

# Nature Based Wastewater Treatment Systems in Hawaii and Coastal Areas

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# Ridge to Reefs: Organization Overview



**Paul Sturm**  
Executive Director



**Phal Mantha**  
Director of Agriculture & Sustainability



**Kelly Harris**  
Project Developer & Ecological Engineer



**Albert McCullough, PE, PWS**  
Ecological Engineer



**Aya Lindquist**  
Geographer and Project Manager

**Mission:** *We catalyze local capacity & develop nature-based solutions to create communities where connected human and natural systems thrive.*

**Our Work:** *We are based out of Sykesville, MD, with staff throughout the U.S and the Pacific and Caribbean regions.*



**Ricardo Liquet-Gonzalez**  
Agronomist



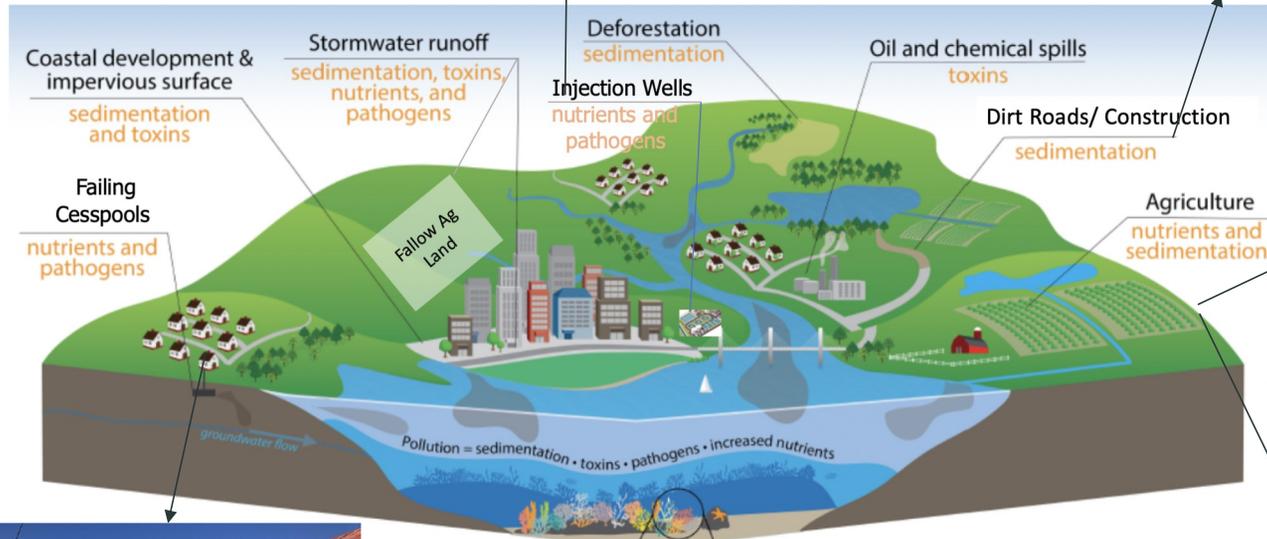
**Keith Ahsoon**  
Restoration Coordinator



**Mitchell Kleckner**  
Environmental Engineer

# Ridge to Reefs:

An applied "whole watershed" approach to mitigating land based sources of pollution.



## OUR VISION

- High quality nature based systems
- Provide safe, low-cost treatment, disposal and reuse of wastewater
- Focus on circular economies and reuse of “waste materials” for agriculture and water filtration
- Protect groundwater, coastal waters and coral reef health





## In this talk...

1. Wastewater and nutrient pollution projects
2. Reuse and advanced treatment of nutrient laden water from injection wells

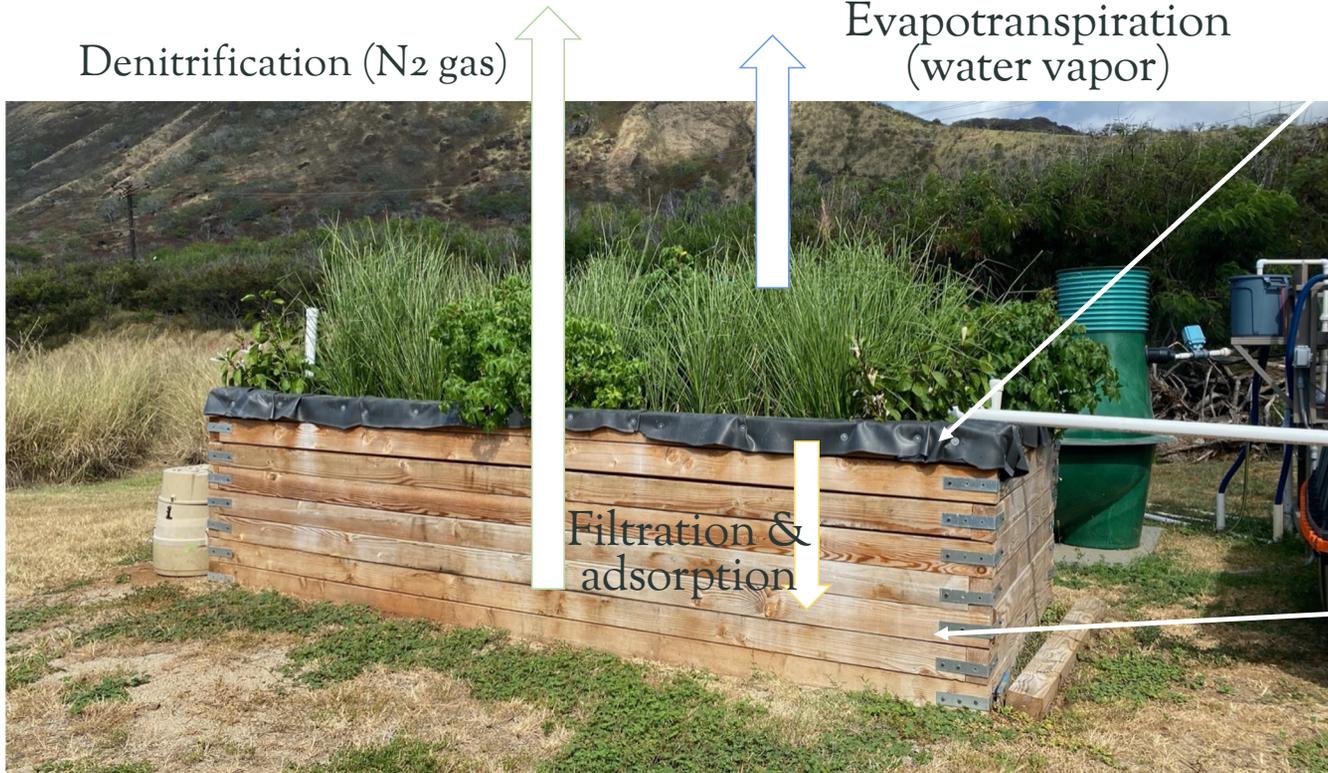
Testing these systems with University of Hawai'i and WAI to meet NSF Standards for N red ux certification



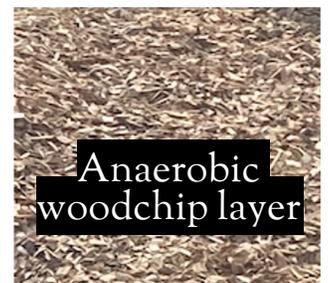
Tested these systems with University of Hawai'i and WAI to ensure they met NSF requirements for water quality and nitrogen removal



# Process

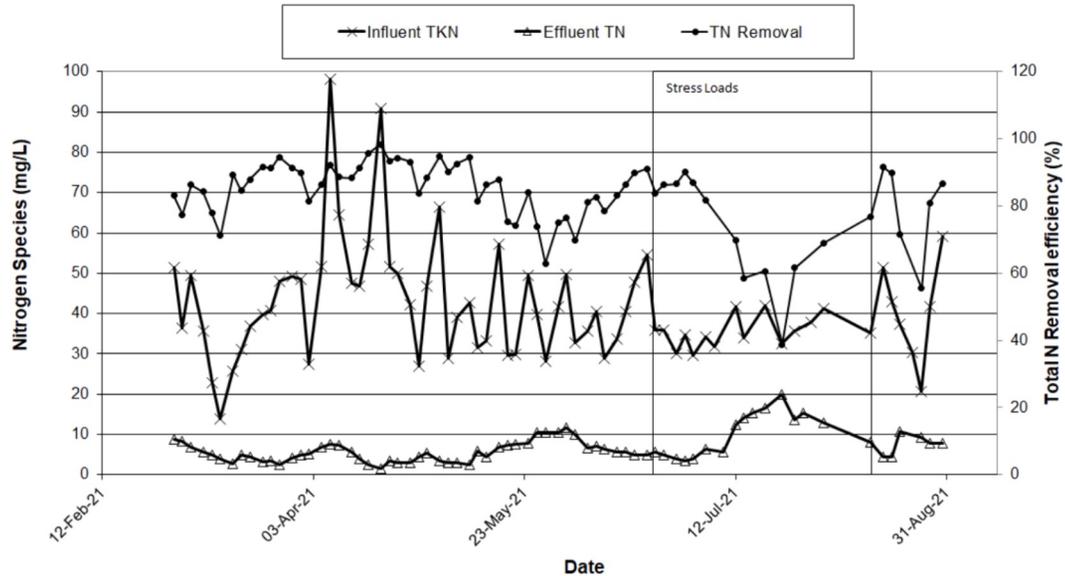


I. Nitrification ( $NH_4 > NO_2^- > NO_3^-$ )



2. Denitrification ( $NO_3^- > N_2$ )

## Reductions from the Univ of Hawaii Study with Dr. Babcock



- 87% Removal of Total Nitrogen

- 83% Phosphorus

- >15-20% Volume reduction \*

- 95% TSS removal

- Meets NSF 40 and 245

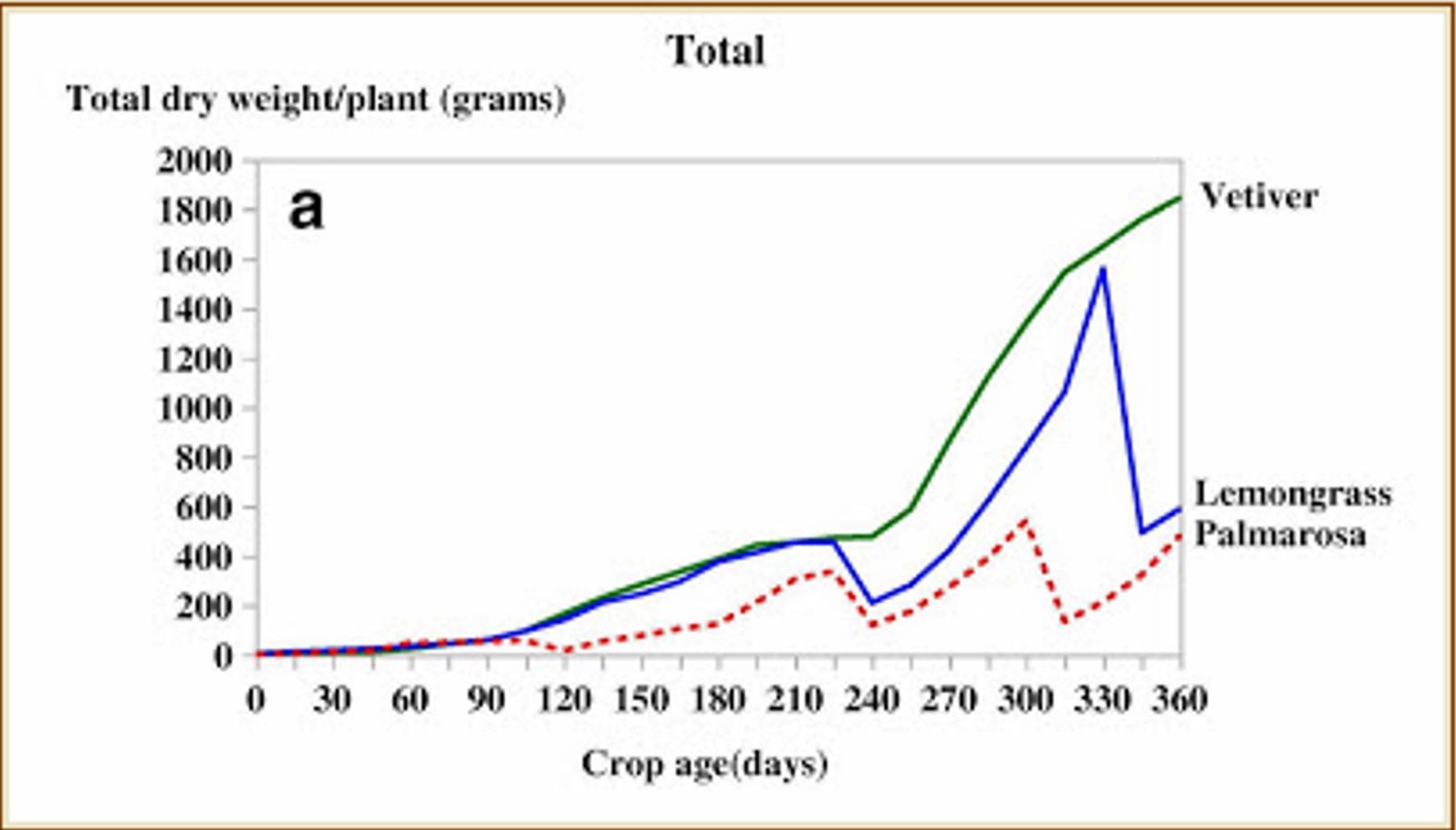
\* Determined at the end of the study with a mature system

## Benefits

- Native plants (for bees) and sterile “sunshine” vetiver grass
- use of woodchips “recycled” from invasive species
- Sequesters carbon
- no external energy source needed
- creates circular economies

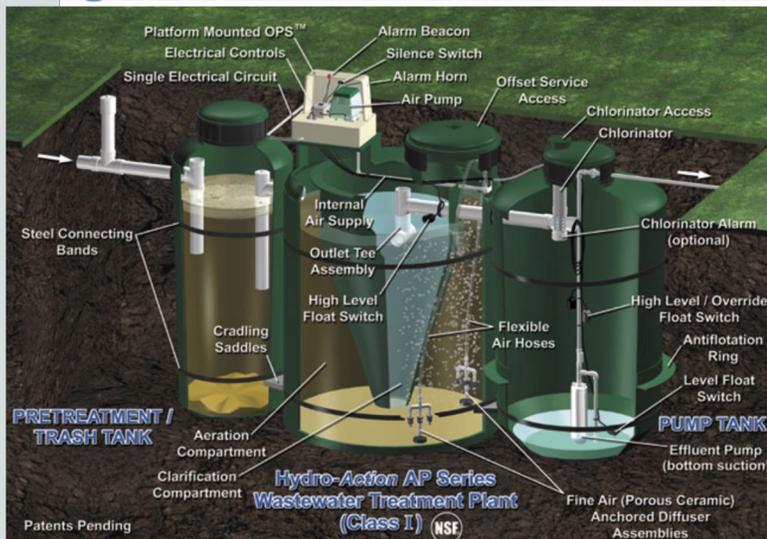
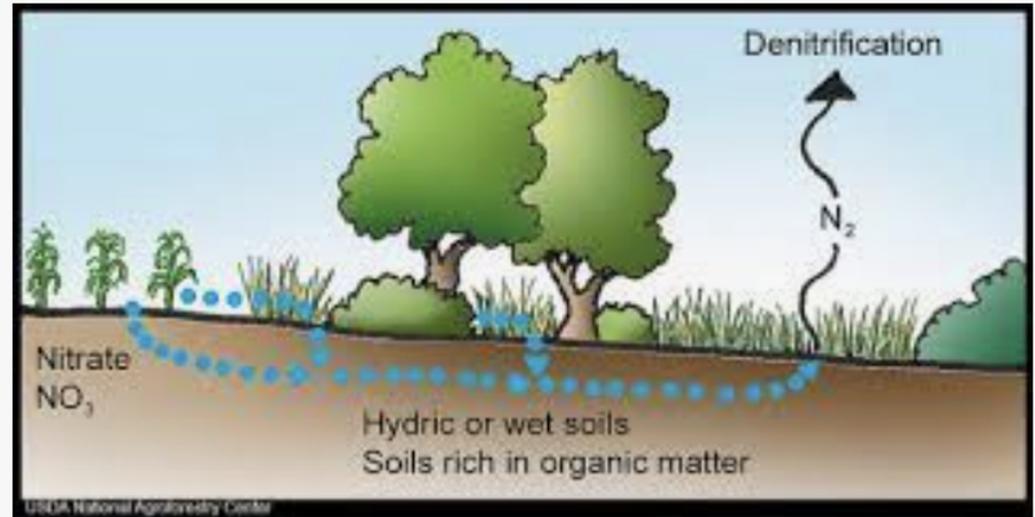


Vetiver grass does not have an annual cessation period

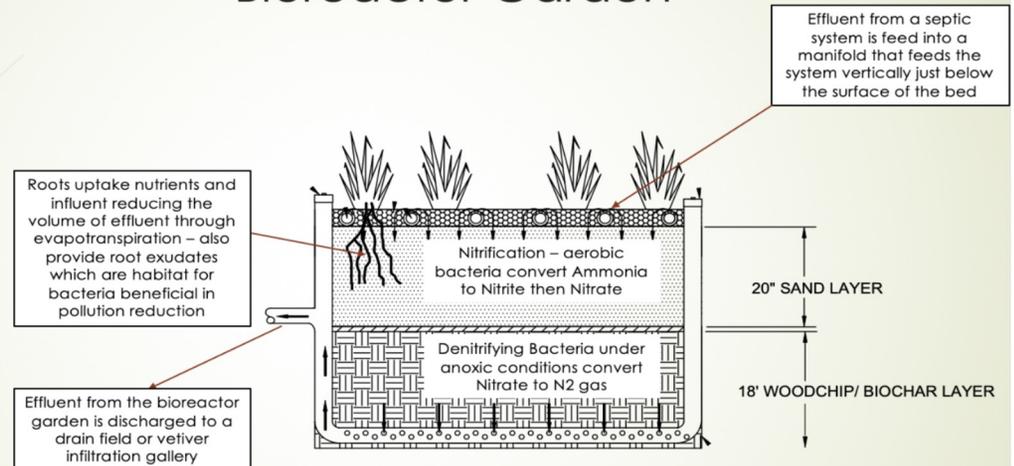


# Natural Treatment Processes vs Conventional Engineering

- Bacterial denitrification – mimic natural habitat and processes
- Filtration and incorporation – sand, biochar, other media
- Vegetation -- Phytoremediation, Evapotranspiration, Microbial Biofilms



## Bioreactor Garden

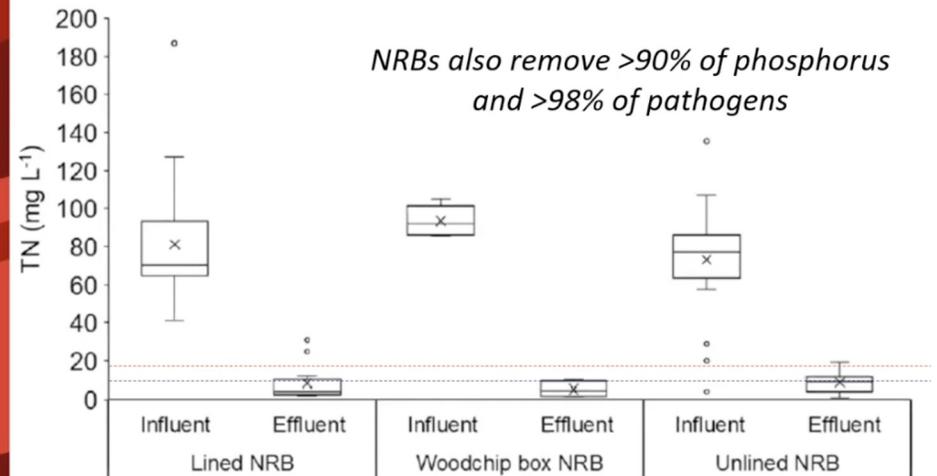


50 – 100% removal of two dozen drugs, pharmaceuticals, personal care products by NRBs in Suffolk County

Compound	Use	Removal (%)
Acetaminophen	NSAID	94 – 100
Caffeine	stimulant	99 – 100
Paraxanthine	human metabolite of caffeine	98 – 99
DEET	mosquito repellent	82 – 96
Nicotine	stimulant	92 – 97
Cotinine	human metabolite of nicotine	86 – 98
Sulfamethoxazole	antibiotic	85 – 97
Diphenhydramine	antihistamine	97 – 95
Trimethoprim	antibiotic	87 – 90
Ciprofloxacin	antibiotic	64 – 78
Atenolol	beta blocker	88 – 97
Metoprolol	beta blocker	85 – 90
Diltiazem	calcium channel blocker	76 – 90
Carbamazepine	anticonvulsant	51 – 60
Ketoprofen	NSAID	68 – 74
TCEP	flame retardant	60 – 70
Salbutamol	bronchiodialator	50 – 78
Ranitidine	anti-acid	82 – 100
Diclofenac	NSAID	76
Propranolol	beta blocker	98 – 100
Venlafaxine	antibiotic	98
Fluoxetine	antidepressant (SSRI)	64 – 66
Lamotrigine	anticonvulsant	82
Primidone	anticonvulsant	58

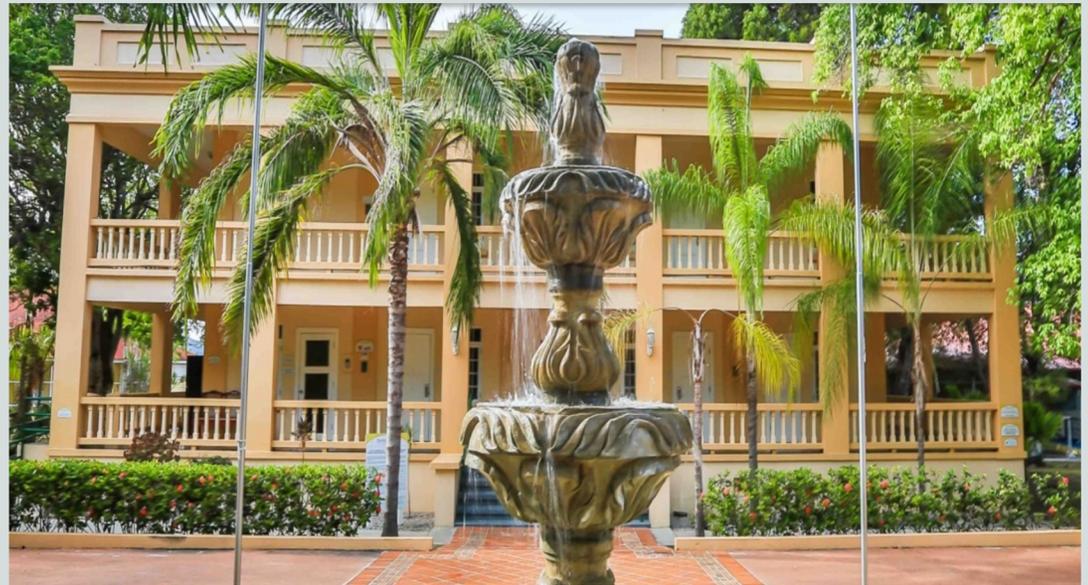
Data courtesy of Dr. Tricia Clyde

## Performance in Suffolk County



## Hotel Guánica 1929

- 27 Room Hotel and Restaurant
- Located on the shores of Guánica Bay in Puerto Rico
- Likely their septic system has been overflowing in Guánica Bay off/on for over 50 years
- Project created a treatment system that can handle ~ up to 6000 gallons per day



## Images from the Construction Process



## Rapid establishment- Images show the project after planting and after 2 months of growth



## Guánica 1929 Close Proximity to Guanica Bay and High Water Table



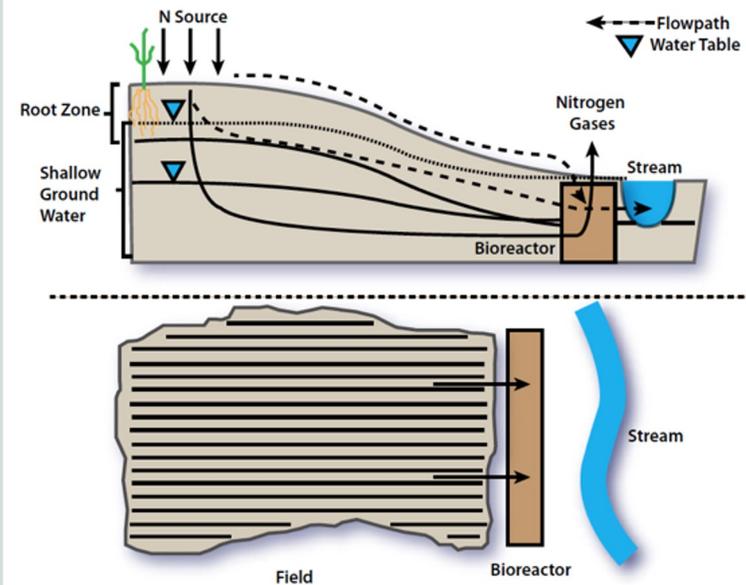


## Mt. Alava Elementary School Classroom Treatment System- Vatia, American Samoa



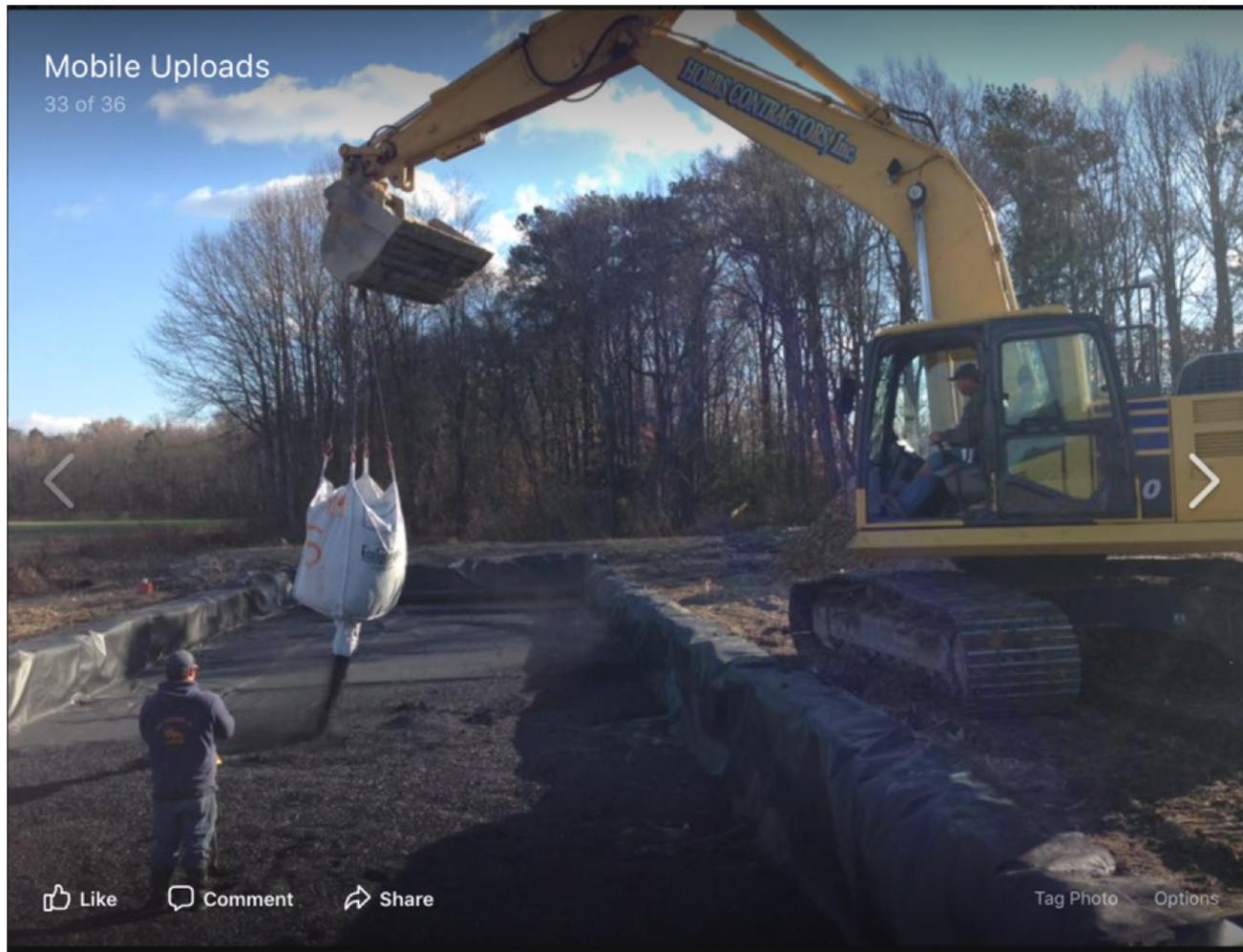
# Denitrification Curtains

- Intercept wastewater or shallow groundwater and filter through biochar, sawdust and woodchips and soil
- Vertical and horizontal flow
- Denitrifying bioreactor – often treat a larger drainage area and are lined





# Denitrifying Bioreactors



**Mason's Heritage Farm, Ruthsburg, MD NO3 (mg/l)**

Date	Box 1	Box 2	Reduction
8/8/14	28.56	0.00	100%
8/14/14	9.00	0.00	100%
8/20/14	7.80	0.00	100%
8/28/14	5.80	0.00	100%
10/16/14	14.30	0.00	100%
10/23/14	6.10	0.00	100%
11/21/14	26.90	0.00	100%
11/25/14	26.20	0.00	100%
12/4/14	7.60	0.00	100%
12/11/14	11.00	0.00	100%
12/19/14	7.20	0.00	100%
12/23/14	11.10	0.00	100%
1/2/15	8.40	0.00	100%
1/9/15	6.40	0.00	100%
1/15/15	9.50	0.00	100%
1/22/15	10.40	0.00	100%
1/29/15	10.30	0.00	100%
2/4/15	9.00	0.00	100%
2/12/15	8.80	0.20	98%
2/25/15	9.10	0.00	100%
3/10/15	5.20	0.20	96%
3/17/15	8.00	0.00	100%
3/25/15	9.50	0.00	100%
3/31/15	9.40	0.00	100%
4/10/15	9.00	0.00	100%
4/16/15	9.30	0.00	100%
4/22/15	10.20	0.00	100%

**Oakland View Farm, Ridgely, MD NO3 (mg/l)**

Date	Box 1	Box 2	Reduction %
8/20/14	16.20	0.00	100%
8/28/14	18.20	0.00	100%
9/5/14	14.40	0.00	100%
9/11/14	48.70	0.00	100%
9/17/14	19.50	0.00	100%
9/23/14	10.90	0.00	100%
10/8/14	5.10	0.00	100%
10/16/14	5.30	0.00	100%
10/23/14	0.90	0.00	100%
11/7/14	3.80	0.00	100%
11/21/14	1.30	0.00	100%
11/25/14	18.20	0.00	100%
12/11/14	5.80	0.00	100%
1/15/15	4.30	0.00	100%
1/22/15	8.20	0.00	100%
1/29/15	15.10	0.00	100%
2/4/15	10.10	0.45	96%
2/12/15	4.89	0.00	100%
2/25/15	2.34	0.00	100%
3/10/15	2.46	0.31	88%
3/17/15	10.64	0.58	95%
3/25/15	5.22	0.15	97%
3/31/15	3.08	0.06	98%
4/10/15	0.10	0.01	90%
4/16/15	1.34	0.01	99%
4/22/15	0.08	0.02	81%



## DISPOSAL / REUSE

- 1/3 acre test project site adjacent to the Kihei Wastewater Treatment Plant
- Used to grow non-invasive vetiver grass to take up and dispose of excess R-1 wastewater from the facility through evapotranspiration - (evaluating for the use of construction grade bamboo, hempcrete or other product substitutions for sustainable building)
- Monitors measure the amount of R-1 water supplied and any R-1 water that is not absorbed by the vetiver

## Vetiver plot – disposal of secondary wastewater, can be used w/ biochar for landfill leachate



## PROJECT RESULTS

Within 7 months of planting:

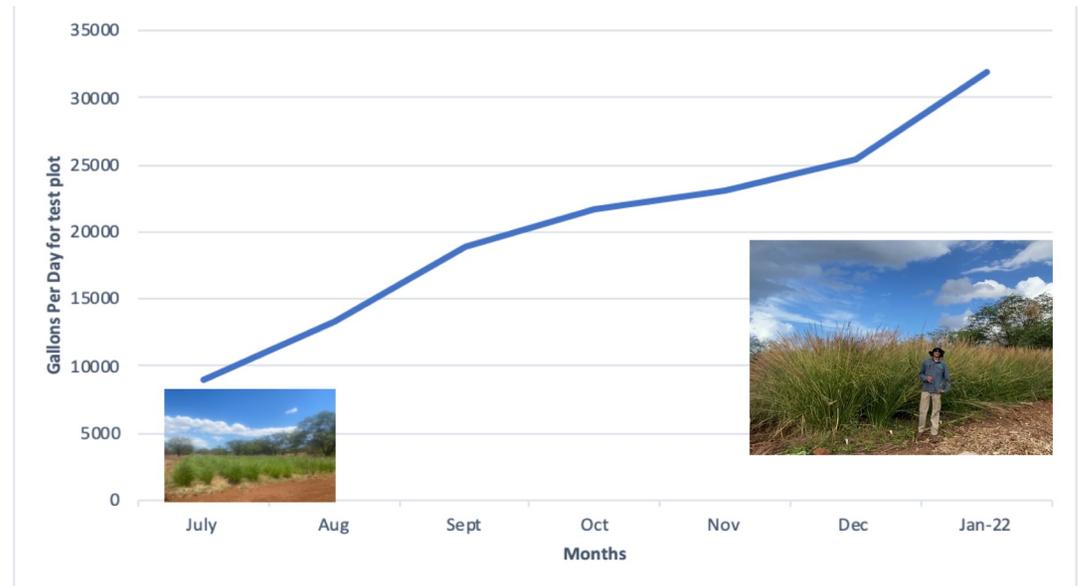
Reached target rate of disposing of 20,000 gallons of wastewater per acre per day

Within 10 months of planting:

Disposing more than 30,000 gallons of wastewater per acre per day



# A FAST SOLUTION TO MAUI'S WASTEWATER DISPOSAL CHALLENGES



Based on our measurements, our vetiver-based system can process 1 million gallons per day (MGD) per 30 acres.

An estimated 60 acres would divert **all 2 million gallons of unused R-1 treated wastewater** from South Maui injection wells each day.

# CONTACT INFO

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