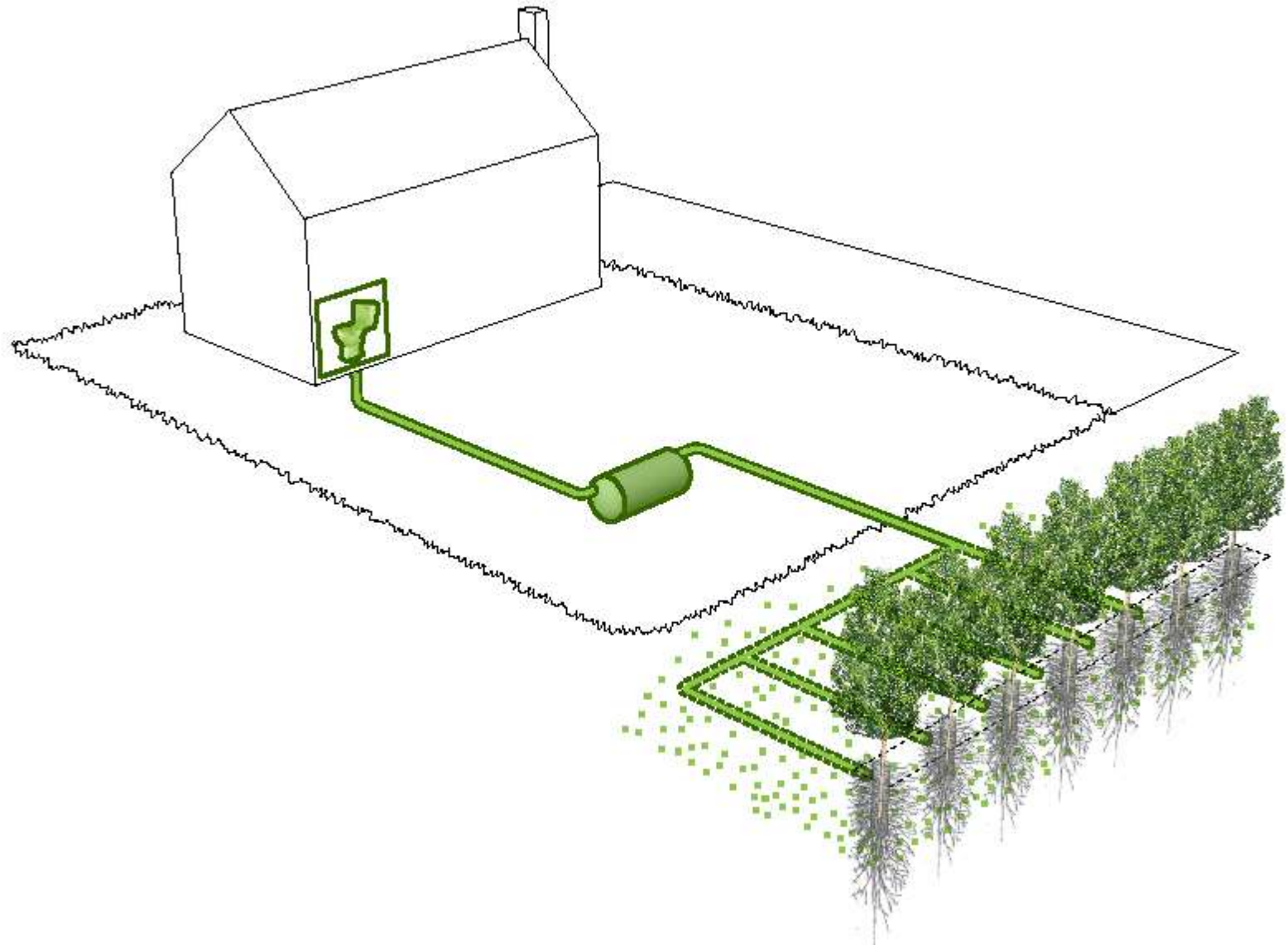
- Nitrate → to nitrogen gas by micro-organisms
- 90-99% removal of nitrate
- Also effective for Phosphorus - fresh water ponds
- 20-30 year media life estimated

# **Other Diagrams Drawn**

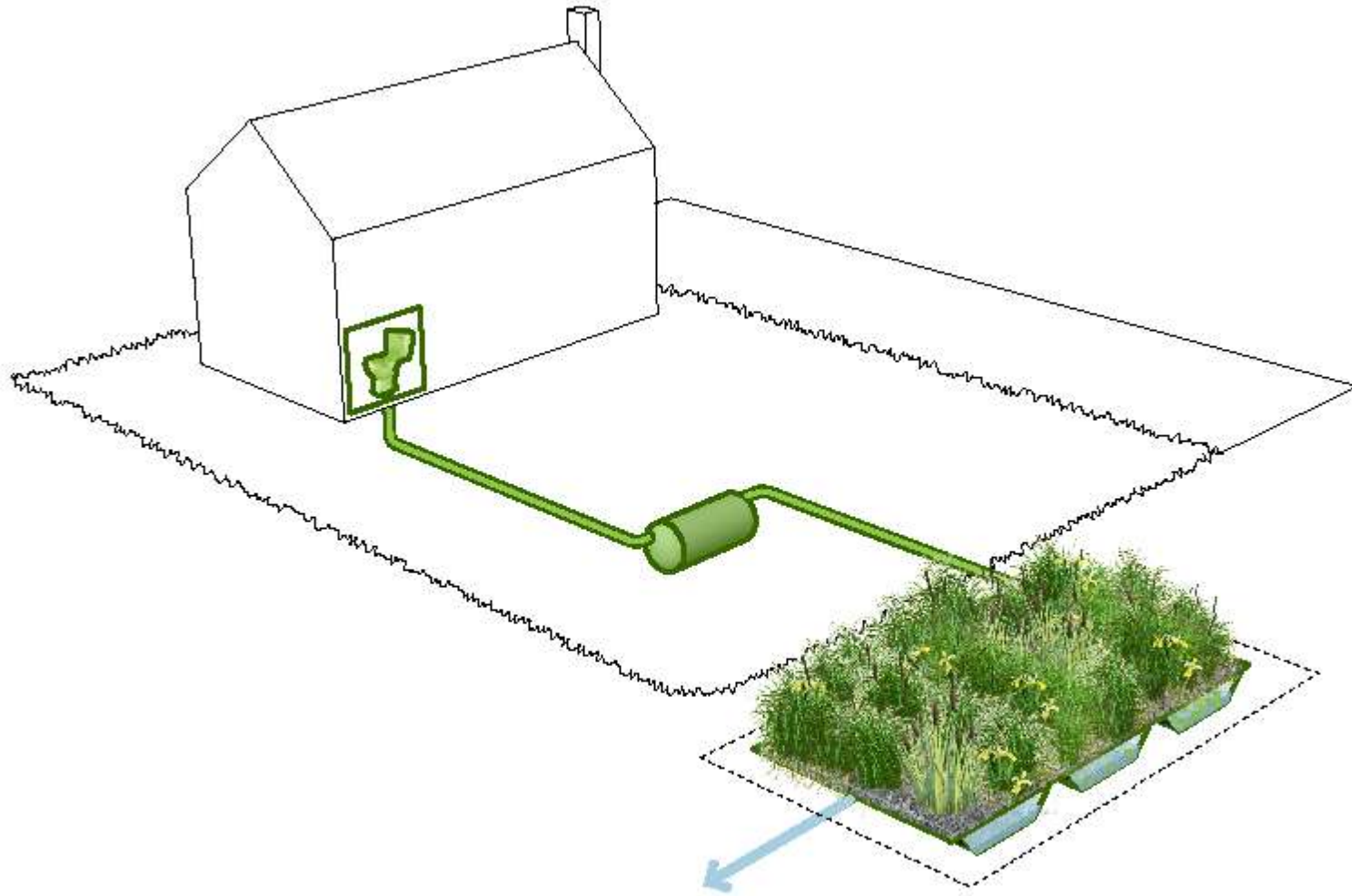




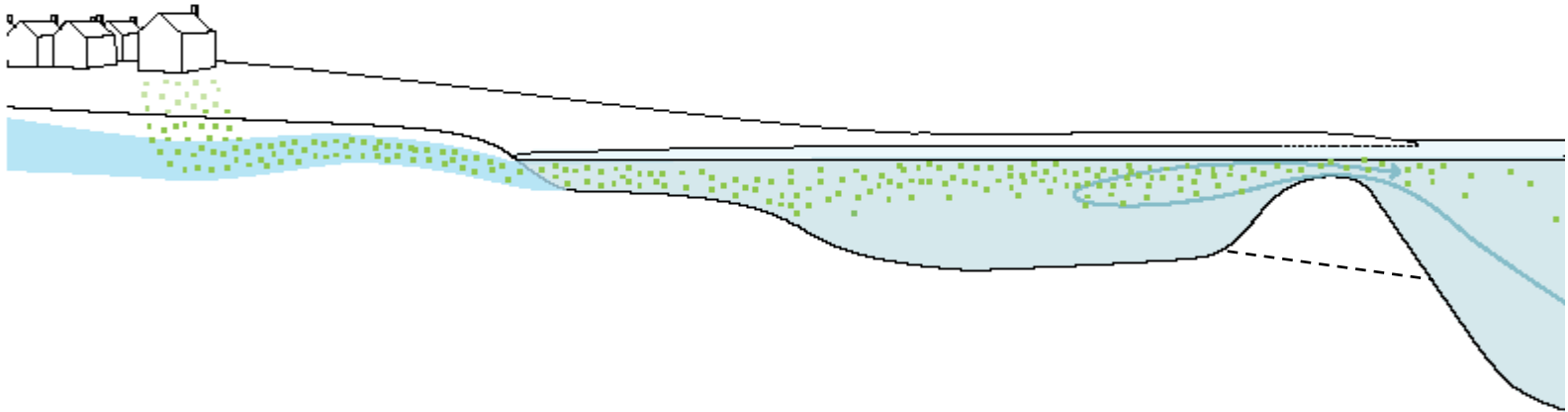
**SITE: Bioswales**



**SITE: Phyto Buffer**



**SITE: Subsurface Wetland**



# WATERSHED: Dredging