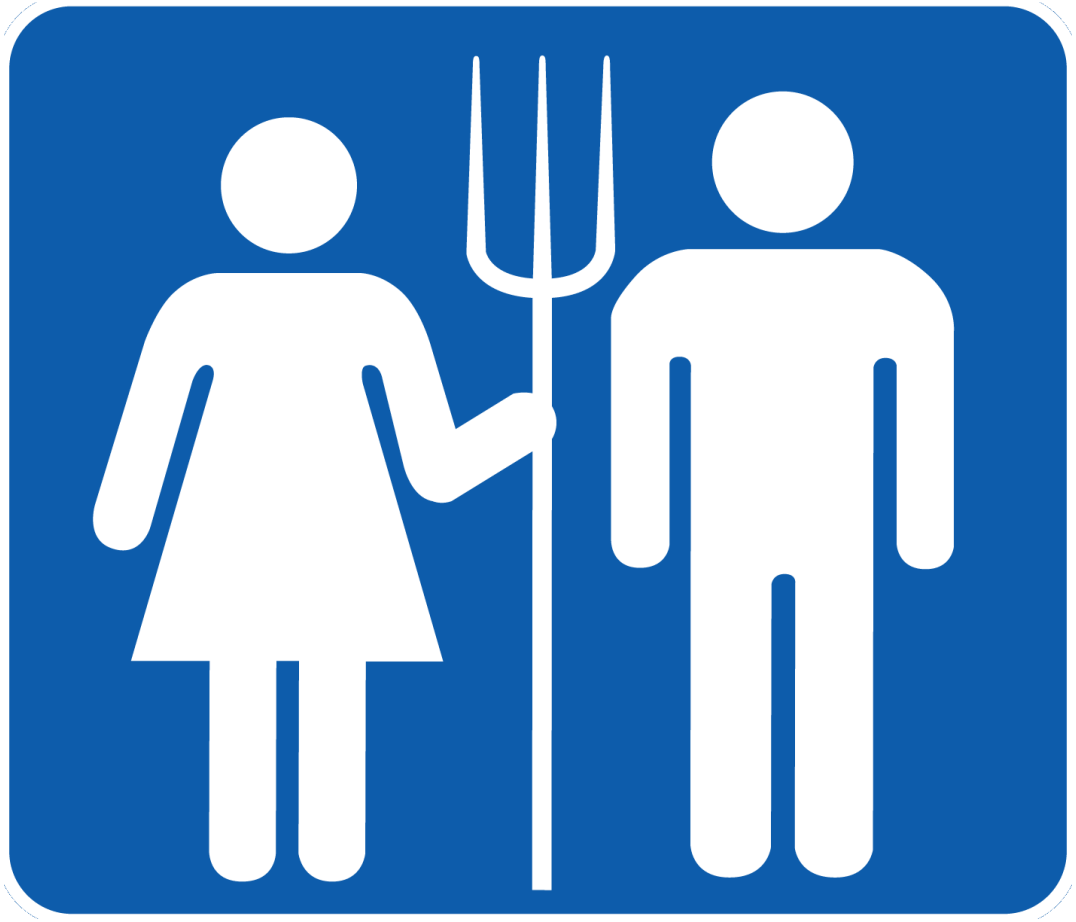

Reducing Water Footprint Through Source-Separating Sanitation

Recipe for Conventional Sanitation:

Place 1.6 - 3 gallons of potable water in a toilet

Add 1 cup urine.

Mix thoroughly.

Flush.

Treat lightly to remove pathogens and organic matter.

Discharge the nutrient-rich effluent to a river or lake.

Allow nitrogen and phosphorus to create algae overgrowth, killing fish and rendering water unfit for drinking or recreation.

OR...

Use toilets that collect urine for recycling.
Turn the urine into sanitized fertilizer to grow crops.

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The fertilizer in the urine a person creates in one day will grow enough wheat to produce a loaf of bread.

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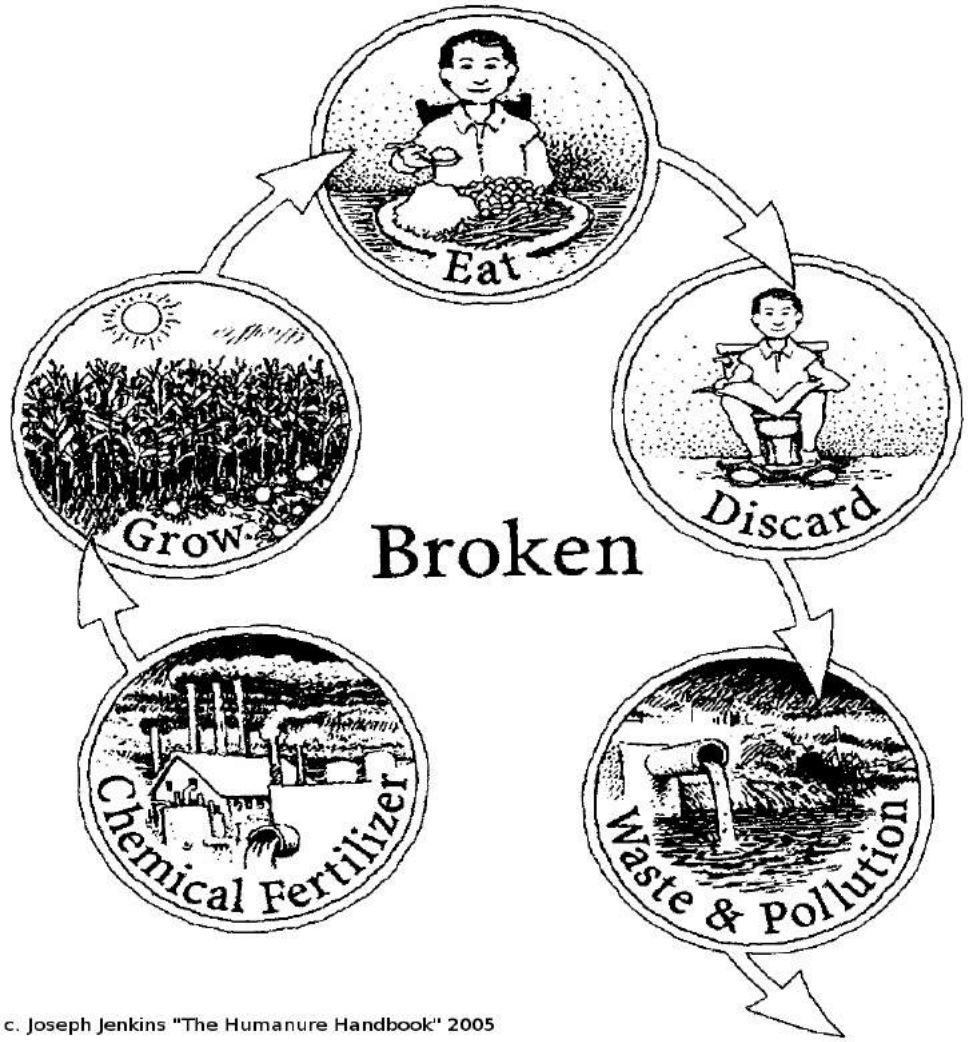
Business as usual

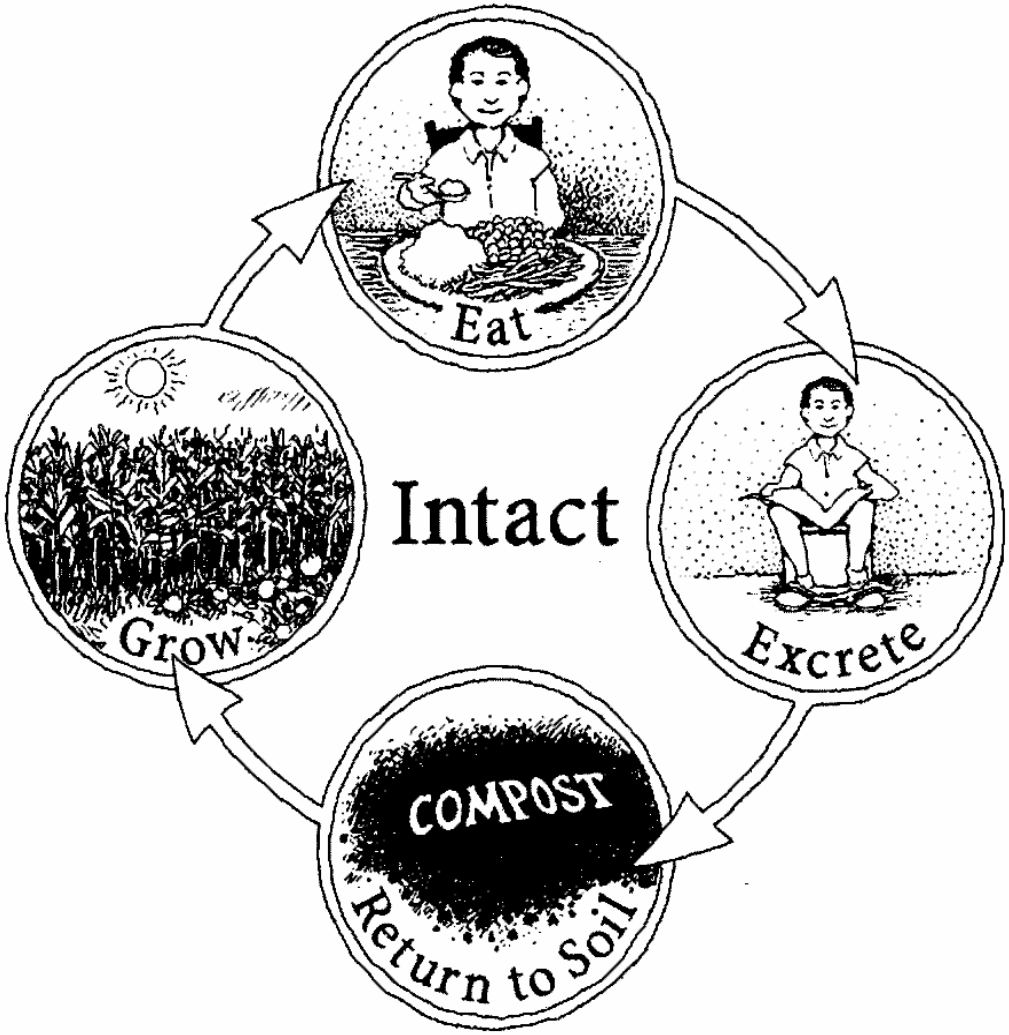
Energy-intensive Unsustainable



c. Joseph Jenkins "The Humanure Handbook" 2005

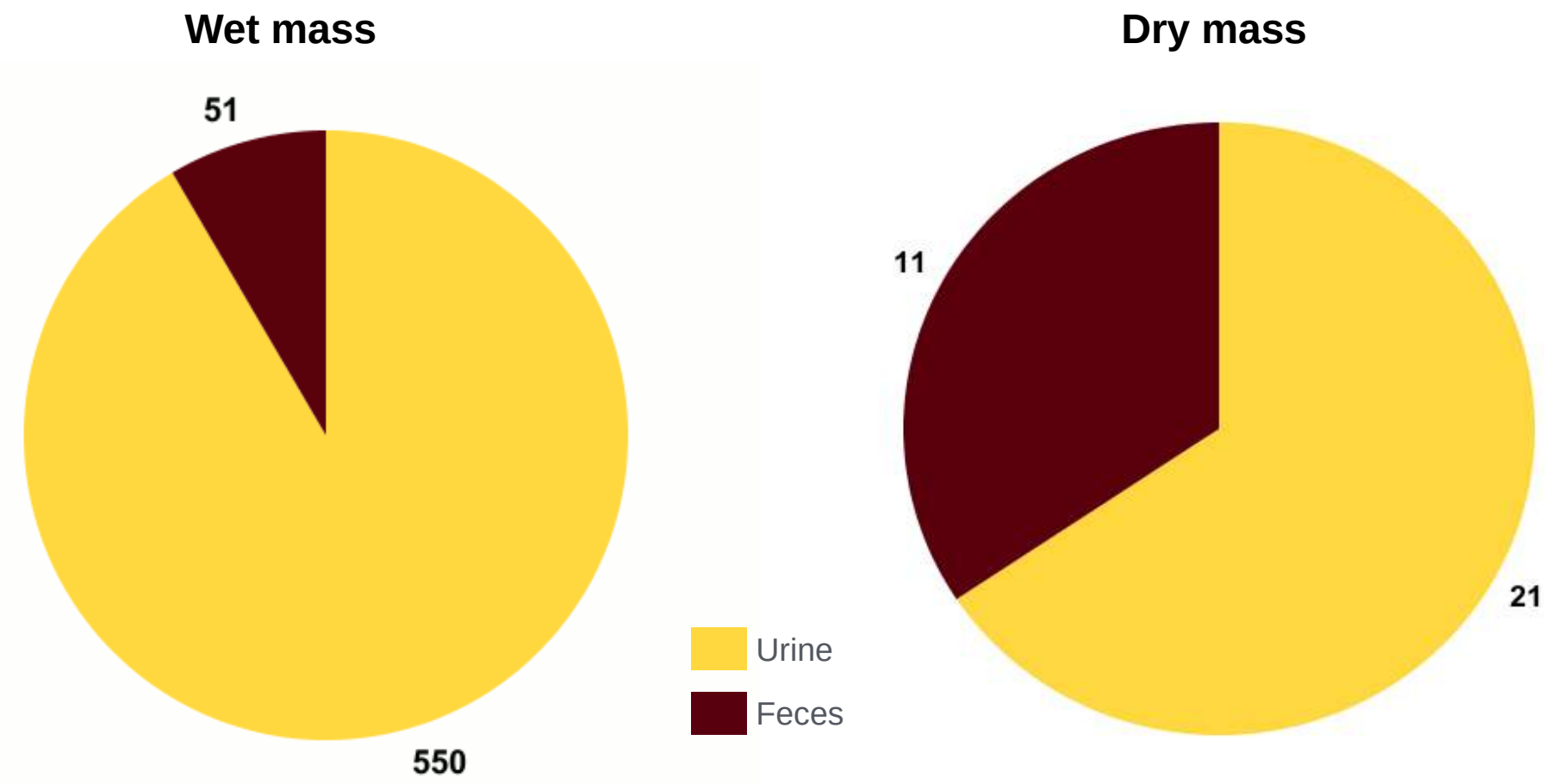
Source-separation with nutrient reclamation

Creates fertilizer Eliminates waste



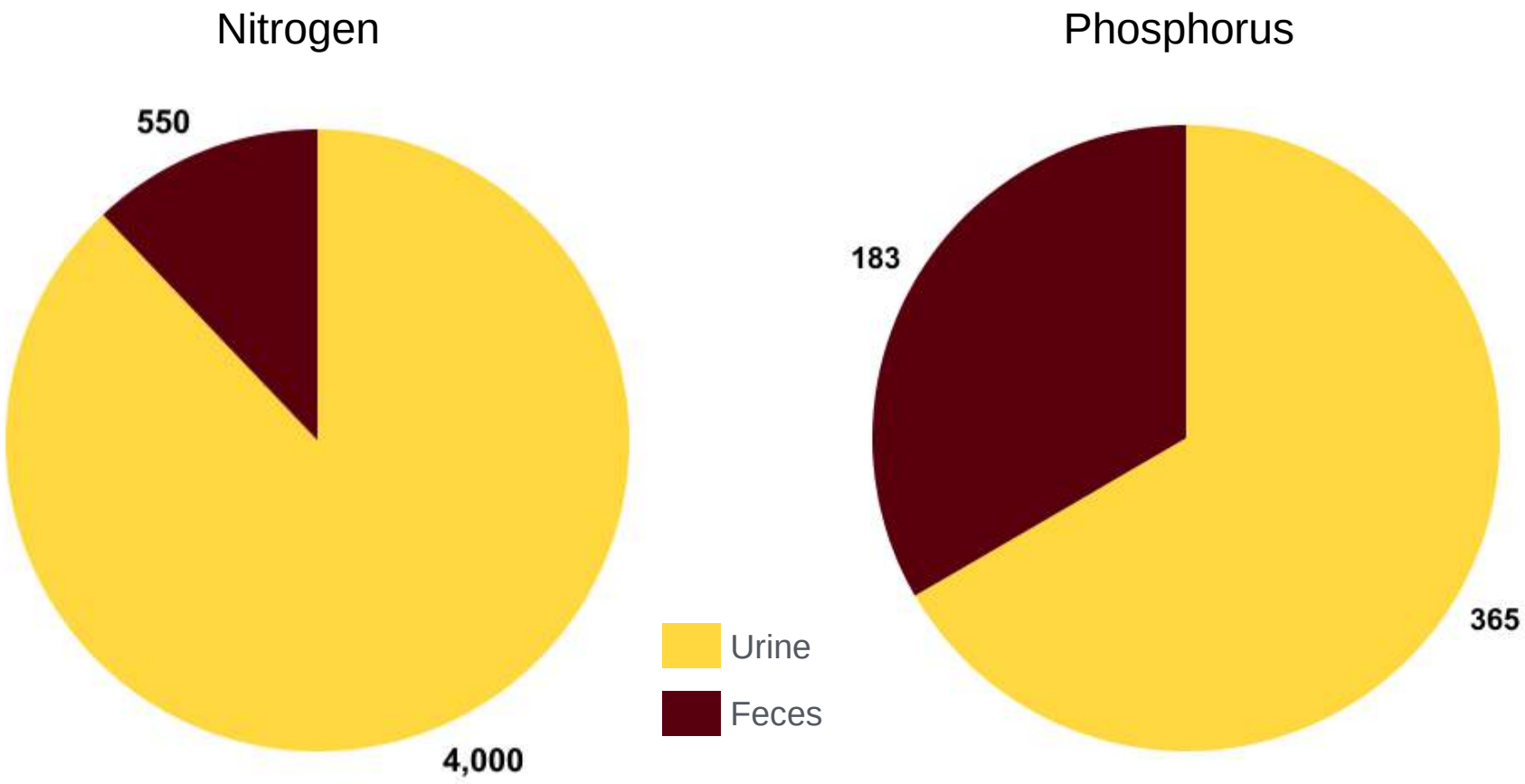
c. Joseph Jenkins "The Humanure Handbook" 2005

Characteristics of Urine



Annual production of urine and feces in (kg/person)

Nutrients in Urine

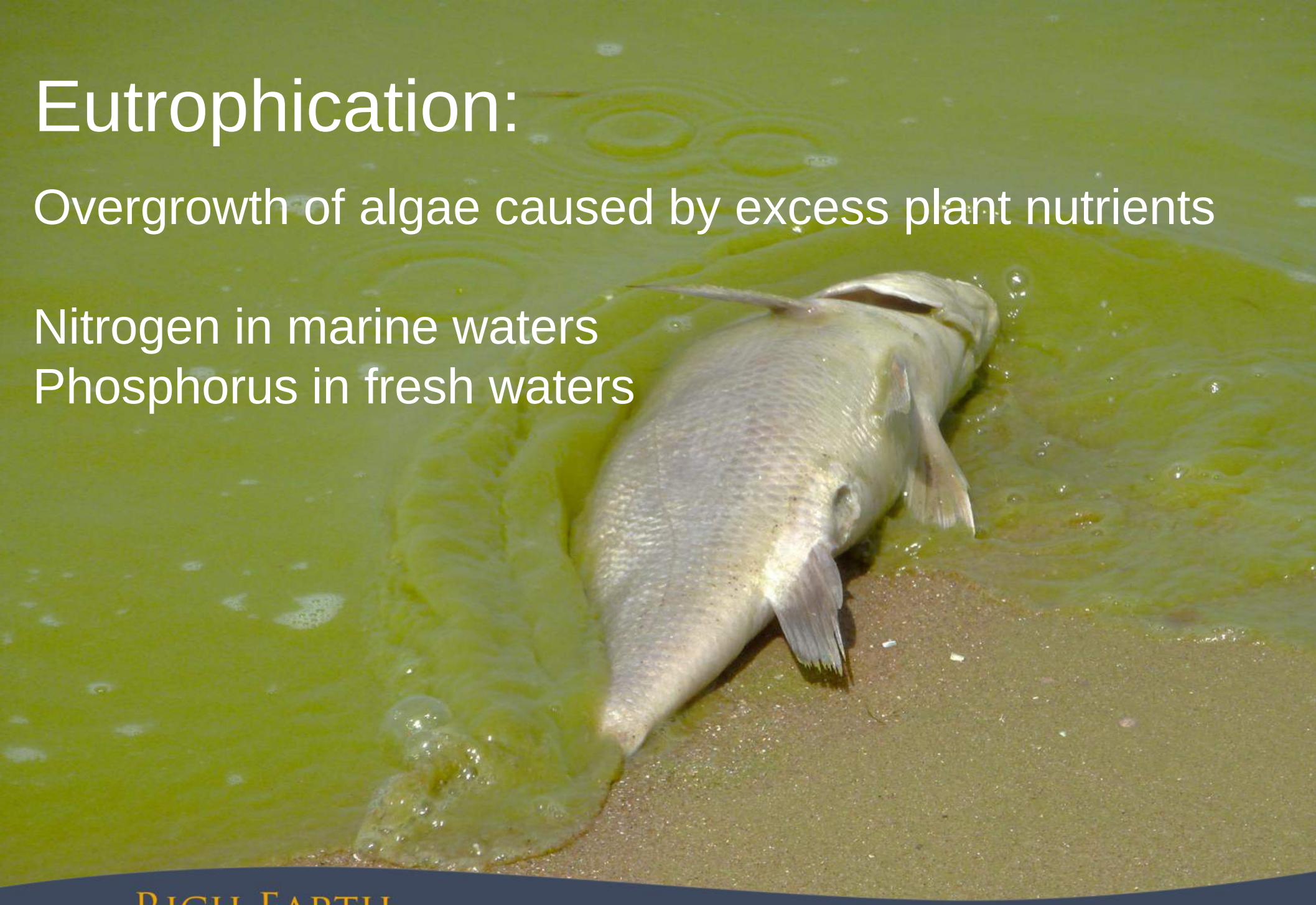


Grams of nitrogen and phosphorus per person/year

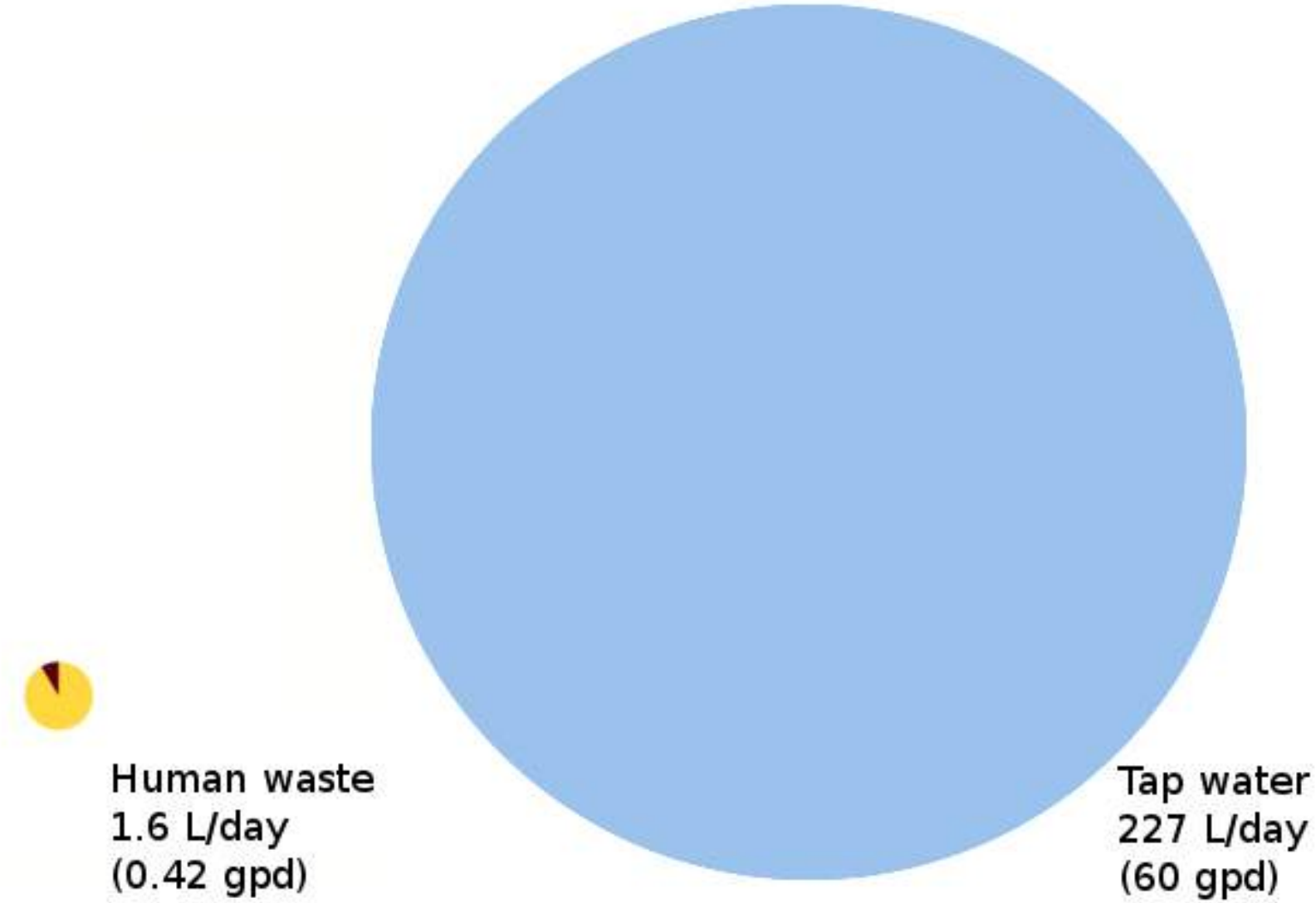
Eutrophication:

Overgrowth of algae caused by excess plant nutrients

Nitrogen in marine waters
Phosphorus in fresh waters



What is wastewater?



Sources of nutrients in wastewater

	Urine	Feces	Combined
Nitrogen	75%	5-10%	80-85%
Phosphorous	55%	25%	80%

(Larsen and Gujer 200, Otterpohl 2002, Maurer *et al.* 2006, Lienert *et al.* 2007, Vinneras *et al.* 2002, and Meinzinger and Oldenburg, 2009)


Source
separation/
urine
diversion

Practical Benefits

- Water conservation
- Nutrient reclamation
- Wastewater quality
  - Reduced nutrient pollution
  - Pharmaceutical removal

Urine Nutrient Reclamation Project

First community-scale urine-recycling project in the United States

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Transport

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Pasteurization

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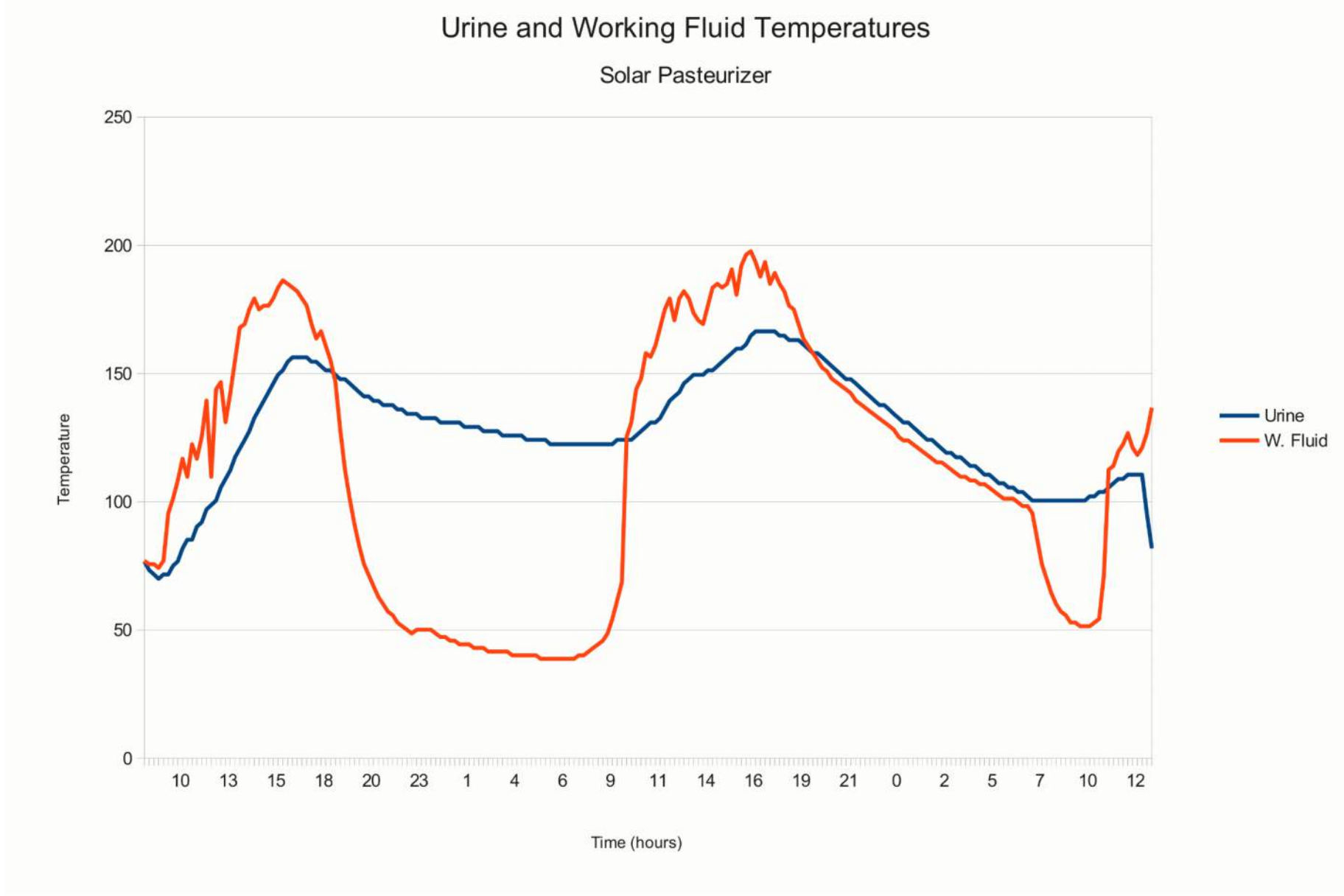
30 Minutes at 158° F



Urine application to hay

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Field Trials

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Soil Analysis

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Quantifying Yields

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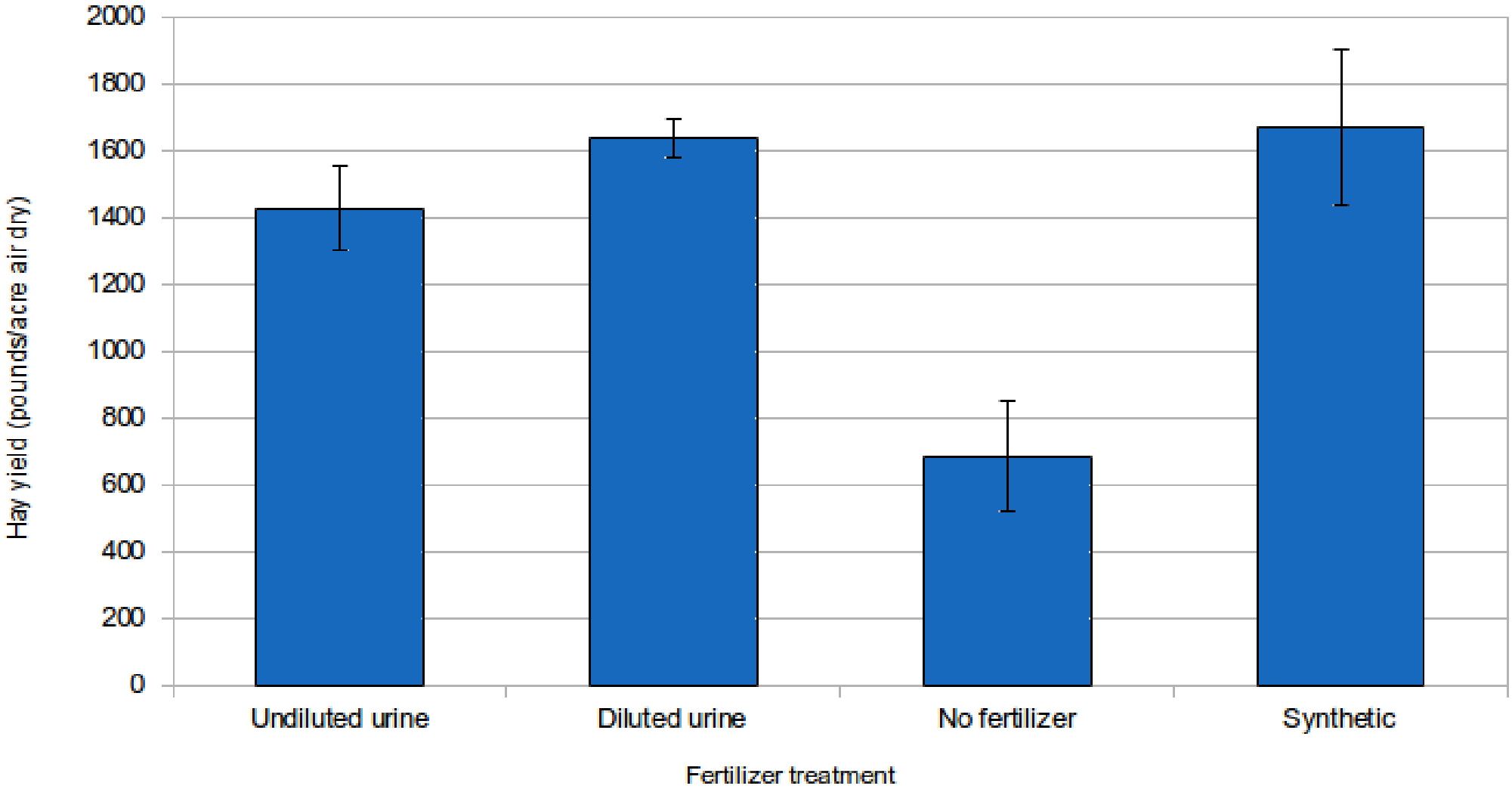
Effect of fertilizer on hay yield



Contaminants

	Urine	Sewage
Pathogens	Low	High
Heavy metals	Very low	Potentially high
Industrial and household chemicals	Very low	Potentially high
Pharmaceuticals	Potentially high	Potentially high

2-Year Pharmaceutical Study

funded by the US Environmental Protection Agency

Tracking pharmaceuticals from urine used as fertilizer:

- Soil
- Groundwater
- Harvested crops

Final results will be published in 2016

Rich Earth Institute is collaborating with:

- University of Michigan
- University at Buffalo
- Brown & Caldwell (wastewater engineers)
- Hampton Road Sanitation District

Pharmaceutical contaminants being analyzed

Contaminant	Drug Type
Acetaminophen	analgesic
Caffeine	stimulant
Carbamazepine	anti-seizure
Clofibric Acid	metabolite of the cholesterol-lowering drug Clofibrate
Ciprofloxacin	antibiotic
Diclofenac	nonsteroidal anti-inflammatory
Dilantin	anti-seizure
Erythromycin	antibiotic
Ibuprofen	nonsteroidal anti-inflammatory
Meprobamate	antianxiety
Naproxen	nonsteroidal anti-inflammatory
Sulfamethoxazole	antibiotic
Sulfamethoxazole-acetyl conjugate	metabolite of antibiotic sulfamethoxazole
Trimethoprim	antibiotic


Soil water from
lysimeters

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Where is urine diversion already the best solution?

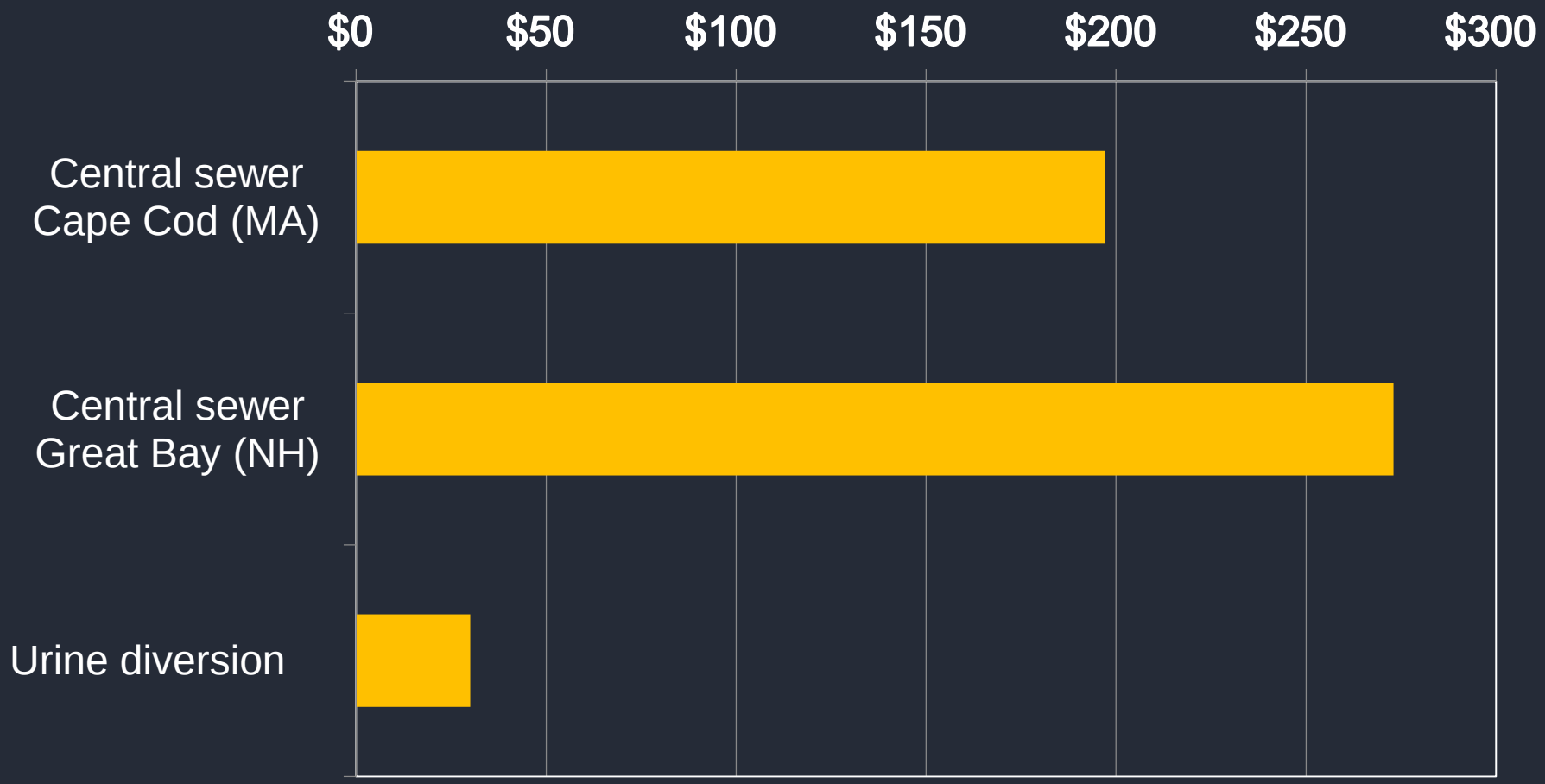
Small treatment plants (building or campus)

Communities in sensitive watersheds
with many septic systems:

Connecticut River and Long Island Sound
Chesapeake Bay
Great Bay, NH
Cape Cod

Cost to remove nitrogen

dollars / pound (single family home)



The Rich Earth Institute is developing:

- Technical innovations
- Urine treatment methods
- Regulatory pathways
- Public acceptance
- A network of leaders in this emerging field

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Reverse Osmosis

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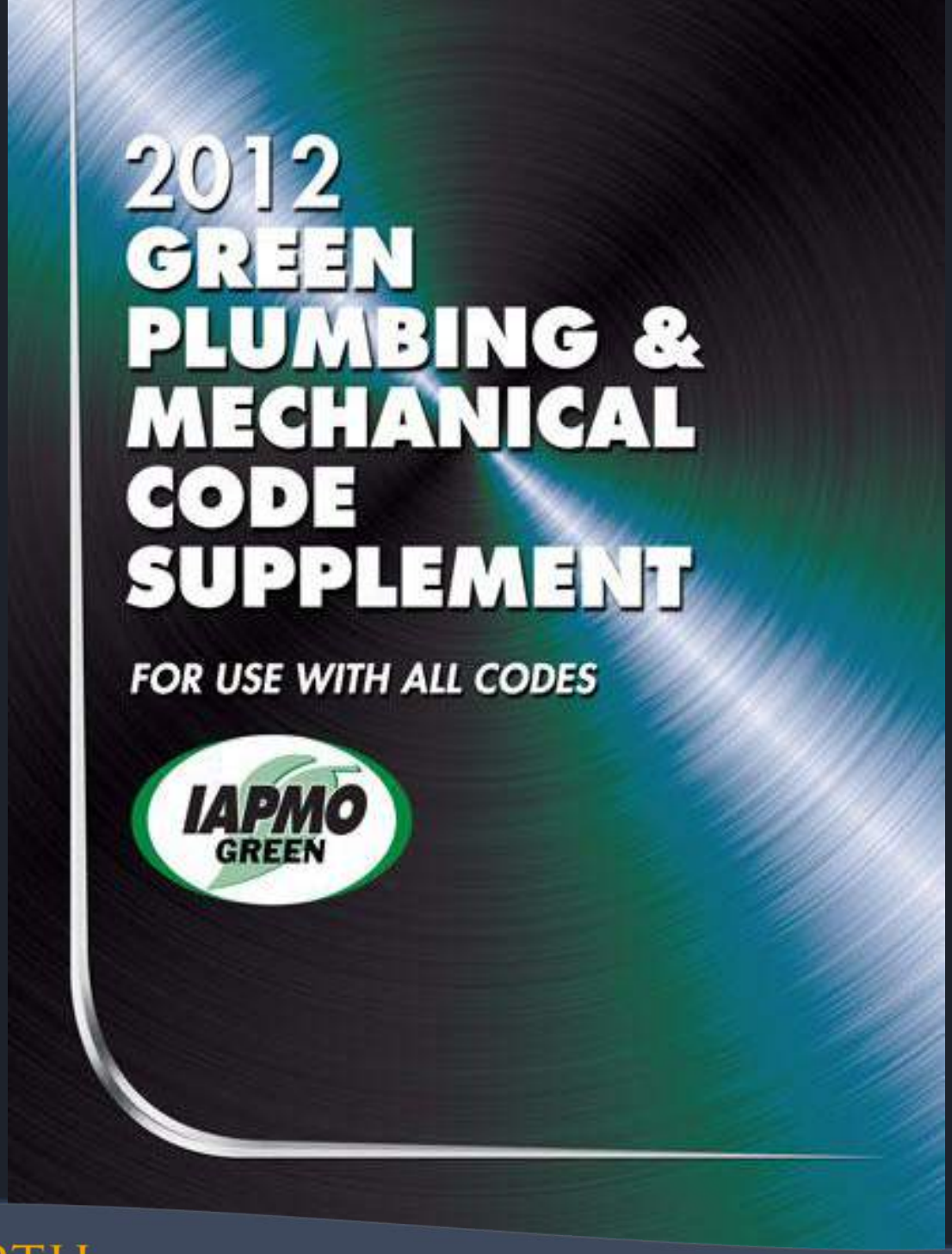
2012
GREEN
PLUMBING &
MECHANICAL
CODE
SUPPLEMENT
FOR USE WITH ALL CODES
IAPMO
GREEN

2015 Urine Diversion Summit

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Our strategy

Make urine recycling accessible to architects, planners, and municipalities by providing tested tools, technologies, and techniques.

Public Demonstration Projects

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Urine diversion throughout the U.S. would:

- Save 960 billion gallons of water per year (3,000 gallons per person)
- Remediate nutrient pollution and restore damaged waterways
- Replace 9 billion pounds of synthetic fertilizer with urine-derived fertilizer

Small investment for a big change

The time to invest in developing and testing source separation technologies is **now**.

$298 billion needed in capital investment for wastewater infrastructure over the next 20 years. (ASCE Infrastructure report card)

Source separation today is like recycling in the early 90's

- Currently a very small portion of total flow
- A fundamentally different method of waste management
- Potential for massive growth

“Pollution is nothing but the resources we’re not harvesting.”

—Buckminster Fuller

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