

# Urine diversion: practical experiences from Brattleboro VT

Abraham Noe-Hays

CAPE COD CONFERENCE

Tuesday, June 18th

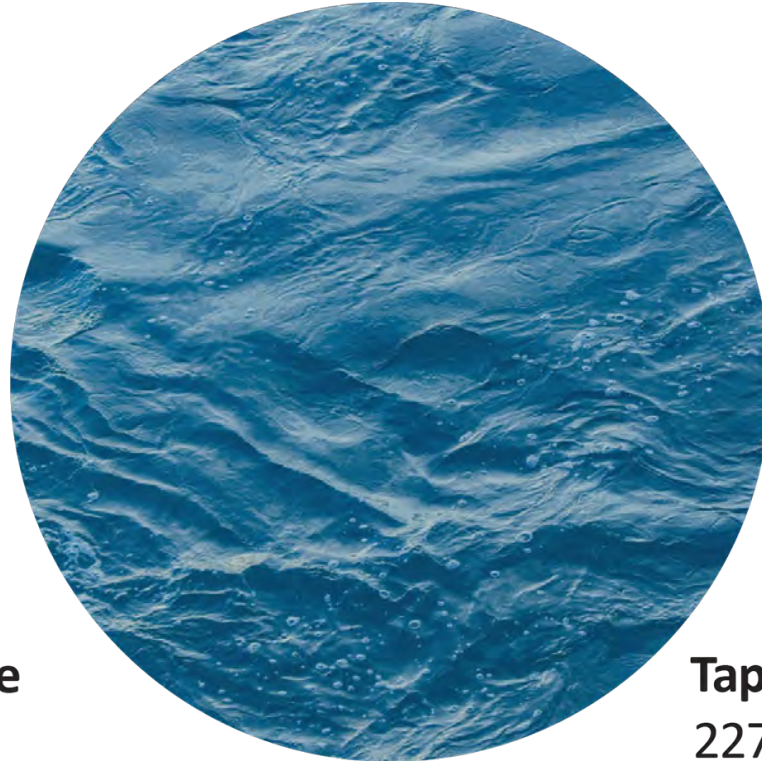


# Wastewater is over 99% tap water



**Human waste**

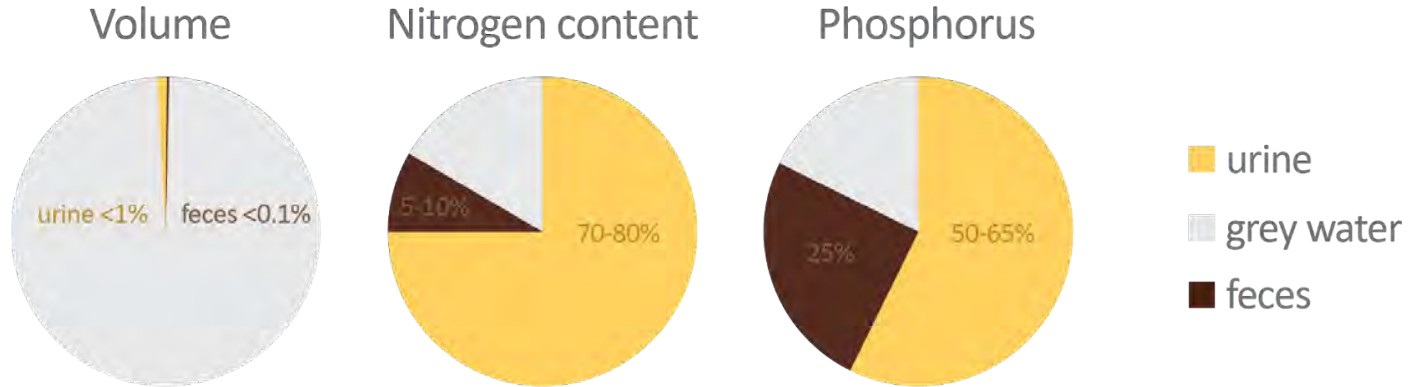
1.6 L/day  
(0.42 gpd)



**Tap water**

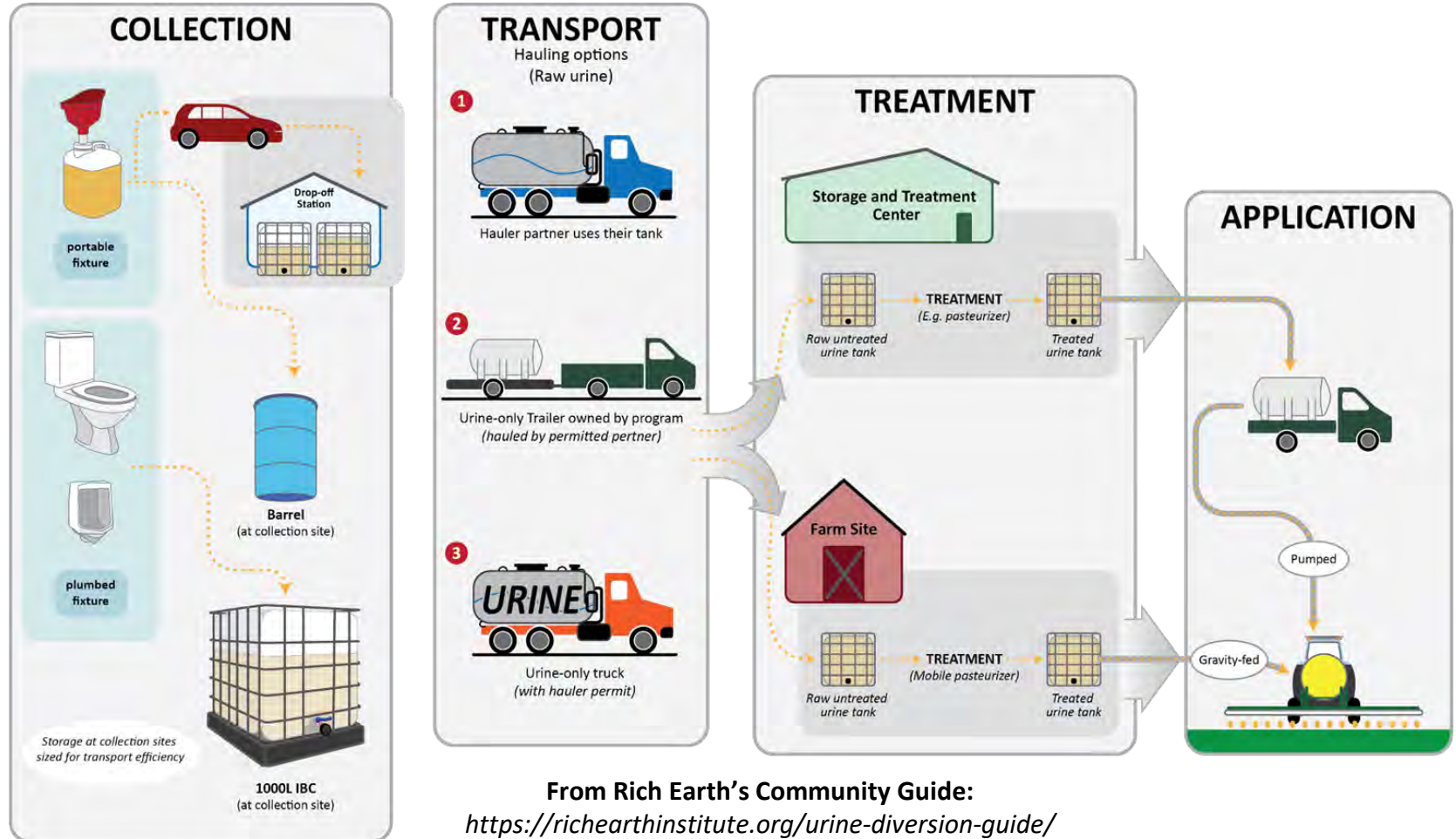
227 L/day  
(60gpd)

# Constituents of urine, feces, and greywater



Urine contains three quarters of the nitrogen and over half the phosphorus in domestic wastewater

# Logistics of Rich Earth Institute's Community urine recycling program



From Rich Earth's Community Guide:  
<https://ricearthinstitute.org/urine-diversion-guide/>

# Collection: Stand-alone urinal with odor prevention

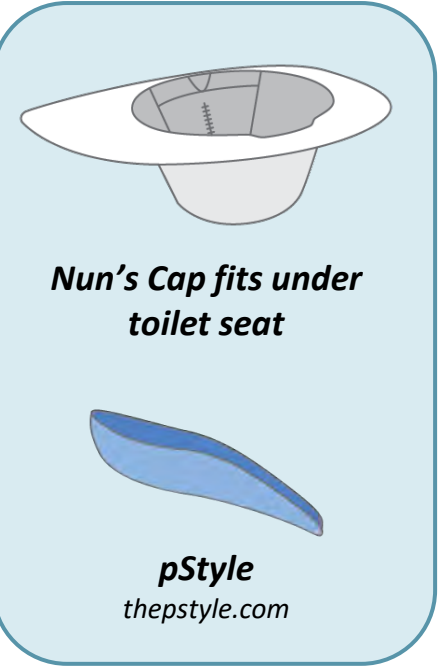
**Plastic ball**  
Blocks odors



*Minimizing odor also ensures nitrogen fertilizer retention*



**Optional Acidification**  
1-2 cups of white vinegar  
- or -  
1 Tbsp of citric acid per 5-gallons

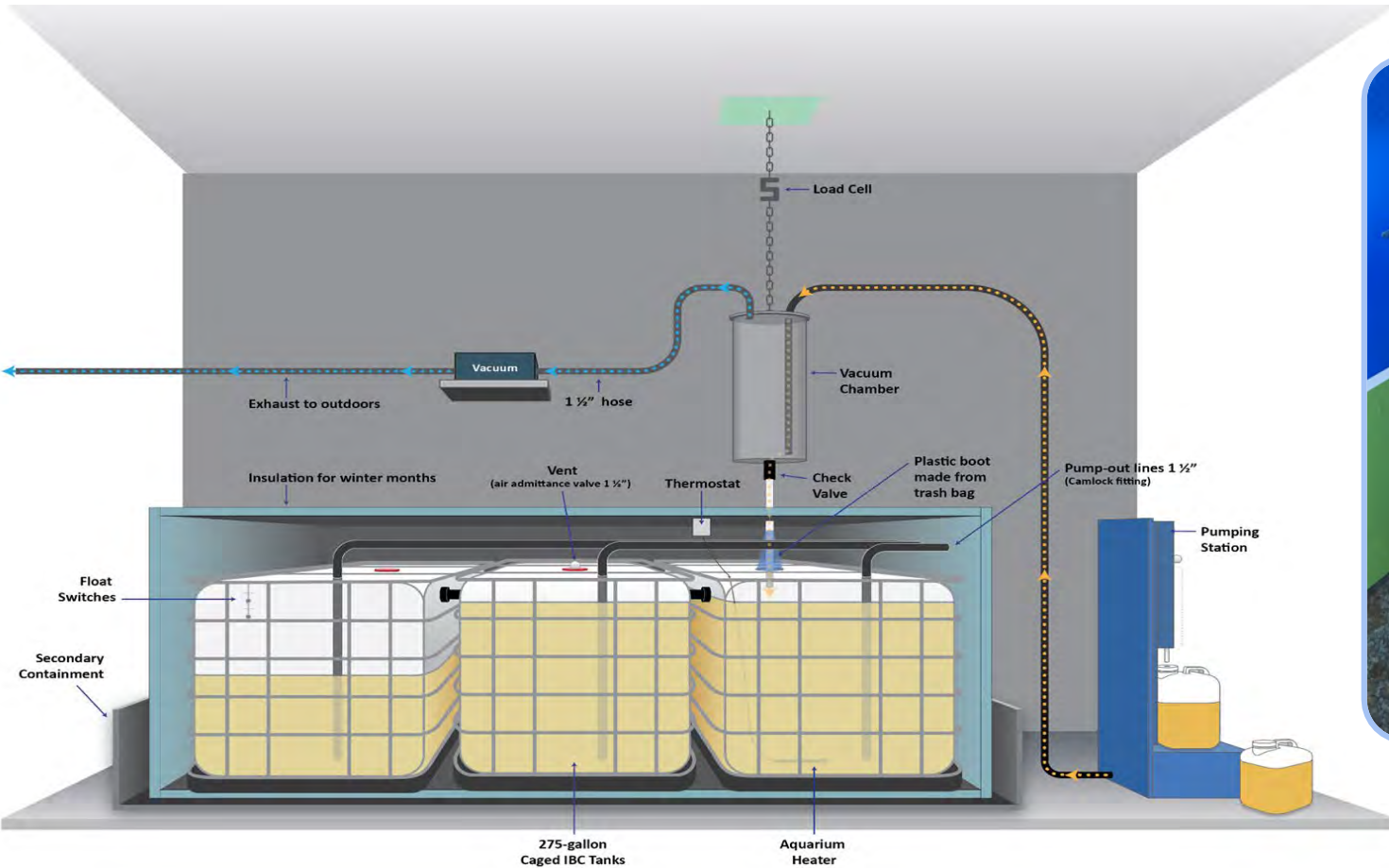


**5-gallon plastic Jug with funnel attachment**

# Stand-alone urinals prepared for Cape Cod

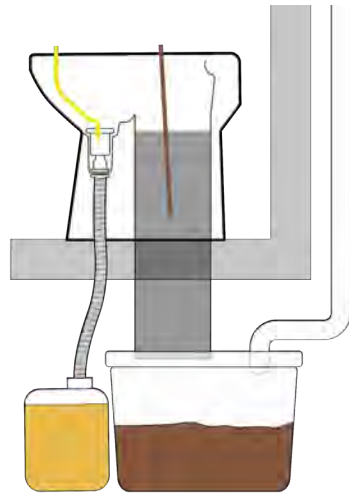


# Collection: Urine Depot

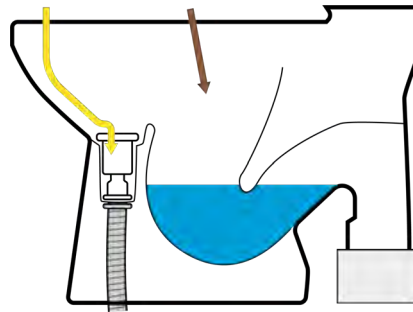


# Collection: Urine-diverting toilets

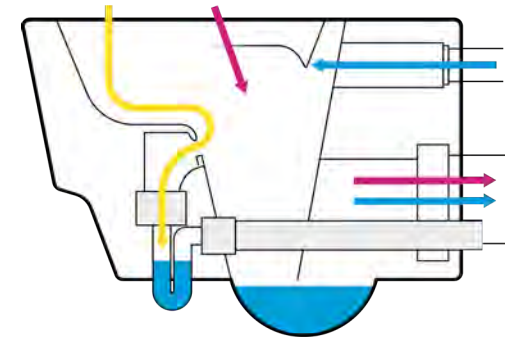
## Wostman EcoDry



## Wostman EcoFlush



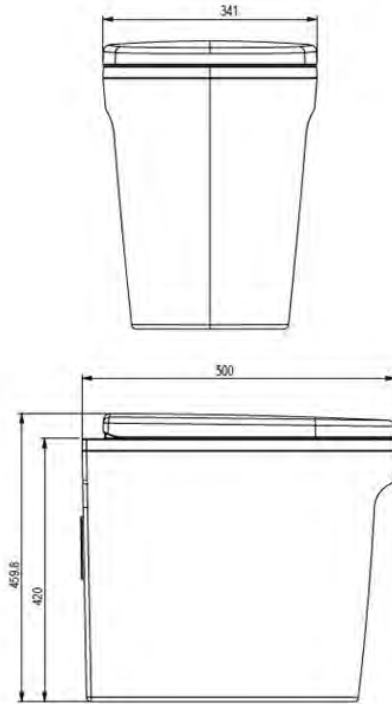
## Laufen SAVE! Toilet





# Collection: Urine-only fixtures

## Cinderella Urinal



## Pee Pod



# Transport: Pump-out

**TRANSPORT**  
Hauling options  
(Raw urine)

**1**



Hauler partner uses their tank

**2**

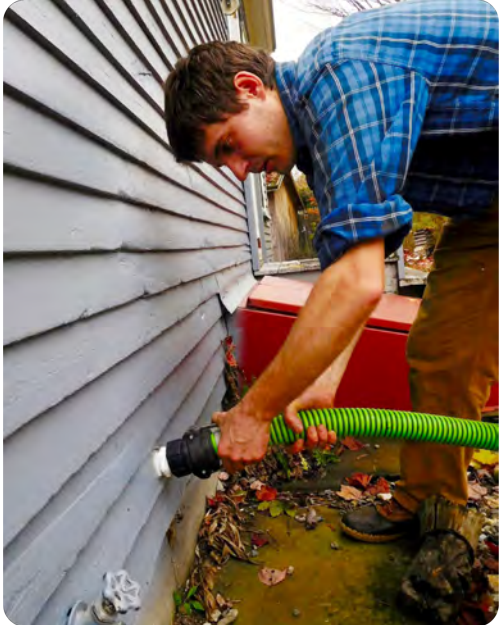


Urine-only Trailer owned by program  
(hailed by permitted partner)

**3**



Urine-only truck  
(with hauler permit)



# Transport: Hauling

Vacuum pump added  
for urine collection



# Pathogen destruction



Approved US  
EPA method  
for biosolid  
treatment

## *Pasteurization*

Heat urine to 80°C  
degrees for 1.5  
minutes

# Concentration



## *Freeze Concentration*

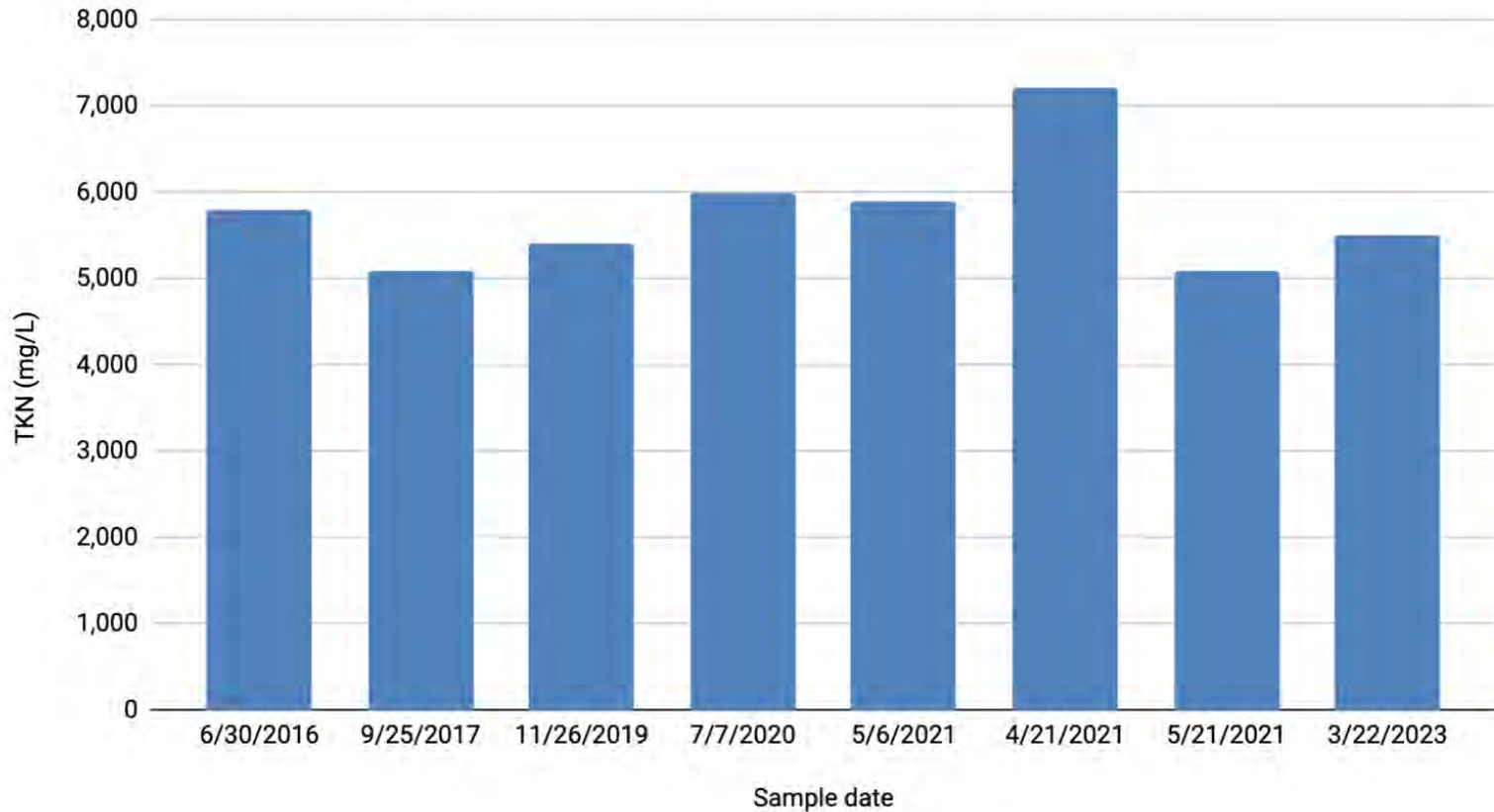
Reduce volume by up to 90%  
for lower storage and  
transport costs

# Primary Vermont end use: Hay farms



# Nitrogen content of urine

Nitrogen analysis of collected urine 2016-2023



Average N concentration = 5,750 mg/L (5.75 g/L)

# Quantifying nitrogen removal

## Urine diversion – direct measurement

<b>Metric</b>	<b>Method for calculating</b>
Gallons of urine collected	Direct measurement of urine hauled to processing center
Nitrogen concentration	Direct chemical analysis of nitrogen concentration in collected urine
Pounds of nitrogen removed	$(\text{Measured volume of urine collected}) \times (\text{Measured nitrogen concentration})$



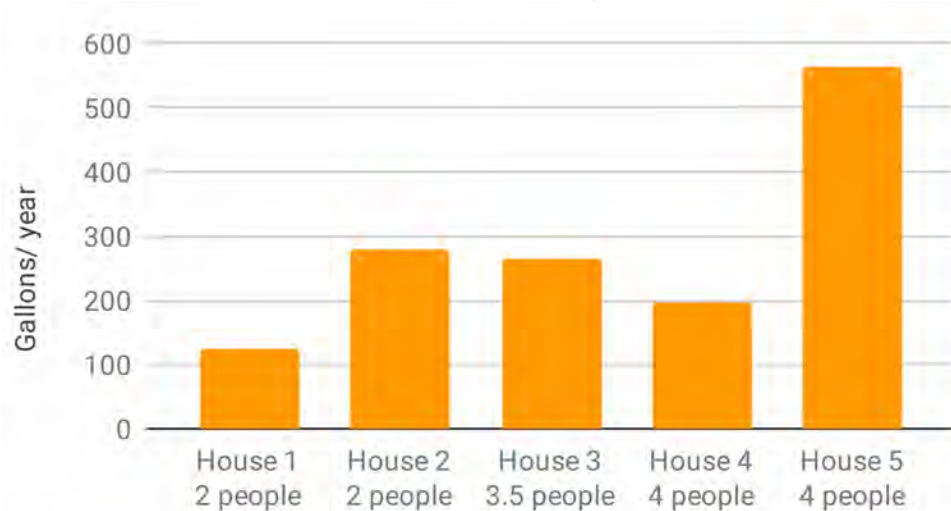
# Quantifying nitrogen removal

## Typical I/A system – indirect measurement

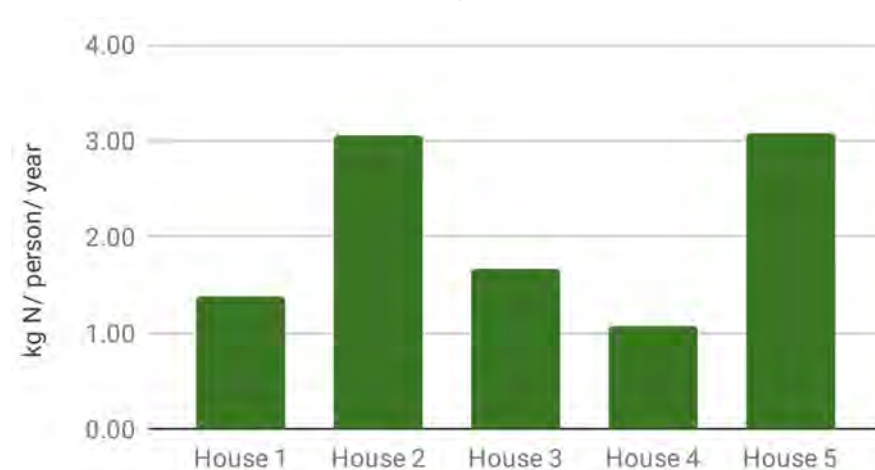
<b>Metric</b>	<b>Method for calculating</b>
Pounds of nitrogen entering system	Estimated using assumptions of a “typical” home’s: Number of occupants Percent time spent at home Nitrogen level in diet
Nitrogen removal rate	Estimate based on testing of well-maintained systems under proper operating conditions
Pounds of nitrogen removed	$(\text{Estimated pounds nitrogen entering}) \times (\text{Estimated nitrogen removal rate})$

# Urine and nitrogen collected using plumbed fixtures

Gallons of urine collected per household per year



Kg of nitrogen removed per person per year (approx.)



# Nitrogen diverted using plumbed fixtures

Annual nitrogen captured by households using plumbed fixtures (1-6 year pumping history)		
	Number of households	5
	Average household size	3.1
Per house	Gallons collected / house / year	286
	Pounds nitrogen / house / year	13.8
	Value of nitrogen load reduction*	\$3,924 - \$10,602
Per person	Gallons / person / year	92
	Pounds nitrogen / person / year	4.4
	Value of nitrogen load reduction*	\$1,266 - \$ 3,420

\* Based on avoided nitrogen removal costs of \$285/pound using sewerage and \$770/pound using I/A systems, from "Comparison of costs for wastewater management systems applicable to Cape Cod" prepared by Barnstable County Wastewater Cost Task Force, 2010

