# SUBMARINE GROUNDWATER DISCHARGE AND CORRESPONDING NUTRIENT FLUXES IN KANEOHE BAY, OAHU

SCHOOL OF OCEAN AND EARTH SCIENCE AND TECHNOLOGY
UNIVERSITY OF HAWAI'I AT MĀNOA

Geology & Geophysics

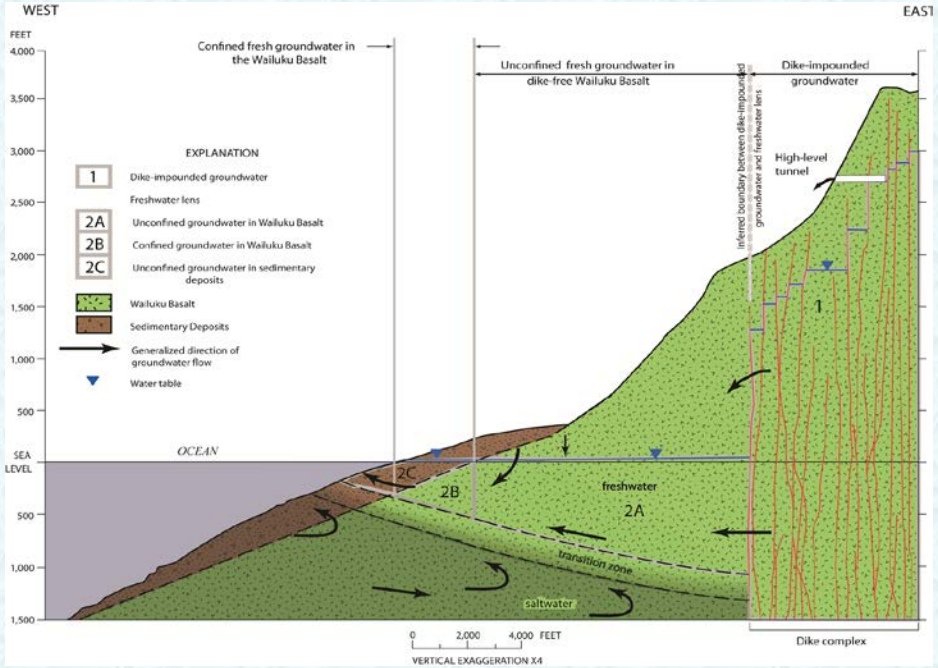

**HENRIETTA DULAI**

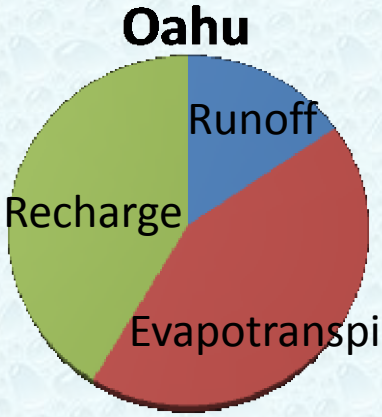
**A. KLEVEN, K. RUTTENBERG, R.A. BRIGGS, F.I. THOMAS**


**SESSION H, DECEMBER 2, 14:20**

# SGD COMPLETES THE WATER CYCLE

- Connects the ridge to the reef and creates a continuum between watershed and coast
- Relevance:
  - Terrestrial geochemical evolution of groundwater
  - Impact on coastal water quality and ecosystems




Rain $7.5 \times 10^6$ $m^3/d$

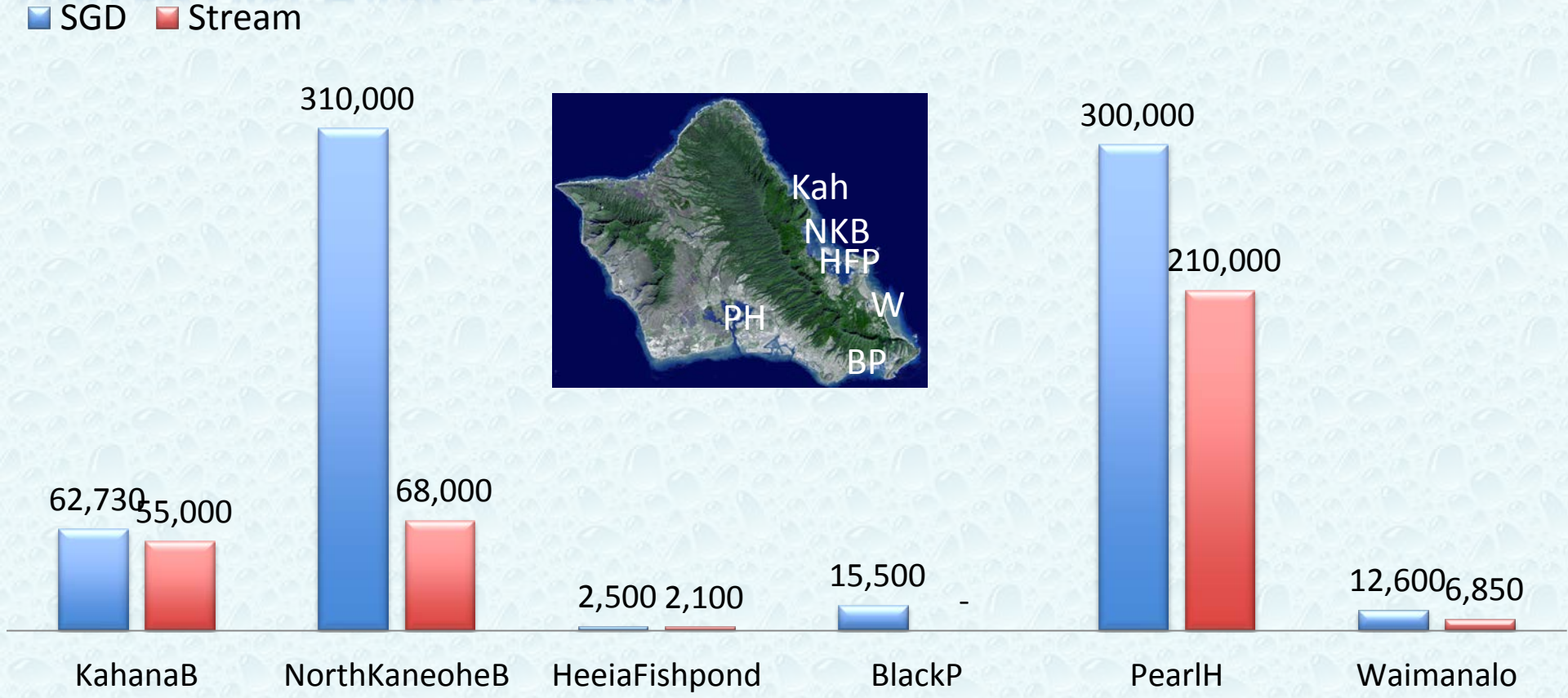

GWD $m^3/m/d$

GWD $m^3/d$

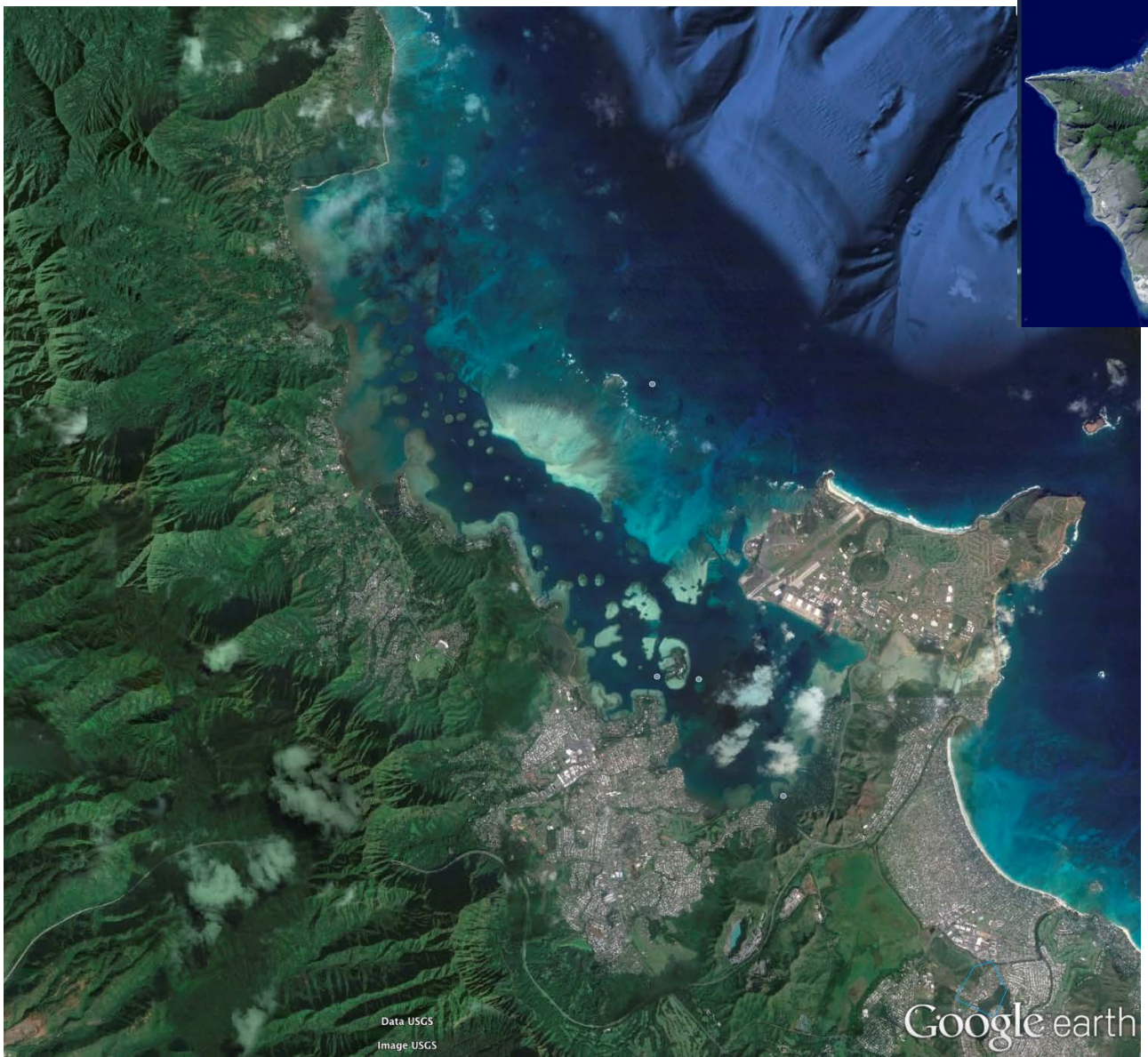
SHADE AND NICHOLS, 1996

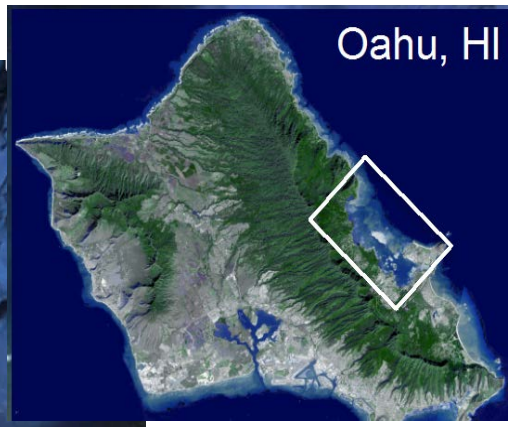
# SGD VS. STREAMS AT SELECTED SITES ON OAHU

## WATER DISCHARGE ($m^3/d$)



# KANEOHE BAY



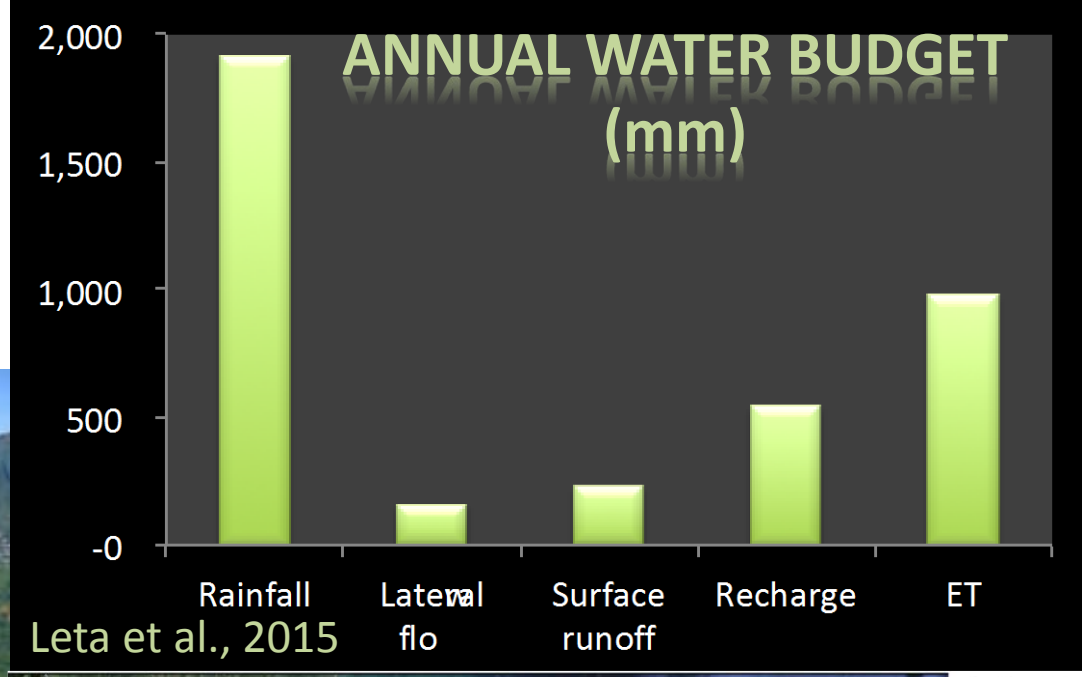



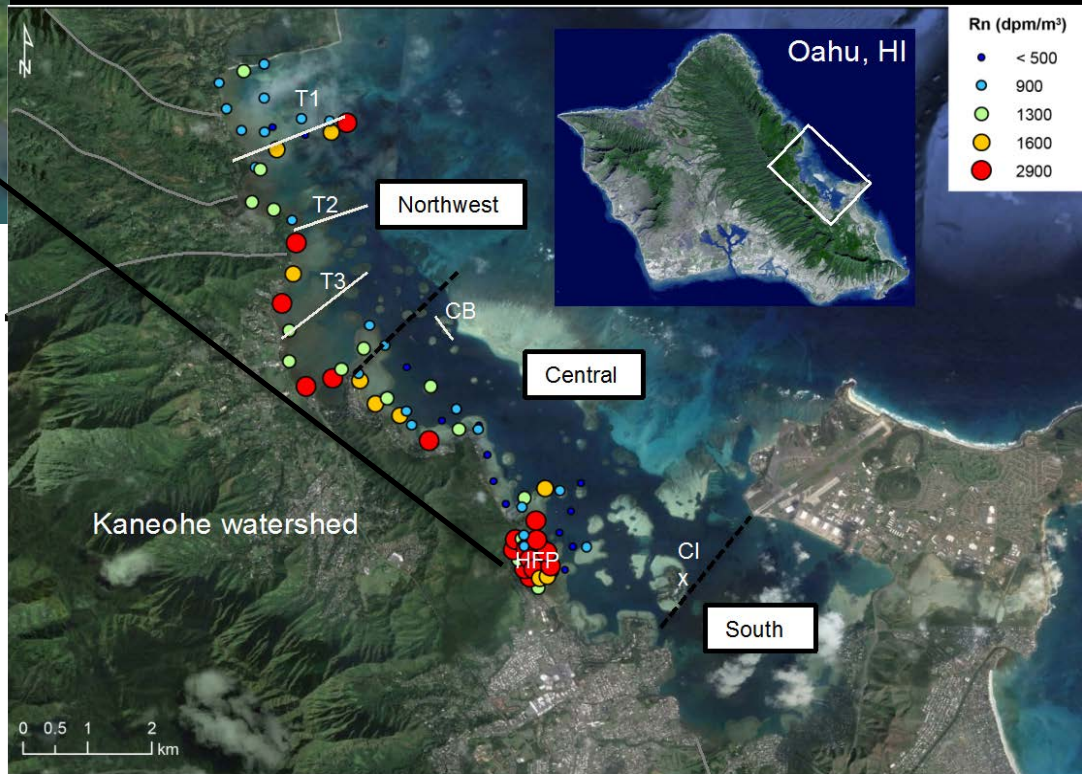
# WATER BUDGET

# HEEIA

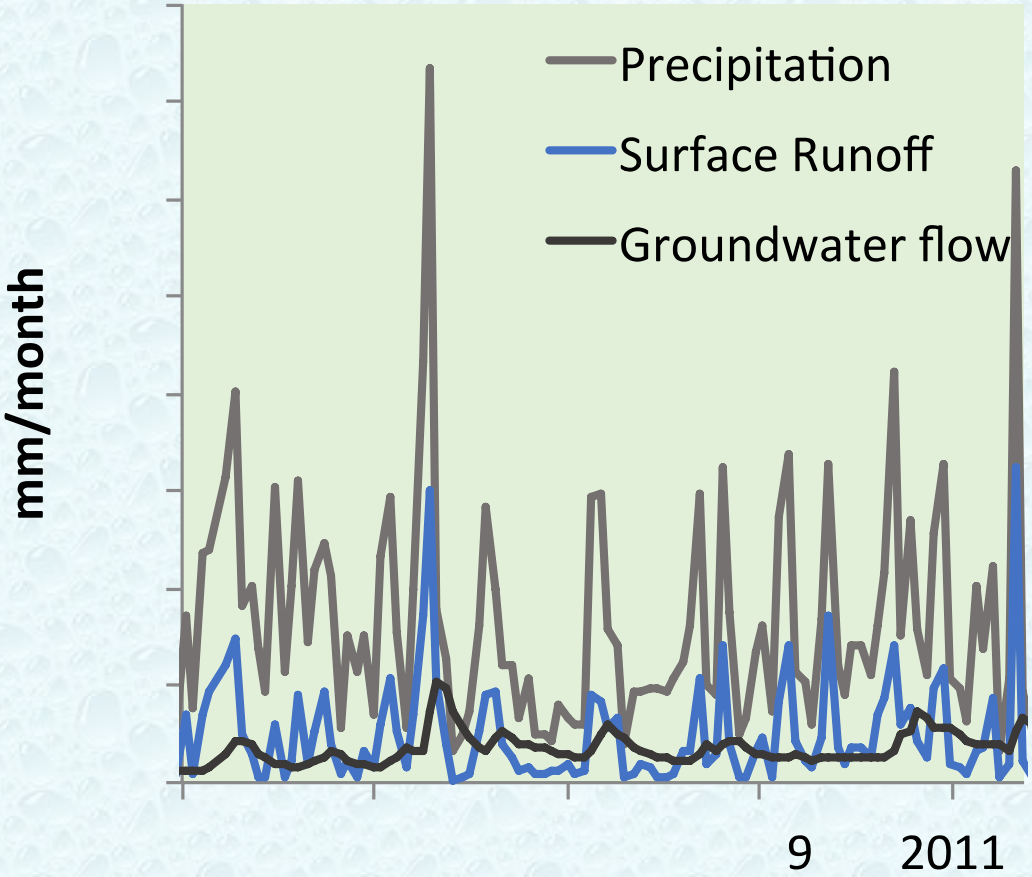
**Leta in Session N: Climate Change and Variability and…**

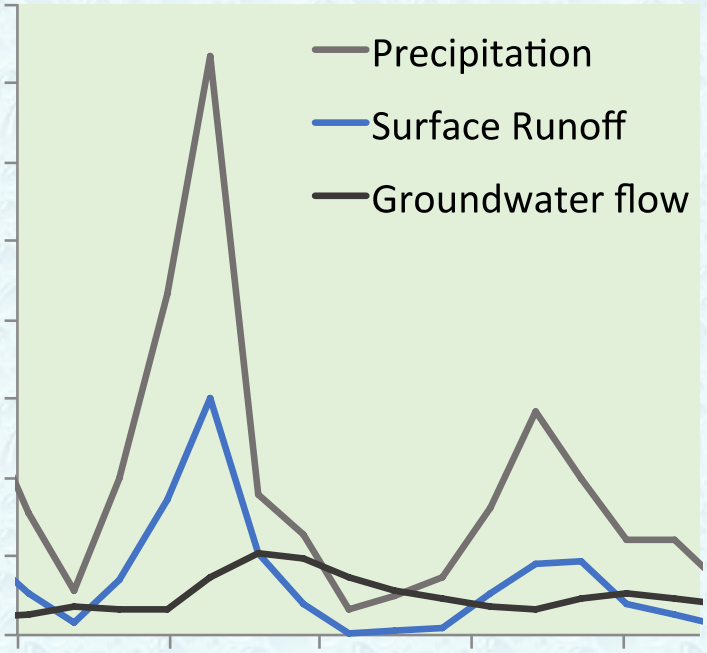
**Thu Dec 3 @15:10**



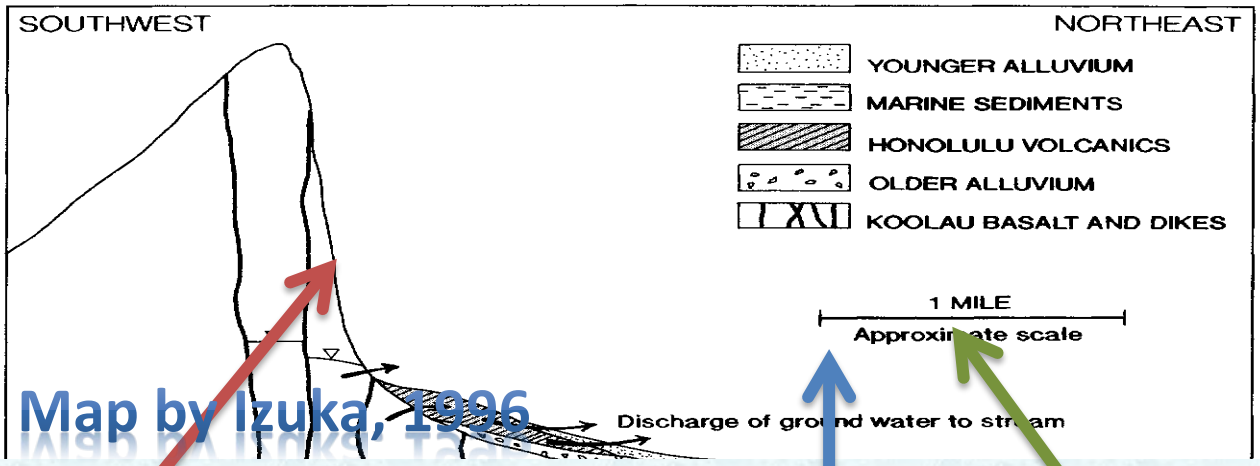
# SURFACE VS GROUNDWATER FLOW




Leta et al., 2015

# WHERE IS THE WATER COMING FROM? HOW OLD IS IT?



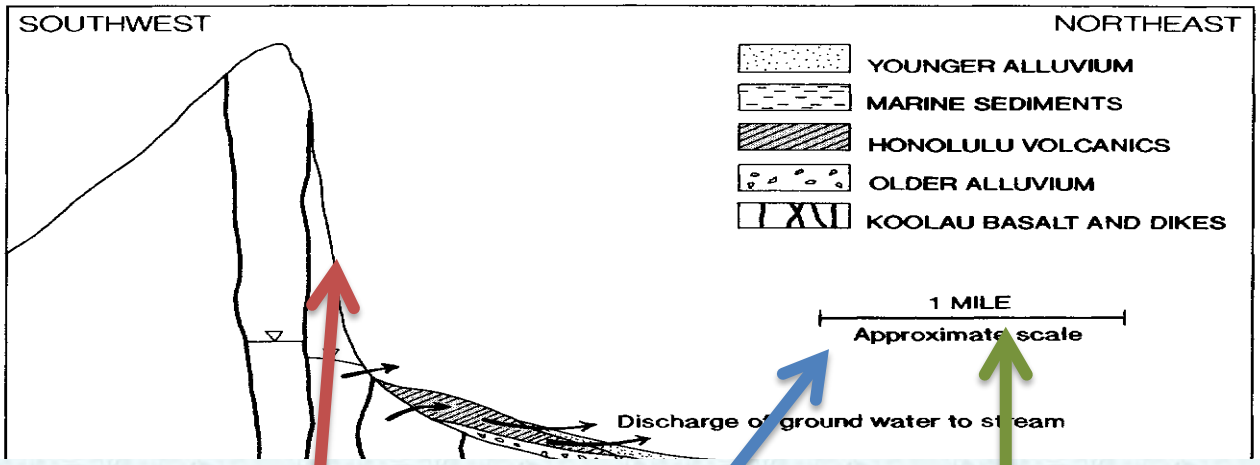

Map by Izuka, 1996

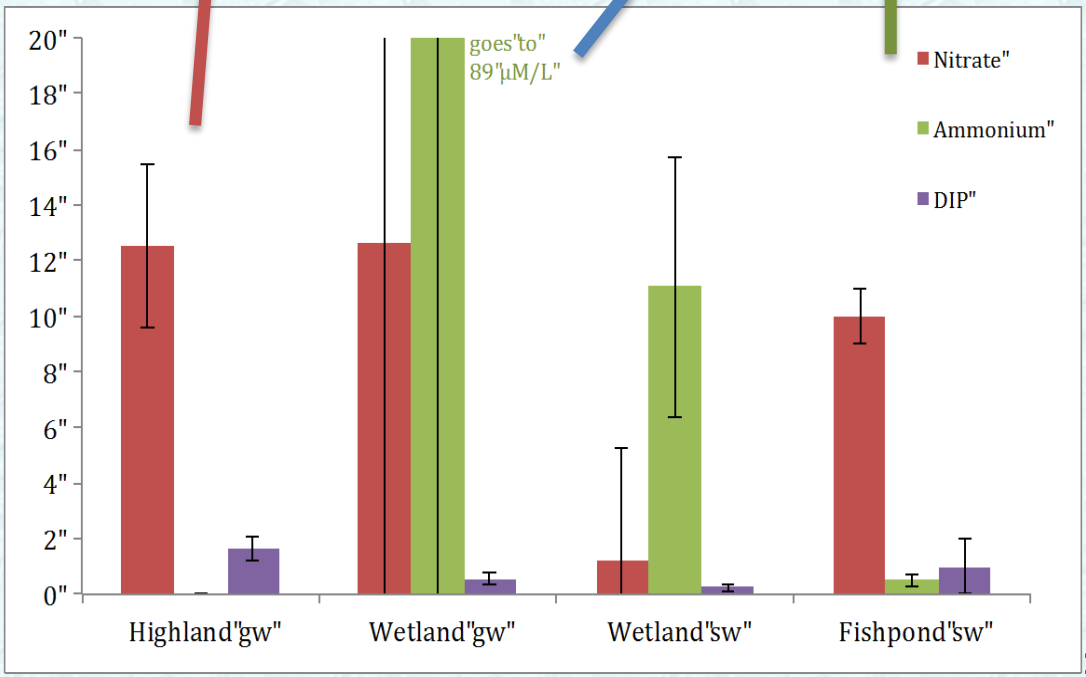
High-level aquifer - Wells, Springs
Water Age: 40 ± 5 yrs
Recharge elevation: 850 ± 150 m

Wetland groundwater
Water Age: 39 ± 15 yrs
Recharge elevation: 330 ± 250 m

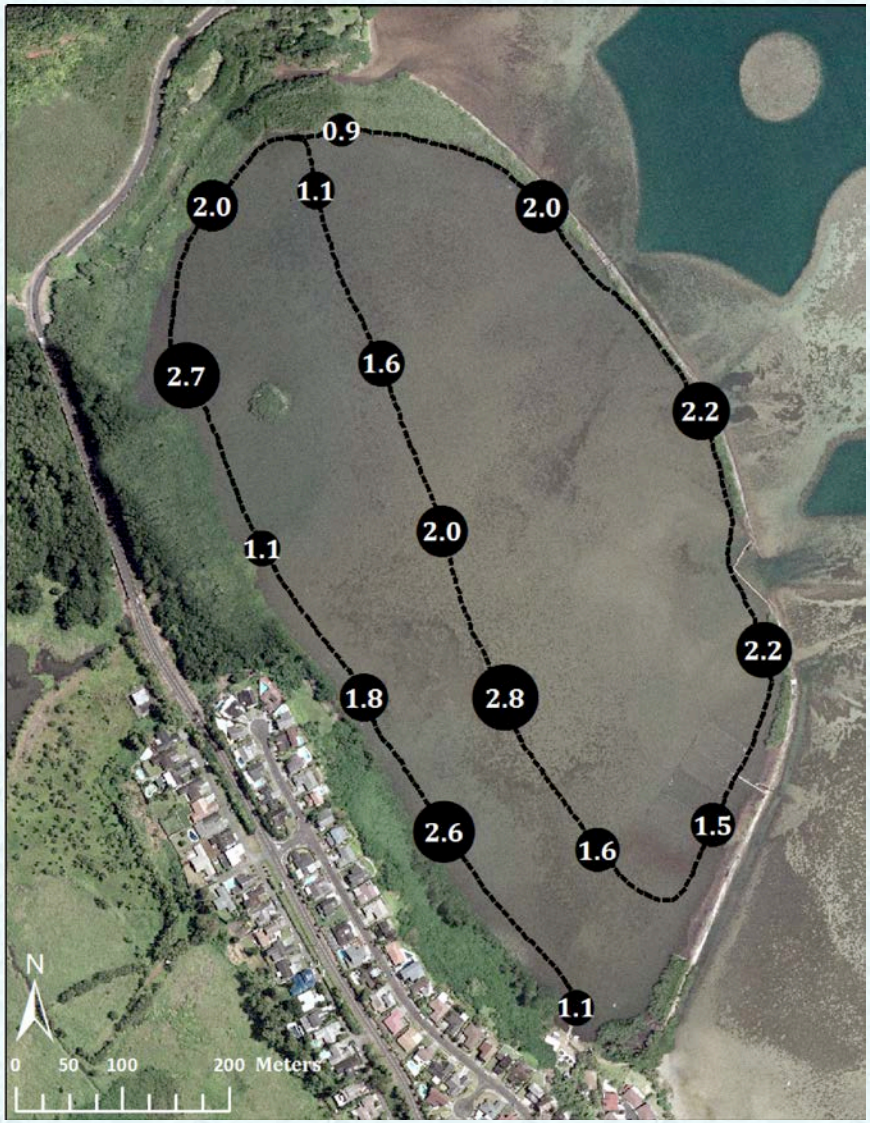
Wetland surface water
10-50 % groundwater fed
Recharge elevation: 420 ± 240 m

# EVOLUTION OF NUTRIENT SIGNATURES

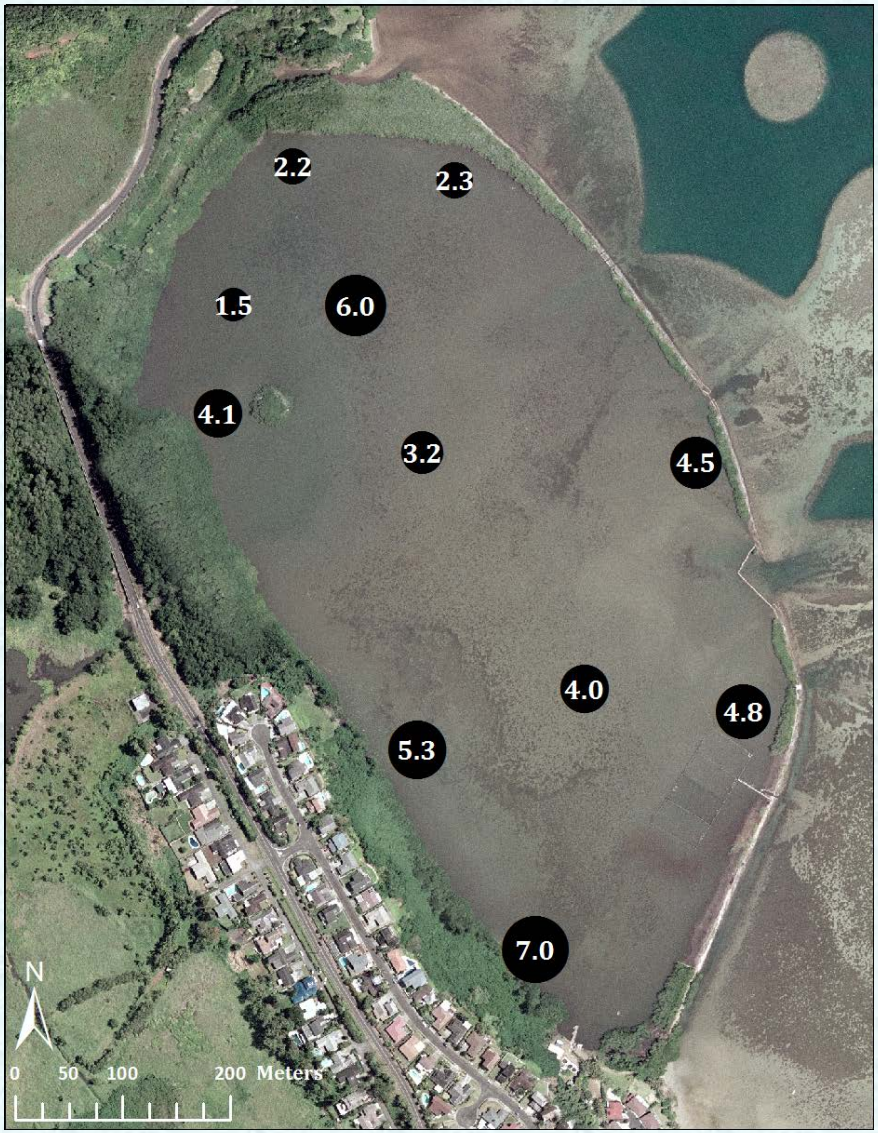


# RADON SURVEY

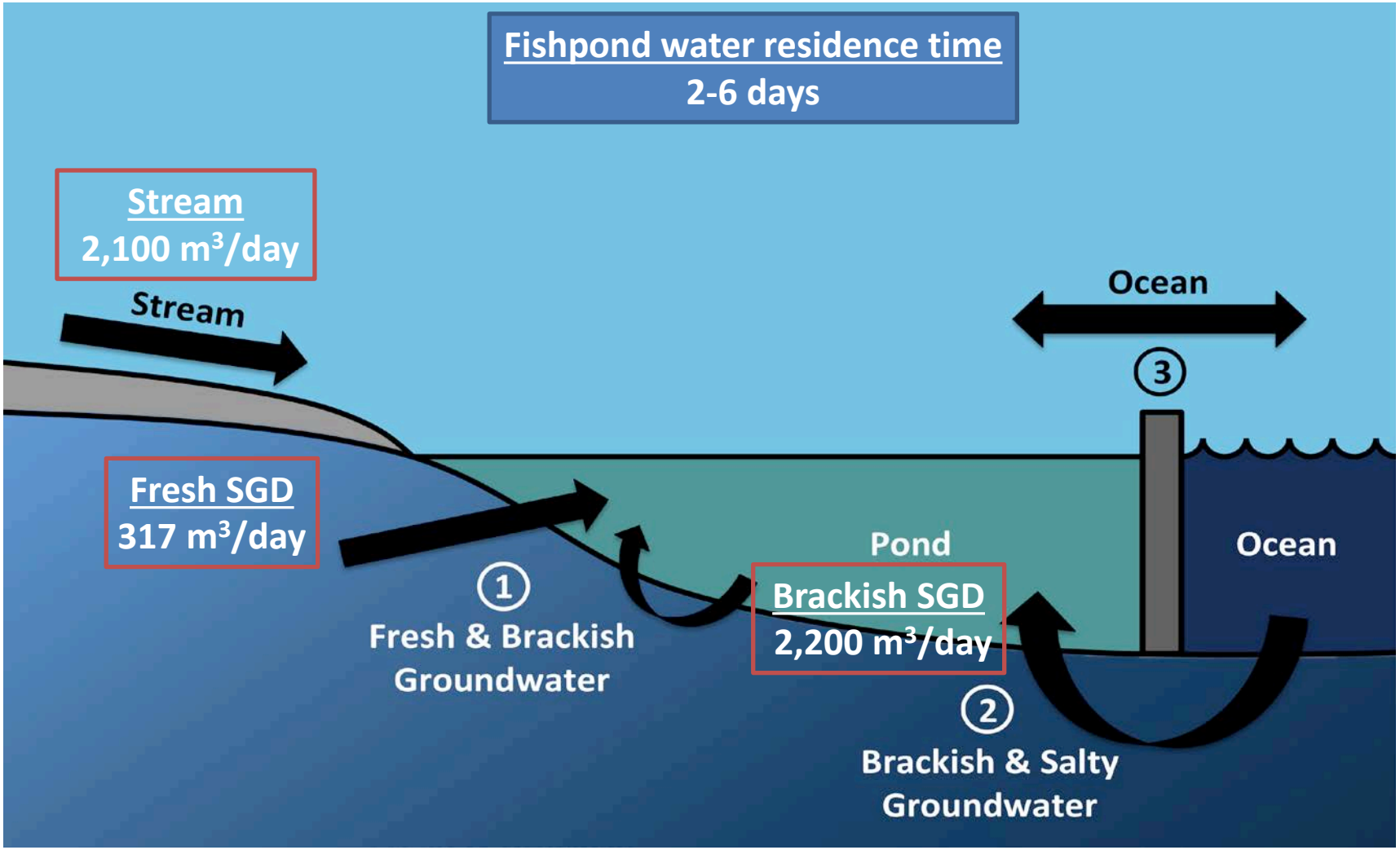



# WATER AGE (DAYS)




Kleven, 2014

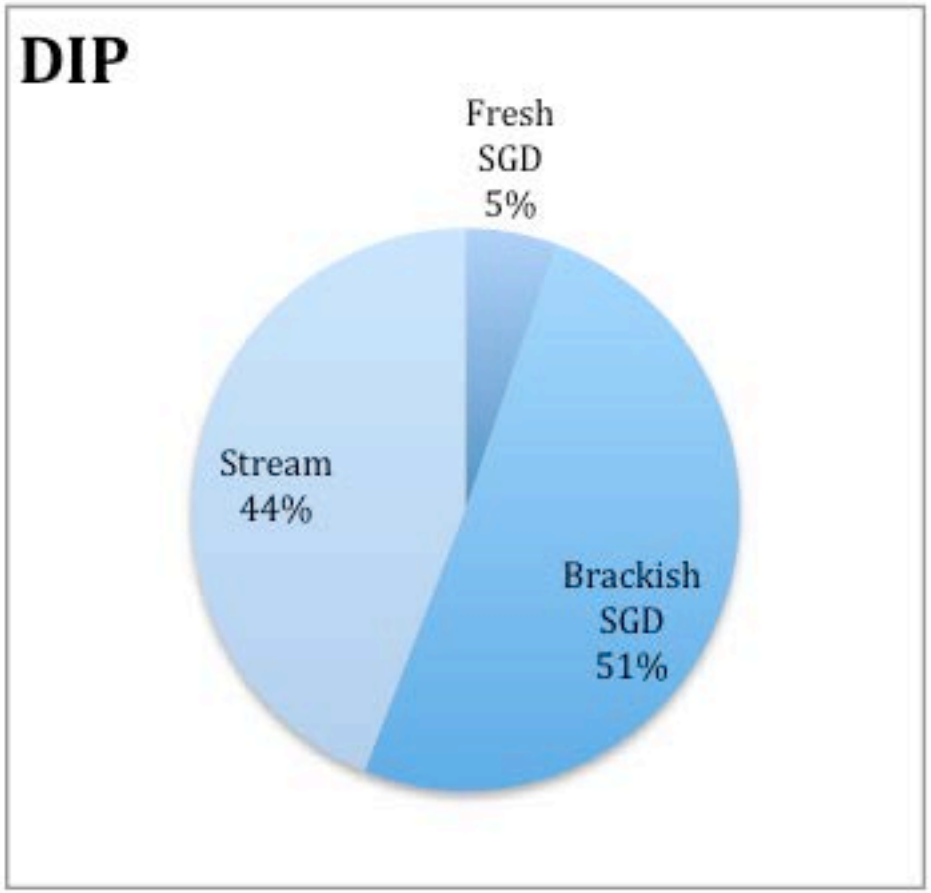
# WATER SOURCES TO THE FISHPOND NOVEMBER 19, 2013



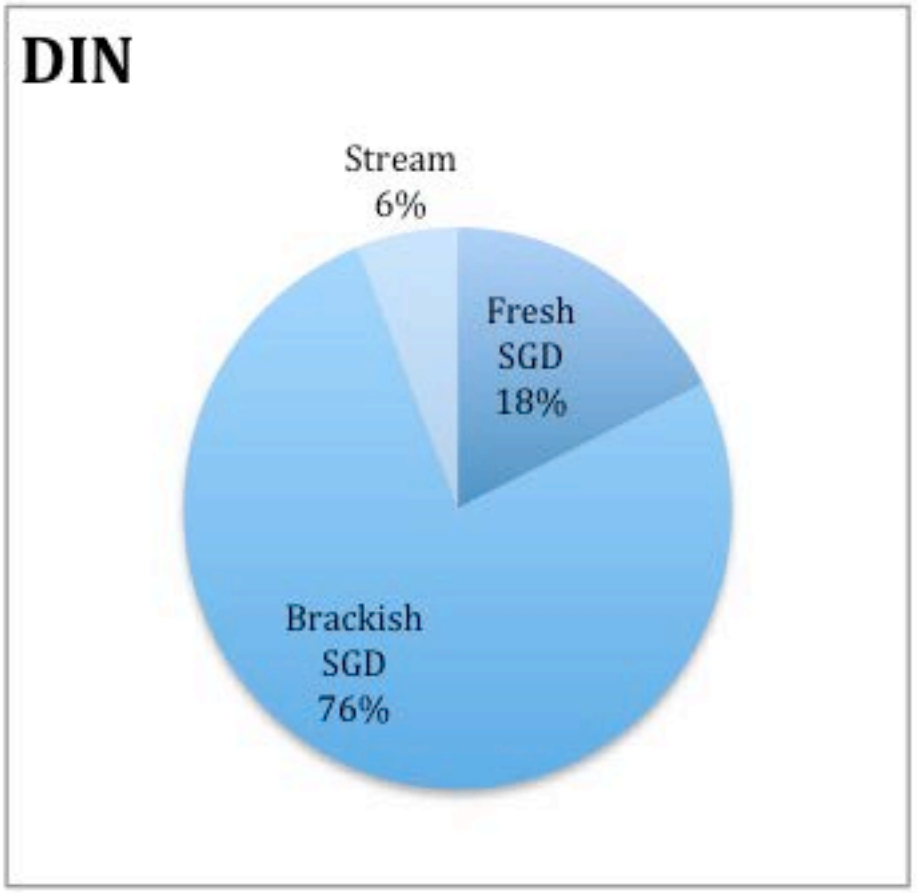

Kleven, 2014

# NUTRIENT CONTRIBUTIONS TO THE POND

## DISSOLVED INORGANIC PHOSPHORUS

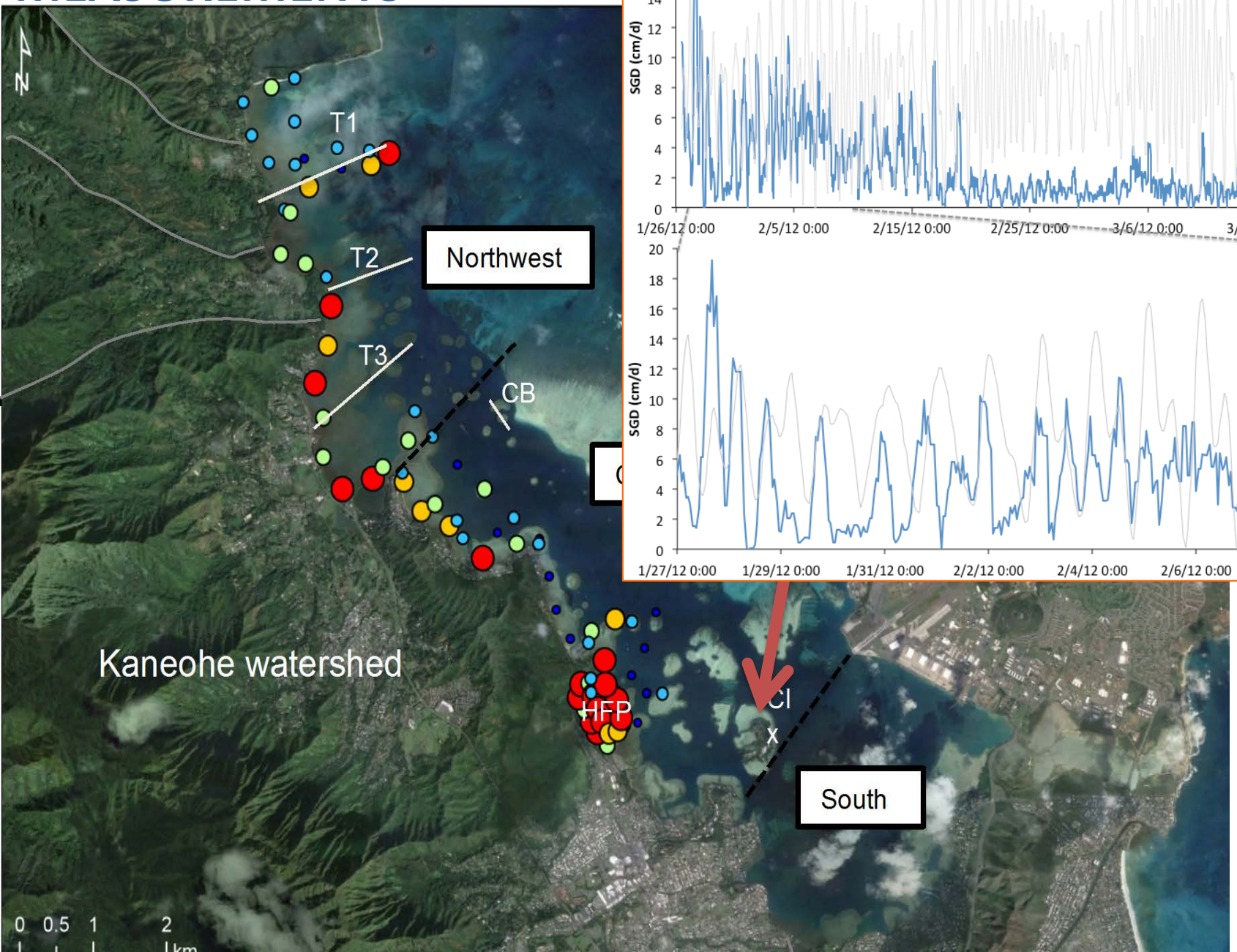


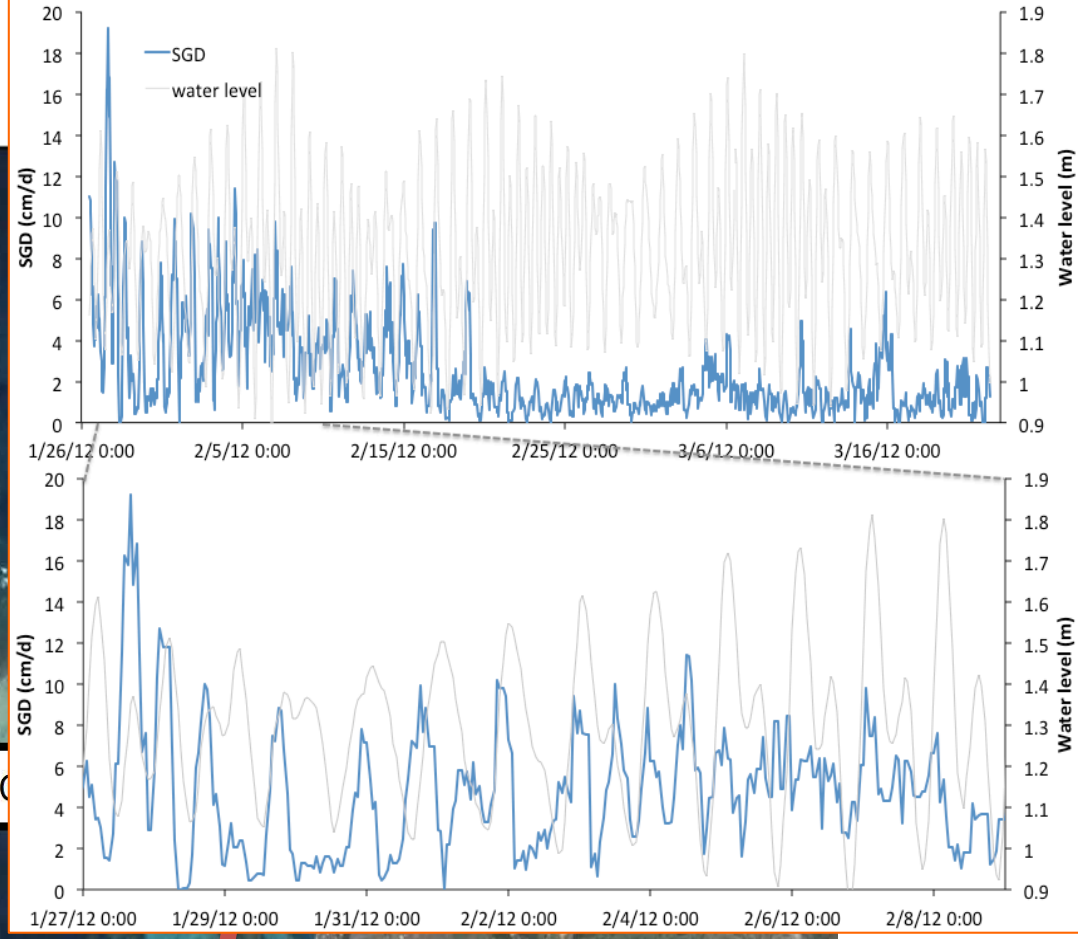

## DISSOLVED INORGANIC NITROGEN



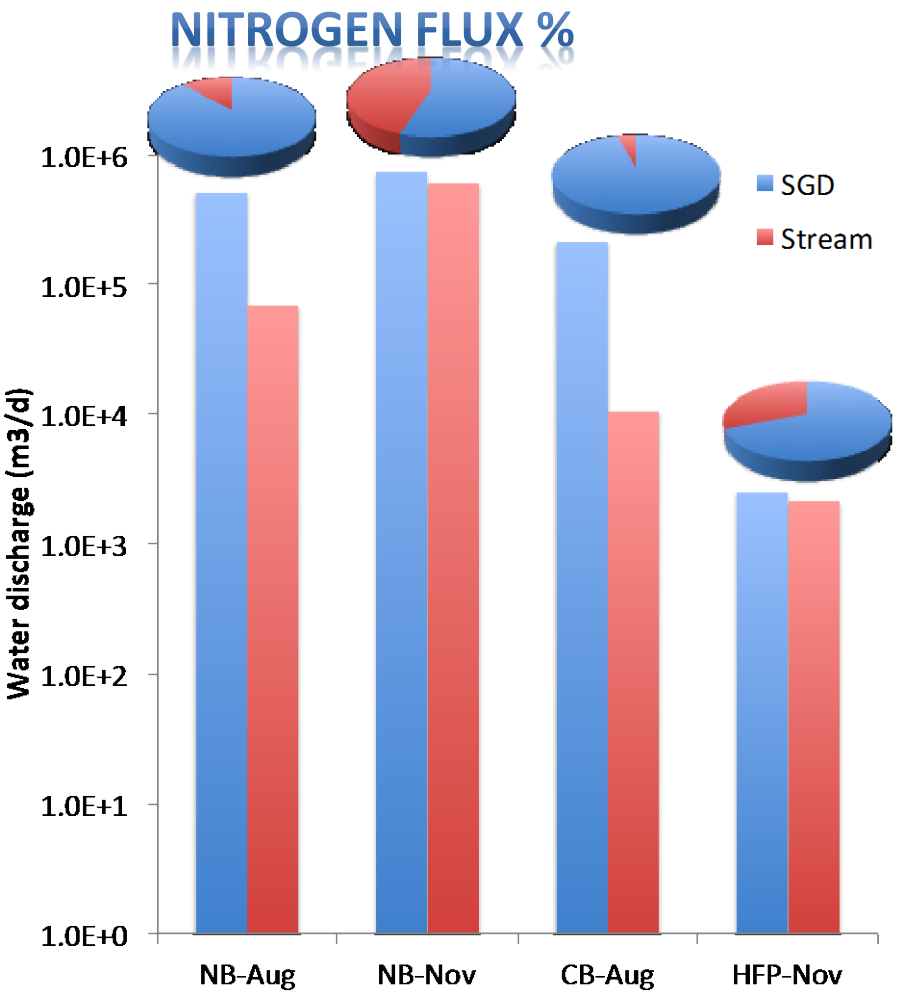

Kleven, 2014; Briggs et al., 2013

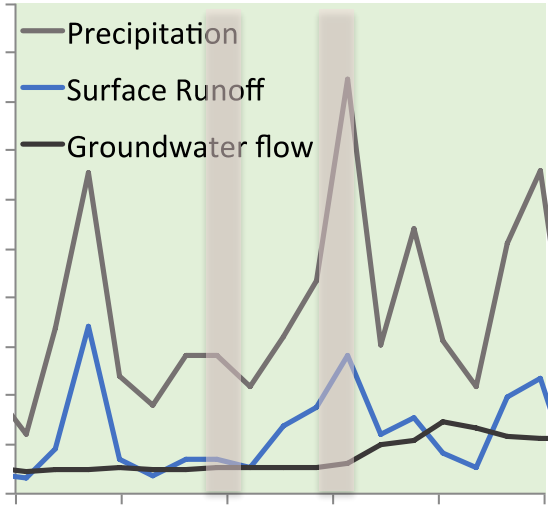
# SGD VIA RADON MEASUREMENTS

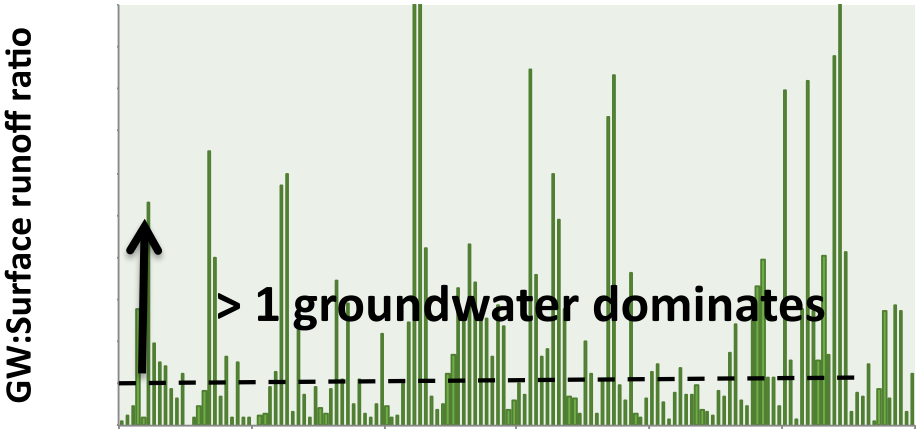


# COASTAL WATER AND DIN FLUXES





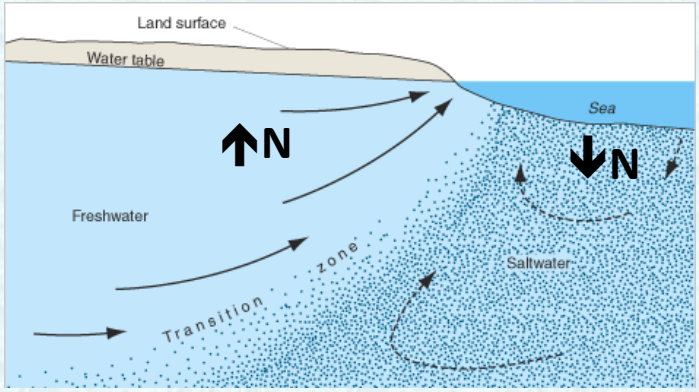

SWAT output from Leta et al., 2015

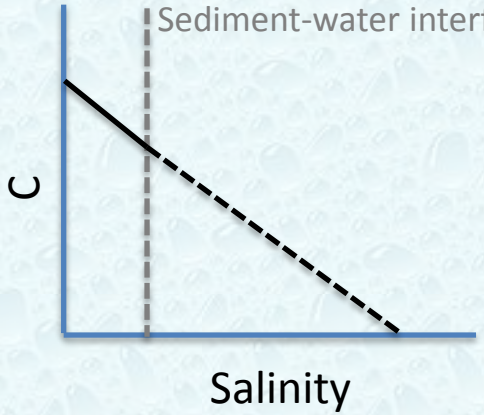
# SHALLOW COASTAL AQUIFER MIXING PROFILES

## KONA PROFILE

SGD source of allochthonous terrestrial nutrients

Freshwater N >> Saltwater N

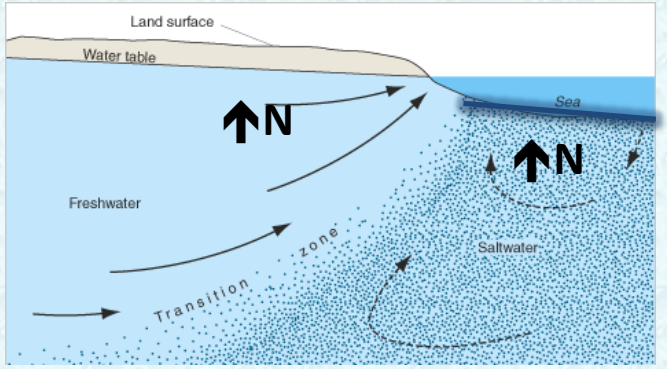


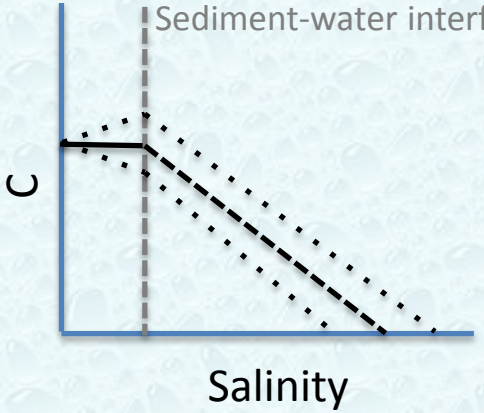




## KANEOHE PROFILE

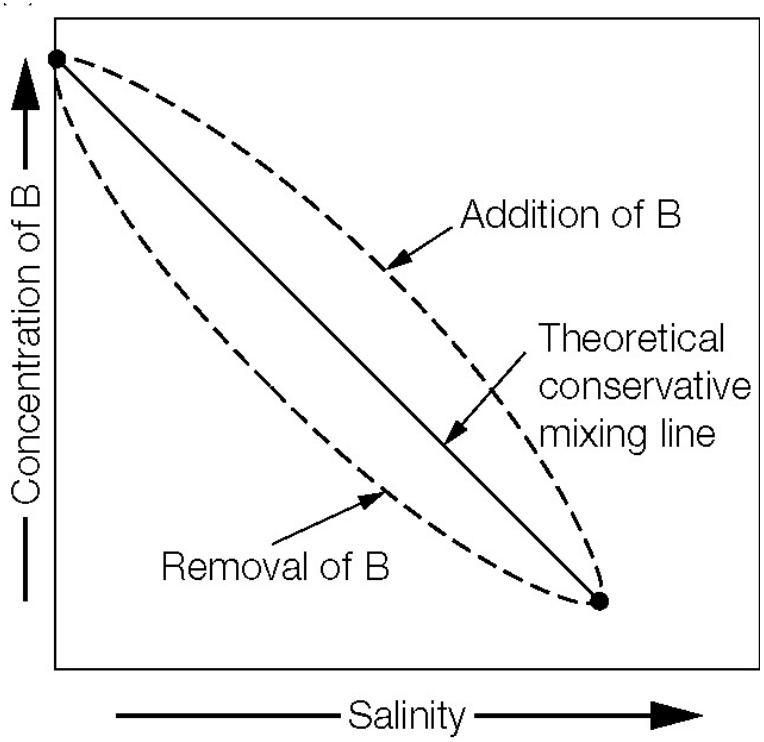
SGD source of allochthonous terrestrial and autochthonous recycled nutrients

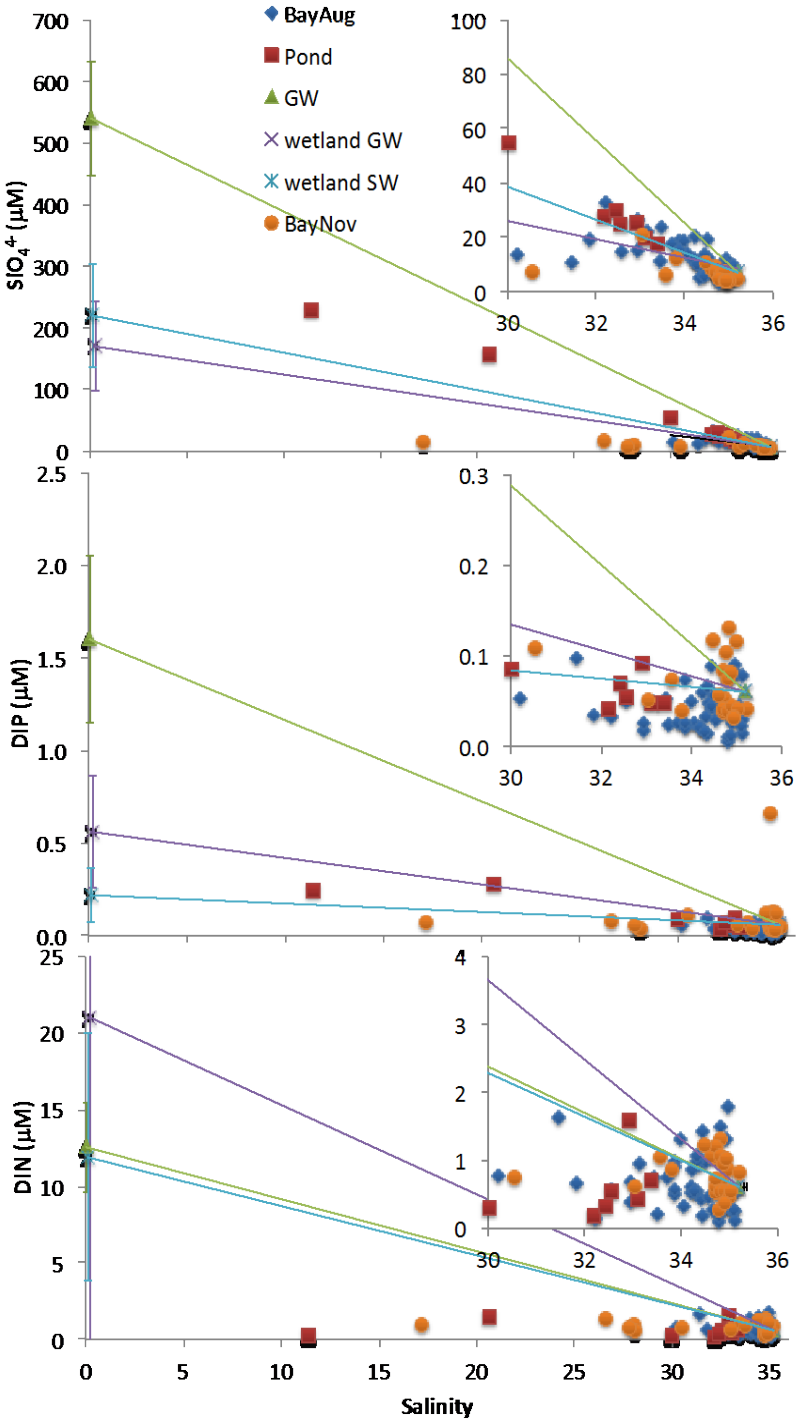
Freshwater N ~ Saltwater N



# THE FATE OF NUTRIENTS IN THE COASTAL OCEAN



# NUTRIENT REMOVAL RATES
# EXAMPLE: DIN IN HEEIA FISHPOND

$$R = I\,Q - C\,Q$$

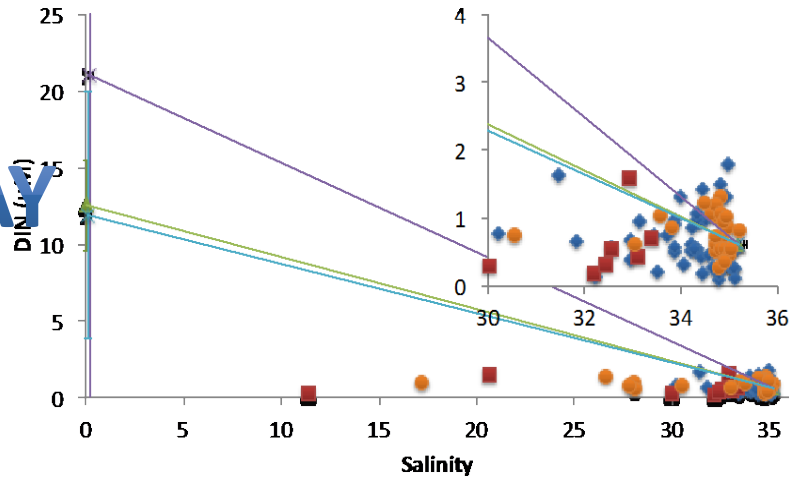
**Q** $= Q_{SGD}+Q_R = 4{,}640\ m^3/day$

**C**oncentration $= 16\ mmol/m^3$

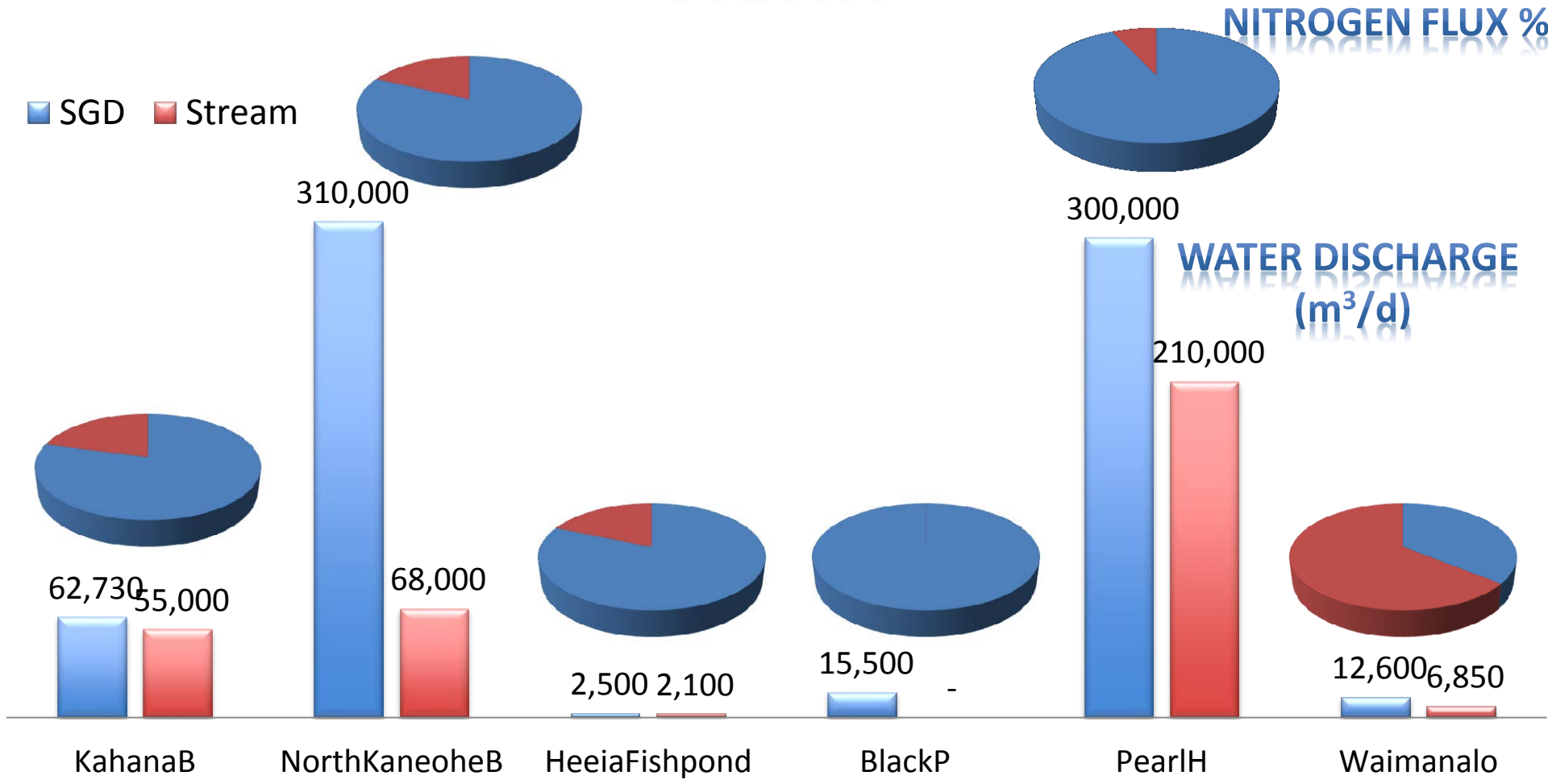
**I**ntercept $= 0.6\ mmol/m^3$

**R**emoval $= 71\ mol/day$

**78-99 % OF NUTRIENTS DELIVERED TO KANEOHE BAY ARE REMOVED**



# SGD VS. STREAMS AT SELECTED SITES ON OAHU



# CONCLUSIONS

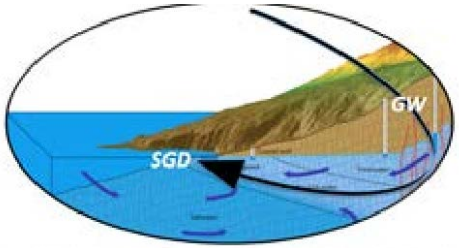
- SGD estimates indicate that it must be considered in a coastal nutrient balance as groundwater delivers significant quantities of terrestrial new- as well as a recycled nutrients

- 78-99 % of nutrients delivered to the coastline are removed by biotic and abiotic processes in the fishpond and inner Kaneohe Bay.

# ACKNOWLEDGMENTS

Geology & Geophysics

SCHOOL OF OCEAN AND EARTH SCIENCE AND TECHNOLOGY
UNIVERSITY OF HAWAI'I AT MĀNOA




Hydrology and Coastal Groundwater Research Group

BOARD OF WATER SUPPLY
City and County of Honolulu

Paepae o He'eia
He'eia Fishpond, He'eia O'ahu

BOARD OF WATER SUPPLY
CONSERVE WATER

Sea Grant
University of Hawai'i

KĀKO'O 'ŌIWI