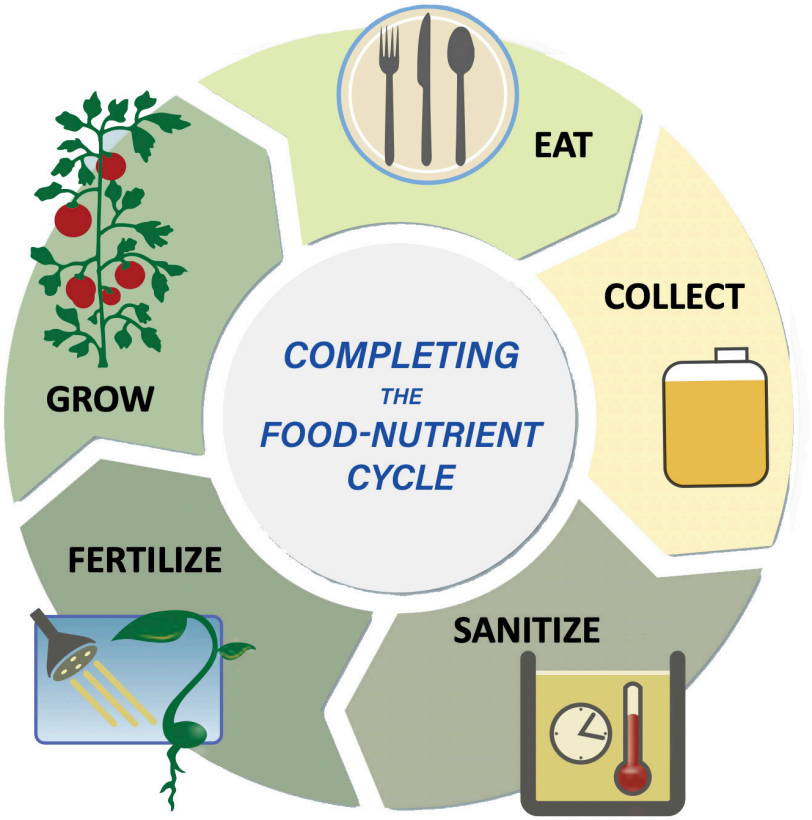
PeeCycling Matters

reduce pollution

recover nutrients

conserve water



produce fertilizers

socially equitable

reliable

affordable

reduce greenhouse gas emissions

The Green Center, Inc

For more information and tax-deductible donations go to https://newalchemists.net or info@greencenterinc.com

October 2023

THE PROBLEM: flush toilets pollute water!

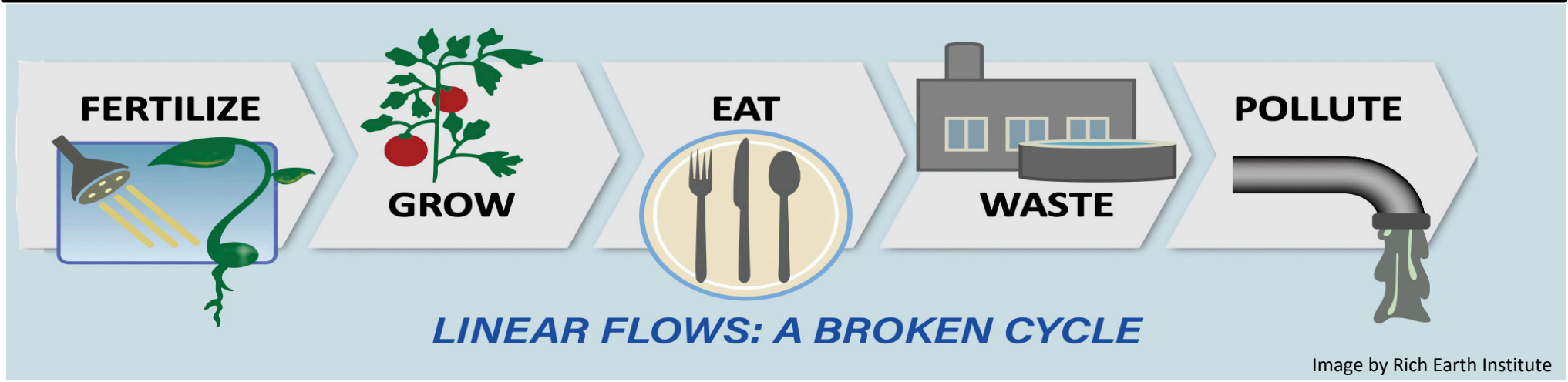


Image by Rich Earth Institute

Our society is entirely dependent on flush-toilet technology that wastes energy, water, and nutrients, and uses our natural environment as a dumping ground for our "wastes".

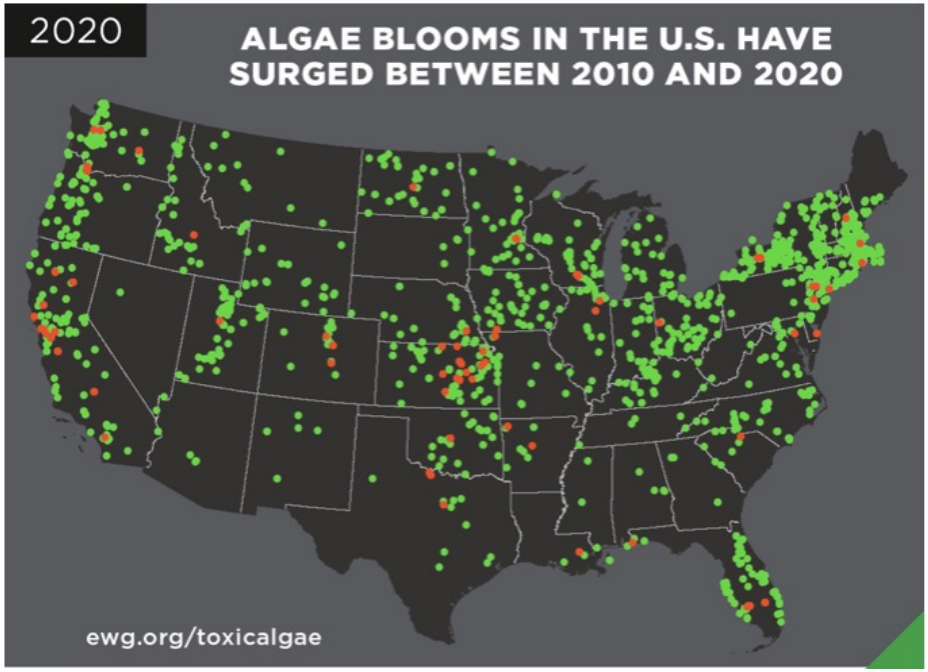
Nitrogen and phosphorus from human wastes are polluting ponds, lakes, rivers, coastal waters, and oceans all over the world.

Toxic blooms of Cyanobacteria

The main source of nitrogen is
Urine,
which is only
1% of the volume of the waste stream
but contains
80% of the nitrogen,
55% of the phosphorus.

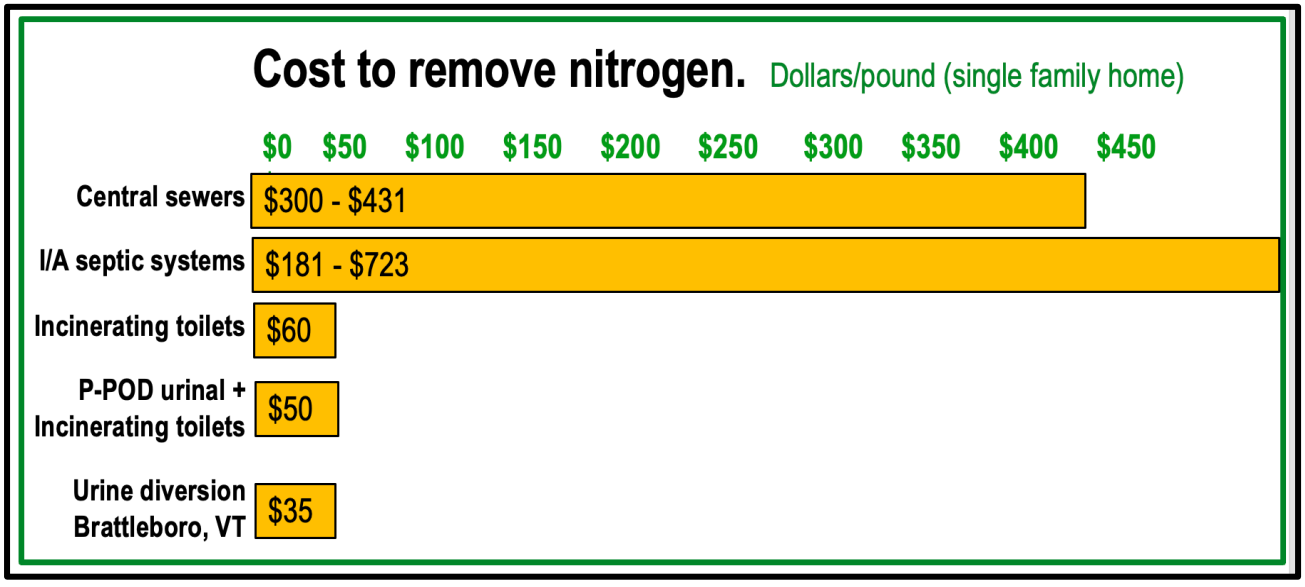
Fish kill due to oxygen depletion

THE SOLUTION: urine diverting (UD) toilets reclaim nutrients



UD toilets are the best way to:

- Protect our ponds, rivers and estuaries
- Reclaim nutrients as fertilizers
- Conserve fresh water
- Reduce greenhouse gas emissions and . . .



. . . Reduce cost of treatment

WHY URINE DIVERSION?

REDUCE POLLUTION: Human waste nutrients contaminate groundwater, rivers, ponds and oceans, causing toxic algae and cyanobacteria blooms in the U.S. and globally, with serious health effects (and death) on people, livestock and wildlife including birds and fish. Global warming increases frequency and intensity of toxic algae blooms.

CONSERVE WATER: Saves 2000-4000 gallons of pure drinking water used per person per year for flushing urine.

RECOVER NUTRIENTS: Most of the nutrients in human waste are in urine. Urine contributes 80% of the nitrogen and 50% of the phosphorus to the waste stream. Phosphorus is a rapidly dwindling, non-renewable resource and is essential to plant growth. No phosphorus no food. Urine contains all the macro- and micro-nutrients needed for plant growth.

RECYCLE NUTRIENTS: One adult excretes 100-120 gallons of urine per year, which contains about 10lbs nitrogen, 1lb phosphorus and 2lbs potassium, enough to fertilize 4000-5000 sq.ft. of agricultural, ornamental or tree crops or lawns and fields.

REPLACE SYNTHETIC FERTILIZERS: Urine-based fertilizers can replace synthetic fertilizers. Prices of synthetic fertilizers have increased by 400% in the last few years, making them unaffordable for many home gardeners, farmers small and large in the U.S. and the rest of the world.

SAFE: Pasteurized urine meets EPA guidelines as a Class A biosolid material. It is pathogen-free and can be safely and legally used as fertilizer on all crops.

HYGIENIC: no splashing, no odor

RELIABLE: Never fails. Keeps urine reliably contained, out of the waste stream and environment. Provides a continuous, reliable and local source of fertilizers.

LOW TECH, DURABLE & AFFORDABLE: Easy to install, easy to maintain, and low-cost. Urinals have no mechanical or electrical parts. Urine-diverting toilets have a small electrical fan. Made of durable polypropylene, UV stable plastic.

SOCIALLY EQUITABLE: Everyone produces and has access to the same amount of nutrient rich urine-based fertilizer at no cost.

IMPROVES EFFICIENCY IN SEWER PLANT: Less energy use, fewer GHG emissions, reduced sludge, reduced use of chemicals, greater capacity, simpler processes.

REDUCE GREENHOUSE GAS EMISSIONS: Sewers and I/A septic systems emit lots of GHG emission from materials, construction, maintenance and decommissioning. They are unsustainable because they waste all nutrients, which all have to be replaced for food and other agricultural production.

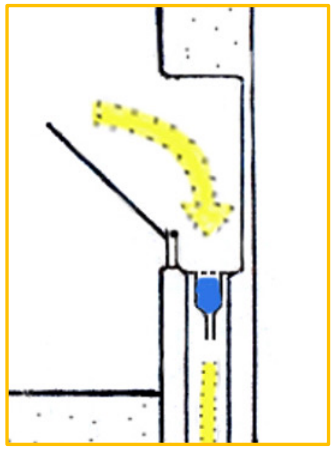
Production of synthetic fertilizers from natural gas and mining of phosphates are both extremely energy intensive. All emit lots of CO2, methane and nitrous oxide.

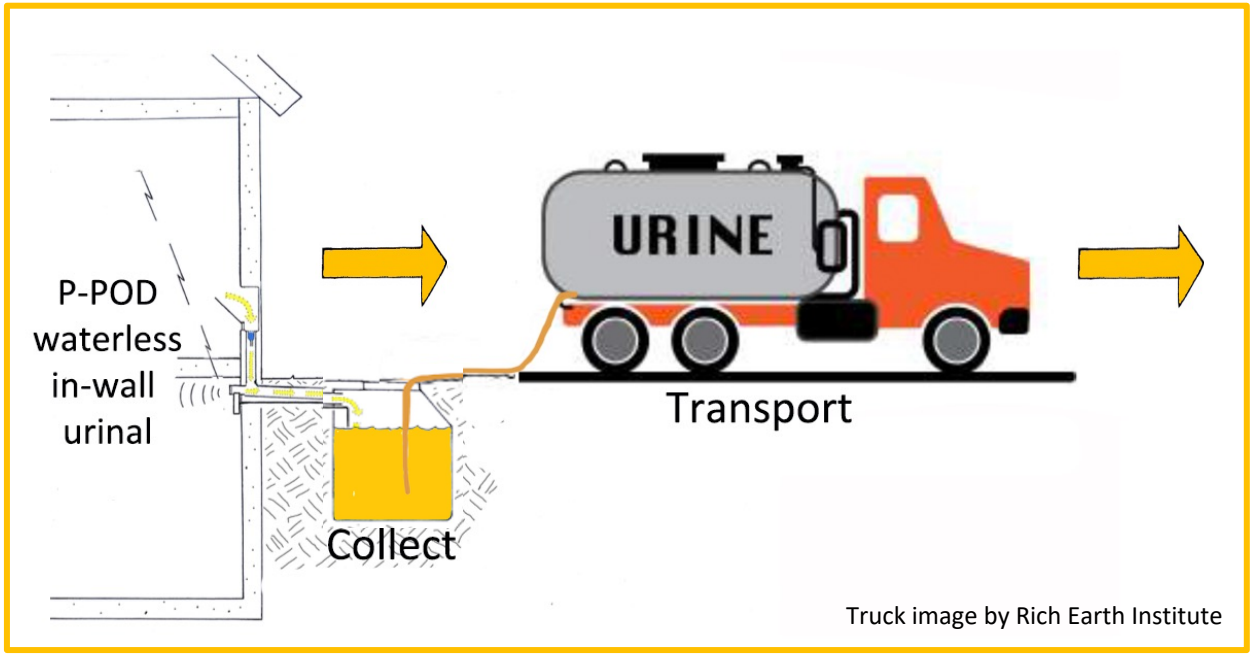
DO THIS FIRST!

Collect Male Urine

- Removes 40% of nitrogen from waste stream
- Removes 27% of phosphorus from waste stream
- Saves 2000 gallons/pers/year on drinking water
- Produces nitrogen and phosphorus rich fertilizers

P-POD waterless In-wall urinal,
with one-way silicon curtain valve





Truck image by Rich Earth Institute

TWO AFFORDABLE WATERLESS URINALS

The "CUBIE"

PORTABLE NUTRIENT-RECOVERING, WATERLESS, UNISEX URINAL SYSTEM

No odors
Ball seals opening

Faucet spout for no-touch pouring

This urinal was developed by the Rich Earth Institute, Brattleboro, VT.
https://richearthinstitute.org

Can be obtained and used immediately
No odors, no splashes.
Urine can be used as fertilizer in the home landscape and/or stored in a container in the basement or outside. Licensed hauler picks up urine for treatment.

Any person diverting their urine removes 80% of nitrogen and 55% of phosphorus from their contribution to the waste stream

Saves 4000 gallons of water/pers/year

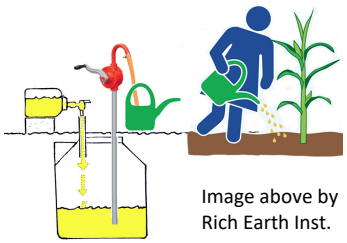
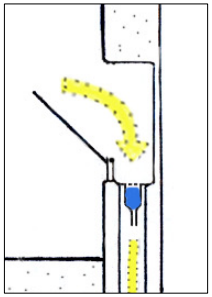


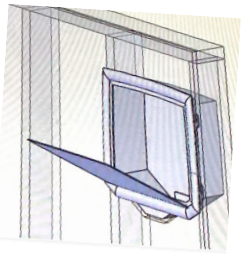
Image above by Rich Earth Inst.

The "P-POD"

IN-WALL, NUTRIENT-RECOVERING, WATERLESS, URINAL SYSTEM



No odors
One-way curtain valve seals opening



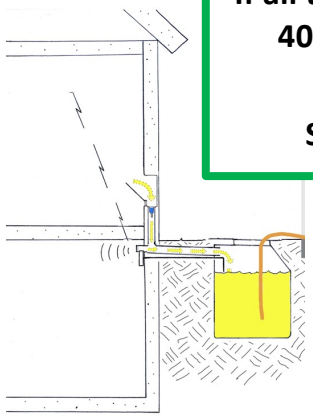
body 16" h x 11.5"w x 4"d
bezel 13.5" h x 11.75"w

This innovative product does not exist anywhere on the market and has been developed by the Green Center, Inc.

Ready for production
No odors. No splashes.
Urine is directed to storage container in basement or outside.
Licensed hauler picks up urine for treatment.

If all the males in a population divert their urine 40% of nitrogen and 27% of phosphorus is diverted from the waste stream

Saves 2000 gallons of water/pers/year



Level sensor sends digital message to hauler when tank is about 70% full.

All storage tanks will have a liquid level sensor.

OTHER URINE DIVERTING FIXTURES

URINE-DIVERTING (UD) TOILETS
with or without water for flushing

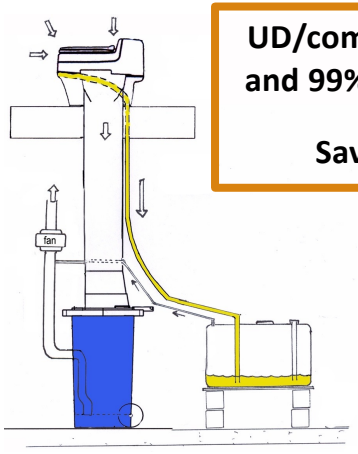
"Separett"
https://separett.com
waterless
UD + composting toilet

"Pee Toilet"
www.toiletsforpeople.com
sit-down pee-only toilet
waterless

"Wostman"
https://www.wostman.se
UD flush toilet
urine is diverted
solids are flushed

"Separett" UD/composting toilets

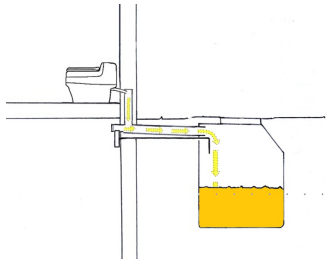
- **Solids collect in bucket lined with compostable bag under seat or in modular bin in floor below for further treatment**
- **Urine collects in storage container in basement or outside in in–ground tank**



"Greenway" UD composting toilet

UD/composting toilets remove 90% of nitrogen and 99% of phosphorus from the waste stream.

Save 6000 gallons of water/pers/year.



"Separett" composting toilet

WATERLESS INCINERATING TOILETS
burn all human waste

"Cinderella" urinal
waterless
urinal toilet

"Cinderella" incinerating toilet
https://www.cinderellaeco.com

- **Permitted as the only toilet in a house**
- **No variance required**
- **Can be approved by local plumbing board**
- **Solves ALL nutrient pollution problems**
- **No I/A septic systems or sewers needed**
- **Produces 1 cup of ashes/week/4 people**
- **Ashes contain all minerals except nitrogen**

Incinerating toilets remove 90% of nitrogen and 99% of phosphorus from the waste stream.

Save 6000 gallons of water/pers/year.

Most of the energy used by incinerating toilets is to evaporate the liquid of the urine.

When any urine is diverted by using a "Cubie", "Pee-Toilet", "P-POD" urinal or "Cinderella" urinal toilet, the incinerating toilet uses much less energy and nitrogen from the urine is saved.

TREATMENT OF URINE

to eliminate odors, pathogens & pharmaceuticals

Home-Scale Treatment

to reduce odors

Before filling Cubie with urine best to add 1 cup vinegar. This will stabilize the urine and stop ammonia from forming.

After each use, one spray of vinegar on inside of funnel keeps funnel fresh.

Home-Scale Treatment

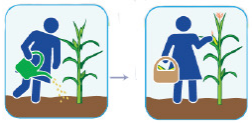
to destroy pathogens

Store urine in closed container for 6 months; pH goes up to 9.5 in a few days which kills pathogens. (2004-2006)

Recent studies suggest that storage time for safe urine reuse is 2 months. (2009)

Home-Scale Use Without Treatment

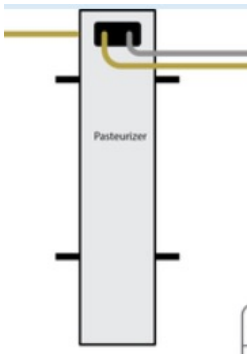
fertilizer in garden or landscape



No storage treatment of urine is needed to fertilize crops within the same household collecting the urine, as long as crops that are eaten raw are not harvested within a month of fertilization. The risk of direct disease transmission within the household is far larger than the risk from using urine to fertilize crops *["Urine diversion – hygienic risks and microbial guidelines for reuse"] by Caroline Schönning (2003) https://www.who.int/water_sanitation_health/wastewater/urineguidelines.pdf*

Community-Scale Treatment

to destroy pathogens & viruses



Urine pasteurizer

Urine becomes an EPA Class A material and safe fertilizer for ALL crops after it has been heated for 3 minutes at 171 F

Cost: $0.01/gallon

Developed and image by https://richearthinstitute.org

Pharmaceuticals

in Crops Grown with Urine Fertilizer

University research over 6 years studying 26 pharmaceuticals showed that:

Pharmaceuticals are present in urine, but when applied as fertilizer, urine enters a complex and biologically highly active soil ecosystem, where it can remain in the active topsoil zone for weeks or months, allowing time for any pharmaceuticals to be biodegraded.

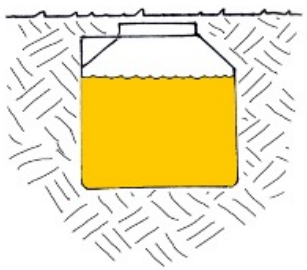
- Pharmaceuticals found in the crop tissues are extremely small, found in parts per billion These quantities are not a significant risk to human health.
- Pharmaceuticals in the soil were found in parts per billion
- Pharmaceuticals in the groundwater below were found in parts per trillion

Reference: "Analysis of Pharmaceuticals in Food Crops Grown in Urine- and Struvite- Fertilized Soil ..." University at Buffalo, Rich Earth Institute, University of Michigan

Community-Scale Urine Infrastructure

1 - Transport to local sewer plant for further treatment. Nutrients wasted.
2 - Transport to "Urine Depot". Pasteurize. Transport to farmers as Class A fertilizer
3 - Transport to "Ecodrum" in-vessel composter
- Combine with landscape & food wastes. Produce compost fertilizer

Three Ways to Treat Collected Urine



Collected Urine

1

2

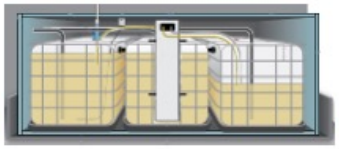
3

SEWER

TRANSPORT

Nitrogen, Phosphorus, heavy metals, toxic waste in sludge

To incinerator and toxic waste dump



URINE DEPOT

+ pasteurizer $24,000
Cost to pasteurize urine $0.01 per gallon

TRANSPORT

$17.-- to transport one person's annual urine volume to farms and fields up to 70 miles away

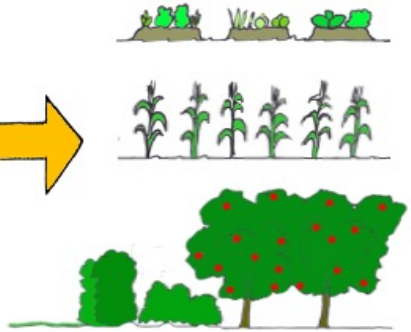
Agriculture

"ECODRUM" COMPOSTER

Urine is mixed with landscape, agricultural, animal and/or food wastes
Pathogens are destroyed by temperatures of 151F for 3 days

COMPOST

EPA Class A fertilizer



CONSERVE FRESH WATER

2000 gallons per person per year
to flush 15 gallons of feces

4000 gallons per person per year
to flush 120 gallons of urine

6000 gallons per person
per year greywater
(showers, laundry, cooking etc.)

6000 gallons of flush water is mixed with 6000 gallons of greywater to produce 12,000 gallons of wastewater per person per year.

Waterless urinals save 4000 gallons per person per year.
Waterless composting toilets save 6000 gallons per person per year.

135 gallons of human waste contaminates 12,000 gallons of water per person per year.

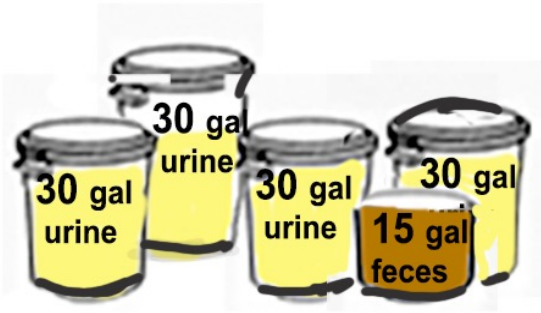
Average yearly volume of urine and feces of one person

URINE
120 gallons

8 lbs nitrogen
0.75 lbs phosphorus

FECES
15 gallons

2 lbs nitrogen
0.65 lbs phosphorus



Urine is the main source of nitrogen and phosphorus pollution in waterways.
It is only 1% of the waste stream
but contains 80% of the nitrogen and 55% of the phosphorus in the waste stream.

For Climate's Sake: Stop the Waste!
Stop the waste of nutrients, water and energy.
Close the nutrient cycle.

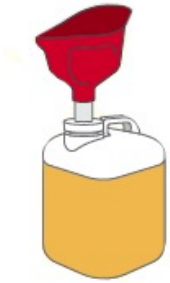
There is no time to waste.

GREEN CENTER UD PILOT STUDY

60 participants in 42 homes

Waterless unisex "Cubie" Urinals and "Pee-Toilets"

In August 2023 volunteer participants came to pick up and pay for their cubies ($80.-) and drum ($25.-).



Over a two-month period, participants collected urine using portable unisex urinals called "Cubies".

55-gallon drums for urine storage

The collected urine was transferred into 55-gallon plastic barrels which were stored on their properties.

After two months MASSTC (Massachusetts Alternative Septic System Technology Center)
- measured the urine volume of each barrel
- mixed the content and took urine samples
- send samples to Barnstable Water Quality Laboratory for total nitrogen and total phosphorus concentrations

Cost for the above services: $167.--/household, paid by each participating household

Interim Report

Early results from 32 households after 2 month of urine collection

Average number of participants per home: 1.4
Average amount of urine collected per home: 31 gallons
Average amount of nitrogen diverted per home: 1.7 pounds
Average amount of nitrogen diverted per person: 1.3 pounds

Interim Report

Extrapolated to one year of urine collection

Urine volume per home: 186 gallons
Nitrogen diverted per home: 10.2 pounds
Nitrogen diverted per person: 7.8 pounds

Final Report including test results from all 42 households expected at the end of 2023

For more information contact us at info@thegreencenterinc.com

Falmouth's 2012-2014 Eco-Toilet Demonstration Program

Tested efficacy of composting toilets in reducing septic effluent nutrient concentration

Falmouth tested the efficacy of different kinds of composting toilets for 2 years

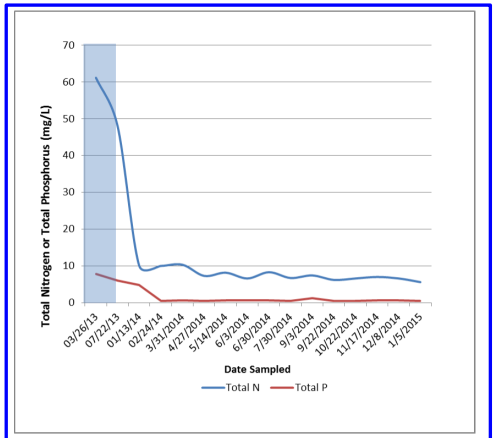
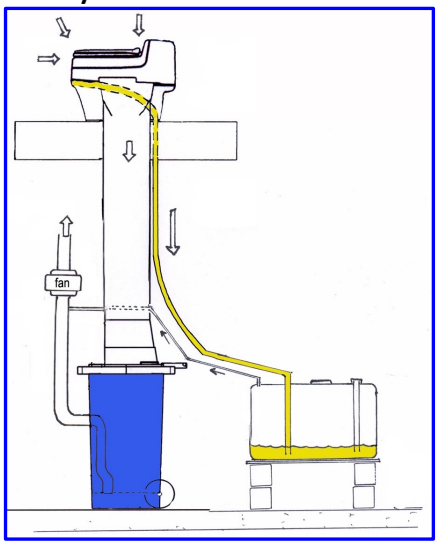


Figure 1. Total Nitrogen (TN) and Total Phosphorus (TP) concentrations in wastewater effluent before and after composting eco-toilet installation.

The best urine-diverting composting toilets,
such as this Greenway urine diverting/composting toilet →

diverted 90% of the nitrogen and 99% of the phosphorus
←from the home's wastewater.



Falmouth's Proposed Urine Diversion Pilot Project

To test efficacy of urine diversion in reducing septic effluent nutrient concentration

Falmouth is planning a pilot project to test several different kinds of urine-diverting fixtures in 50 homes for 3 years.

The project will:
- install (with subsidies for the homeowners) urine-diverting fixtures and urine collection tanks
- measure urine collected, pounds of nitrogen and phosphorus diverted, water conserved
- measure reduction of nutrient concentration in the wastewater effluent from the homes
- determine costs of urine infrastructure
- project how urine-diversion can be used in towns' watershed plans
- measure water use before and after UD fixture installation (most are waterless)

Anyone living in Falmouth (or other town on Cape Cod) interested in participating in this UD pilot project, please email us at falmouthudstudy@gmail.com

LINKS to more information:

Vimeo video - “Join the Pee Cyclers”
https://vimeo.com/871580556?share=copy

YouTube - “Cape Cod’s Water Problems”
https://www.youtube.com/watch?v=CpWEqeCDvKs

WCAI radio audio podcast – urine diversion – Green Center and MASSTC – 8/23/23
https://www.capeandislands.org/show/the-point/2023-08-23/recycling-urine-to-solve-our-wastewater-problem?_amp=true

Rich Earth Institute, Brattleboro, VT.
https://richearthinstitute.org

New York Times 6/17/22 “Meet the Peecyclers”
https://www.nytimes.com › 2022/06/17 › climate › peecy...

New York Times 1/1/23 “A Toxic Stew on Cape Cod”
Christopher Flavelle reports fo r the New York Times with photographs by Sophie Park January 1, 2023.

Nature 2/19/22 “The Urine Revolution”
https://mahb.stanford.edu/library-item/the-urine-revolution-how-recycling-pee-could-help-to-save-the-world/

Green Center, Inc.

https://newalchemists.net

Hilda Maingay
Earle Barnhart
info@greencenterinc.com

“It is our belief that ecological and social transformations must take place at the lowest functional levels of society if humankind is to direct its course towards a greener, saner world.”

New York Times 10.15.23 “How a Fertilizer Shortage is Spreading Desperate Hunger”.
https://www.nytimes.com/2023/10/15/business/nigeria-fertilizer-shortage.html?unlocked_article_code=_O7h6nfo0q1WexL6ovYpCkpH0o_k5WQhYFTGF07dS4T1I_DBIz2HRL4P_Ymh2Pvh1_wopFbKPPtVWidTRdcwcKJfQLhImpQtKJuM32UEQr1N7Mt3oCzI3JueEjBrmvQh1aeCQQgu-3iB1GI7HCVBkEOtfto0bz0Yr_mN6fJ5lqHoivLX4hwPrIBHz46R3ZcEMMk4MwRuF-JapY2MVQudWncPdQ8z68GJiy05jHNYO4bjj3OI7YZIyY71C_7y1bSsc__pFyj6E4FATLmwyBeqpe6xm_-IDIAVFzPruoDHNImxSd4t-3cu2aeV4pyw9R7C1KWORxbcRN8_WW2-qtc1jidWiWU5nmA&smid=em-share

Cinderella incinerating toilet
https://www.cinderellaeco.com

“Separett” urine diverting toilets
https://separett.com

“Wostman” urine diverting flush toilet
https://www.wostman.se

“Ecodrum” Composter
https://ecodrumcomposter.com