

Hawaiian Paradise Park Groundwater Study

Screening for On-Sewage Disposal Contamination

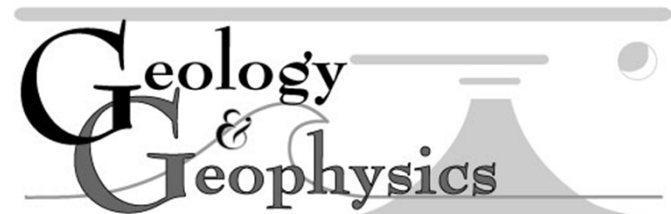
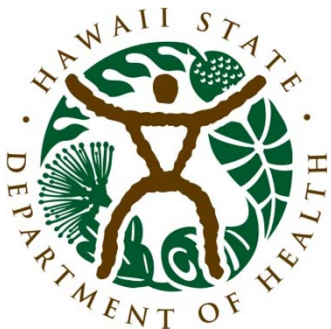
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Background

- Continuation of HDOH evaluation of the health and environmental risks posed by on-site sewage disposal systems.
- Previous studies:
 - Risk evaluation for each island
 - Desk top studies using records and modeling
- Current study is a field investigation of the risk posed by on-site sewage disposal systems to groundwater

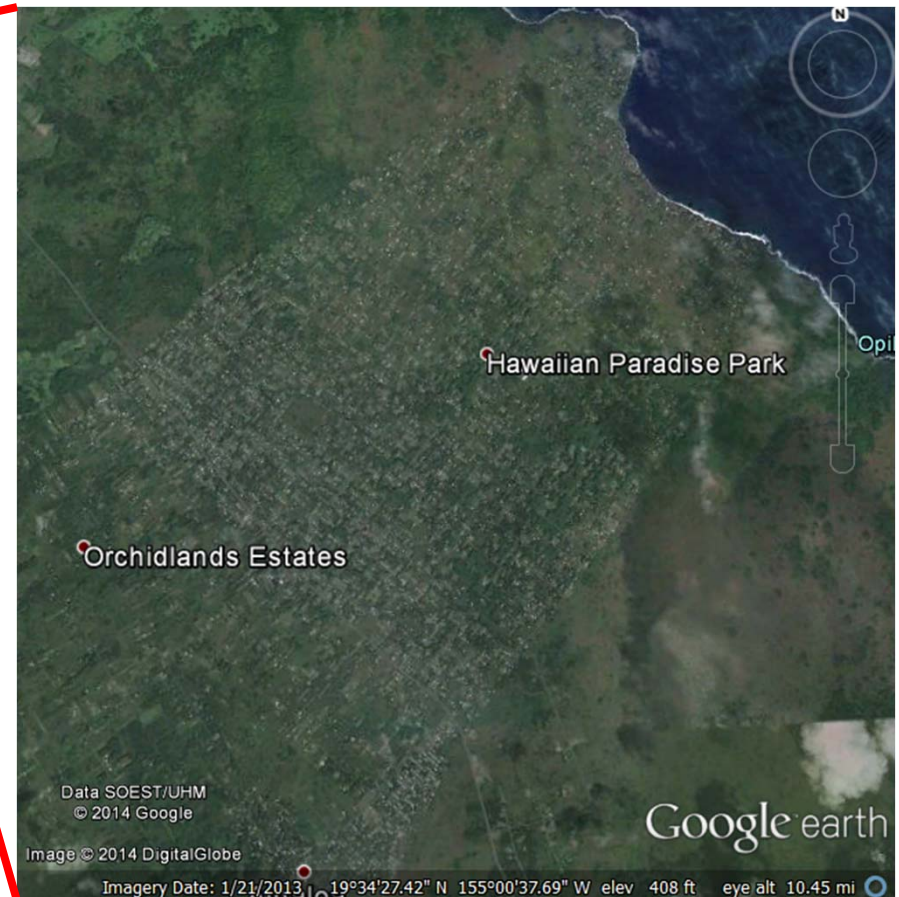
The Study Area

Study Area Description

- Hawaiian Paradise Park
 - Approximately 4,500 residential lots
 - Majority ~ 1 acre
 - Consequently about 4,500 cesspools or septic systems
 - More than 200 domestic supply wells (AKA sampling points)
 - Located on east side of the Big Island
 - Higher rainfall
 - Cooler temperatures

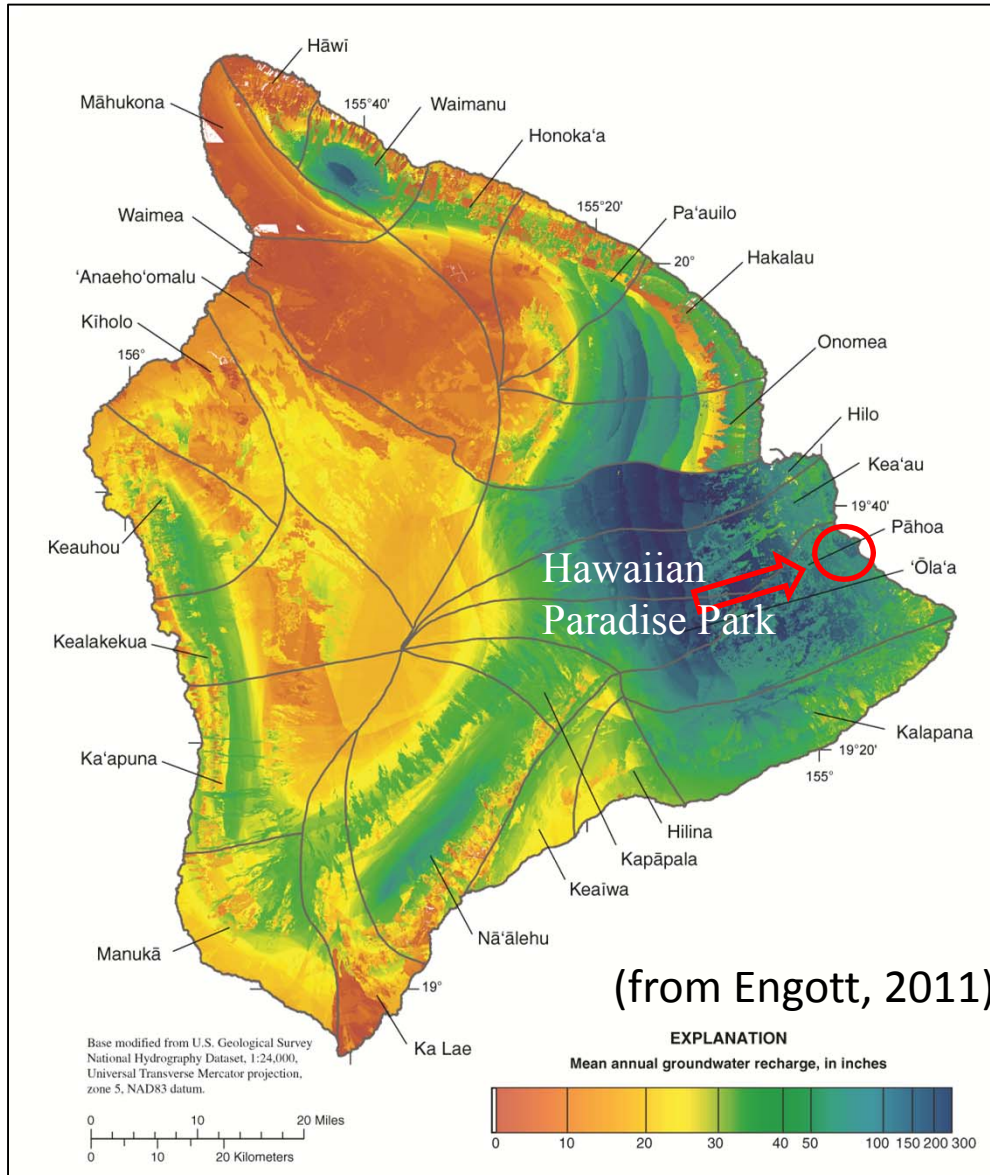
Hawaiian Paradise Park

Located in the Puna District of the island of Hawaii



Hawaiian Paradise Park was subdivided just before statehood (Edwards, 1978)

Hawaiian Paradise Park Hydrology



- High groundwater recharge and high groundwater flow
- Approximately 116 million gallons per day of groundwater flow beneath HPP and discharge to ocean
- Located on geologically recent lava flows from Mauna Loa
 - Allows for rapid infiltration of precipitation

On-Site Sewage Disposal Systems (OSDS)

On-Site Sewage Disposal System

Formal Version

An on-site sewage system (OSDS) is a complete wastewater system installed on a parcel of land, under the control or ownership of any person, which accepts sewage for ultimate disposal under the surface of the ground of the parcel where the wastewater is generated.

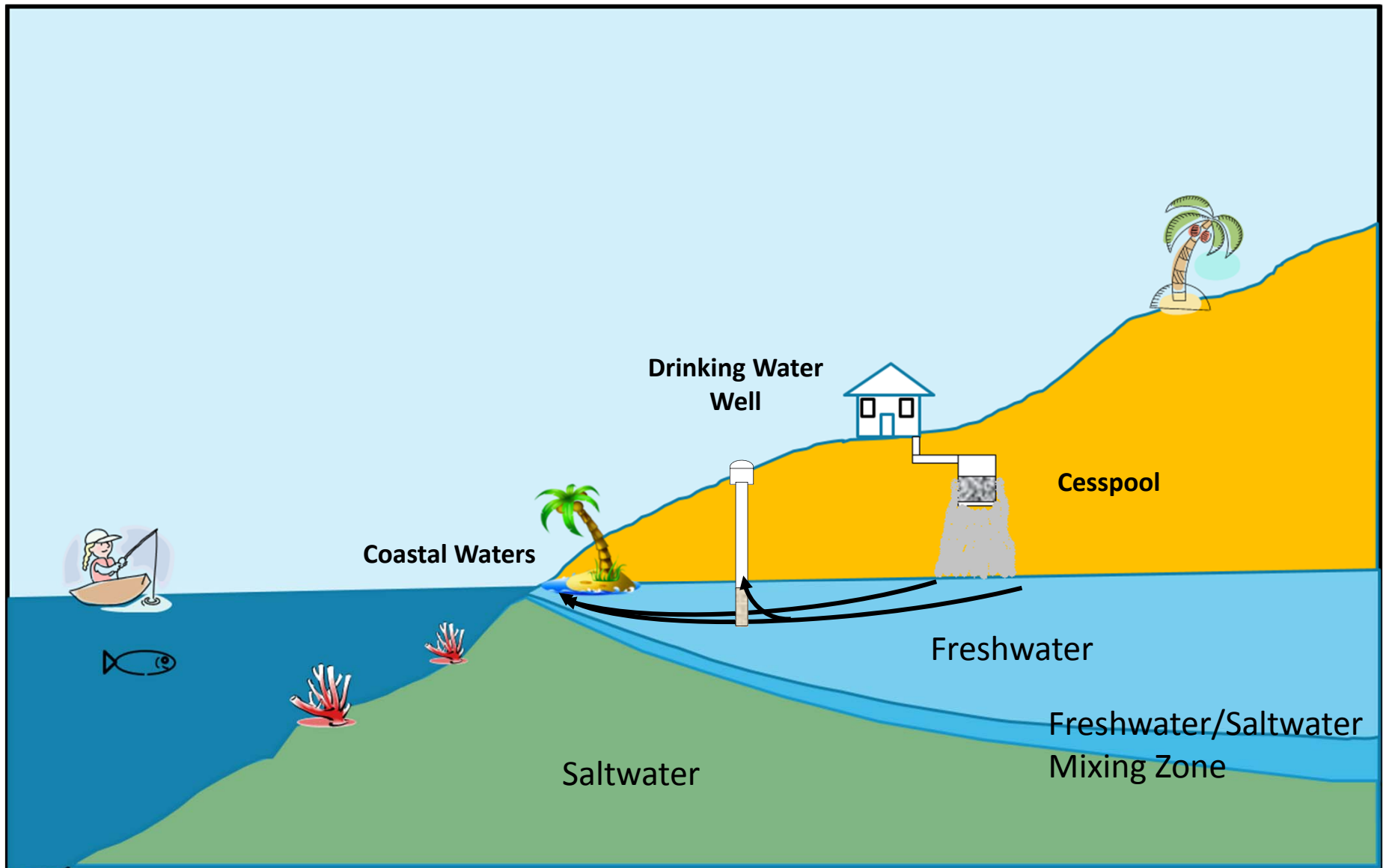
Basically a:

- Cesspool, or
- Septic system

OSDS in Hawaii & in Hawaiian Paradise Park

Area	Total OSDS	Systems with soil treatment	Systems Discharging to a seepage pit			Daily Effluent (mgd)	Daily N Flux (Kg/d)	Daily P Flux (Kg/d)
			Septic	Aerobic	Cess-pools			
State Wide	111,438	19,170	2,730	650	87,969	69.6	12,529	3,568
Hawaii	58,982	8,951	694	68	49,344	34.6	6,607	1,848
Hawaiian Paradise Park	4,553	443	10	1	4102	2.6	530	146

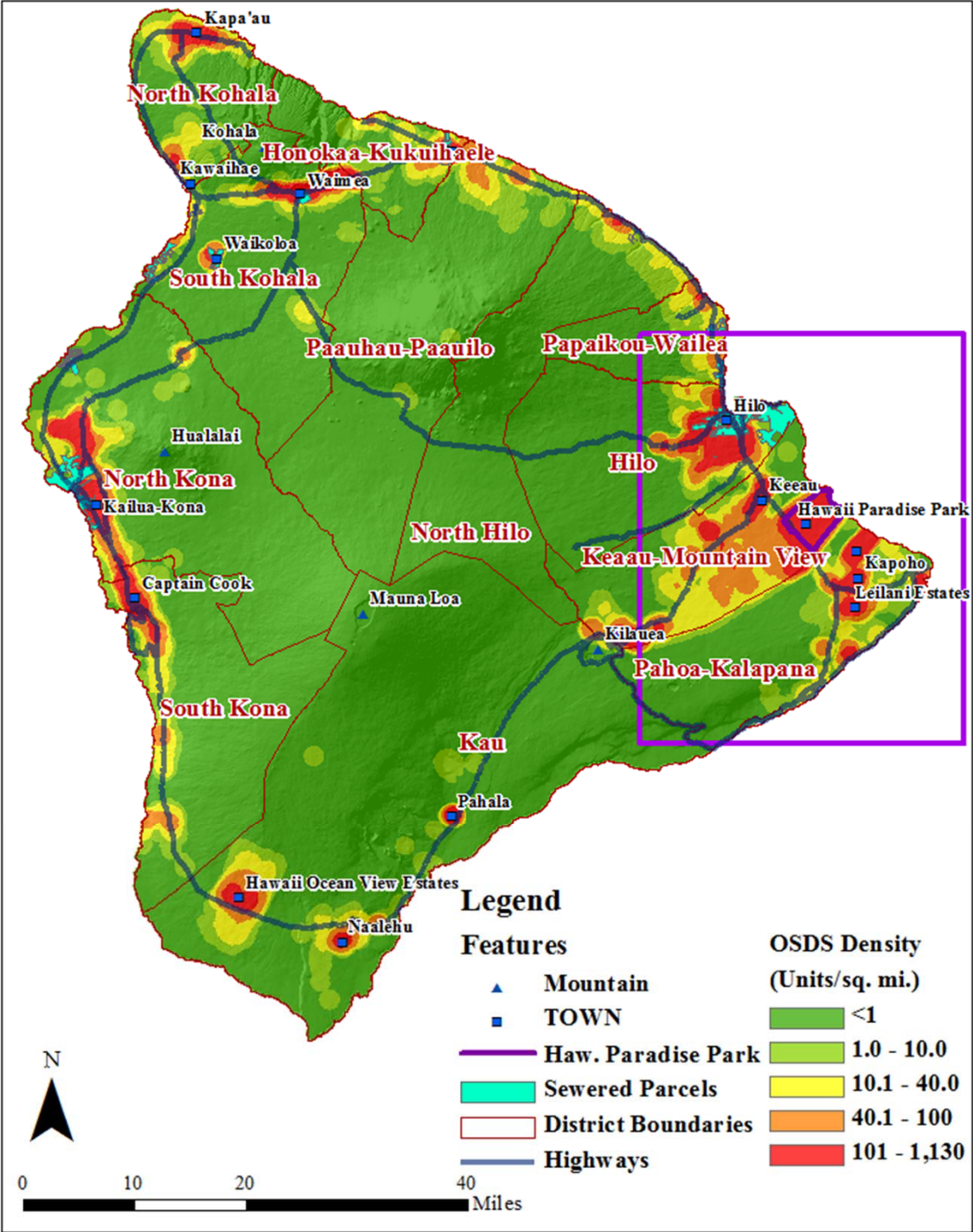
(From Whittier and El-Kadi, 2014)

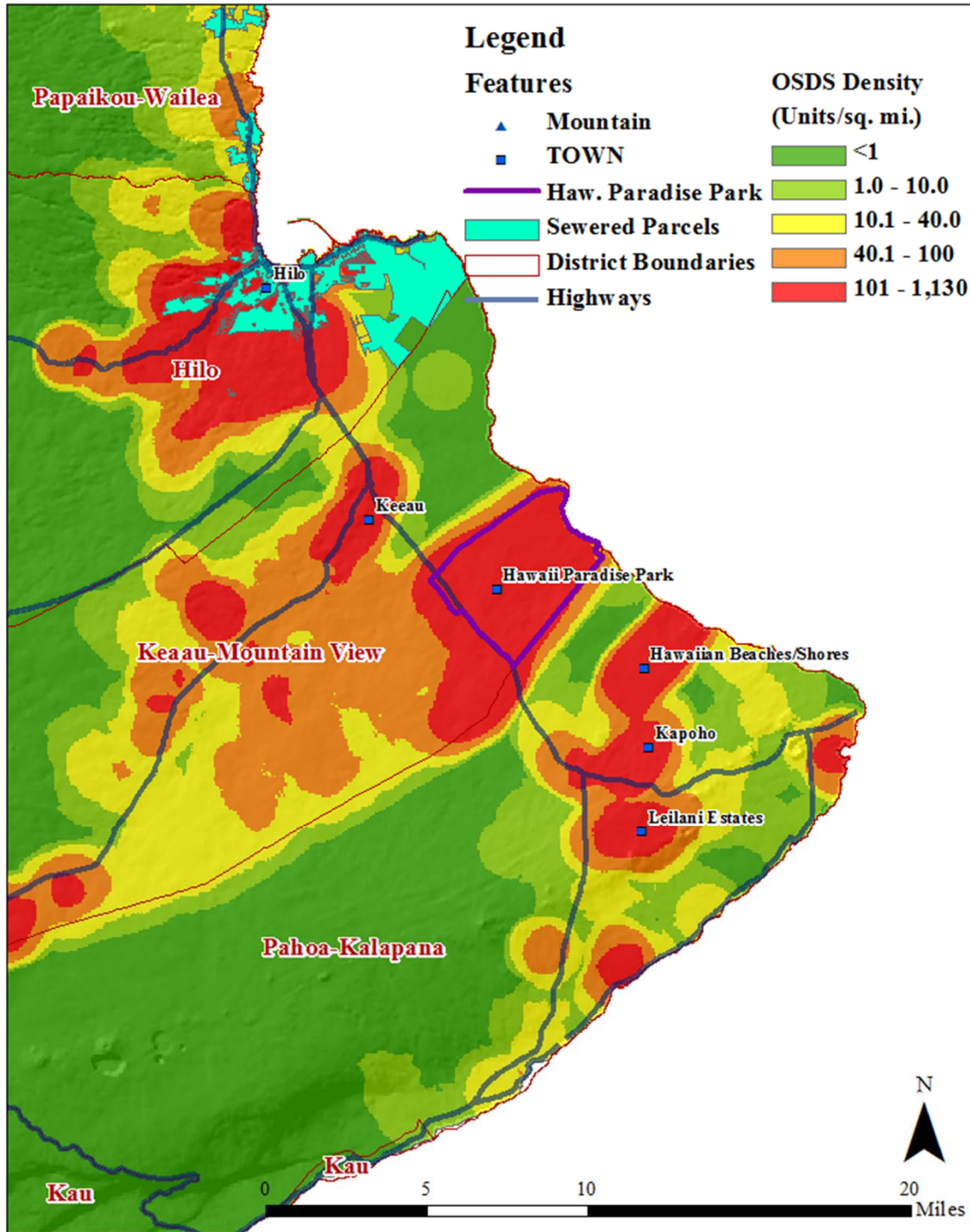


Cesspool leachate seeps into the groundwater then is transported down gradient to wells and to the shoreline

The OSDS Density of the Island of Hawaii

- Groundwater risk varies by OSDS density (Yates, 1985)
 - < 10 units/mi² – low density
 - 10 to 40 units/mi² – medium density with potential for groundwater contamination (1 unit per 16-64 acres)
 - > 40 units/mi² – high density (1 unit per 16 acres)

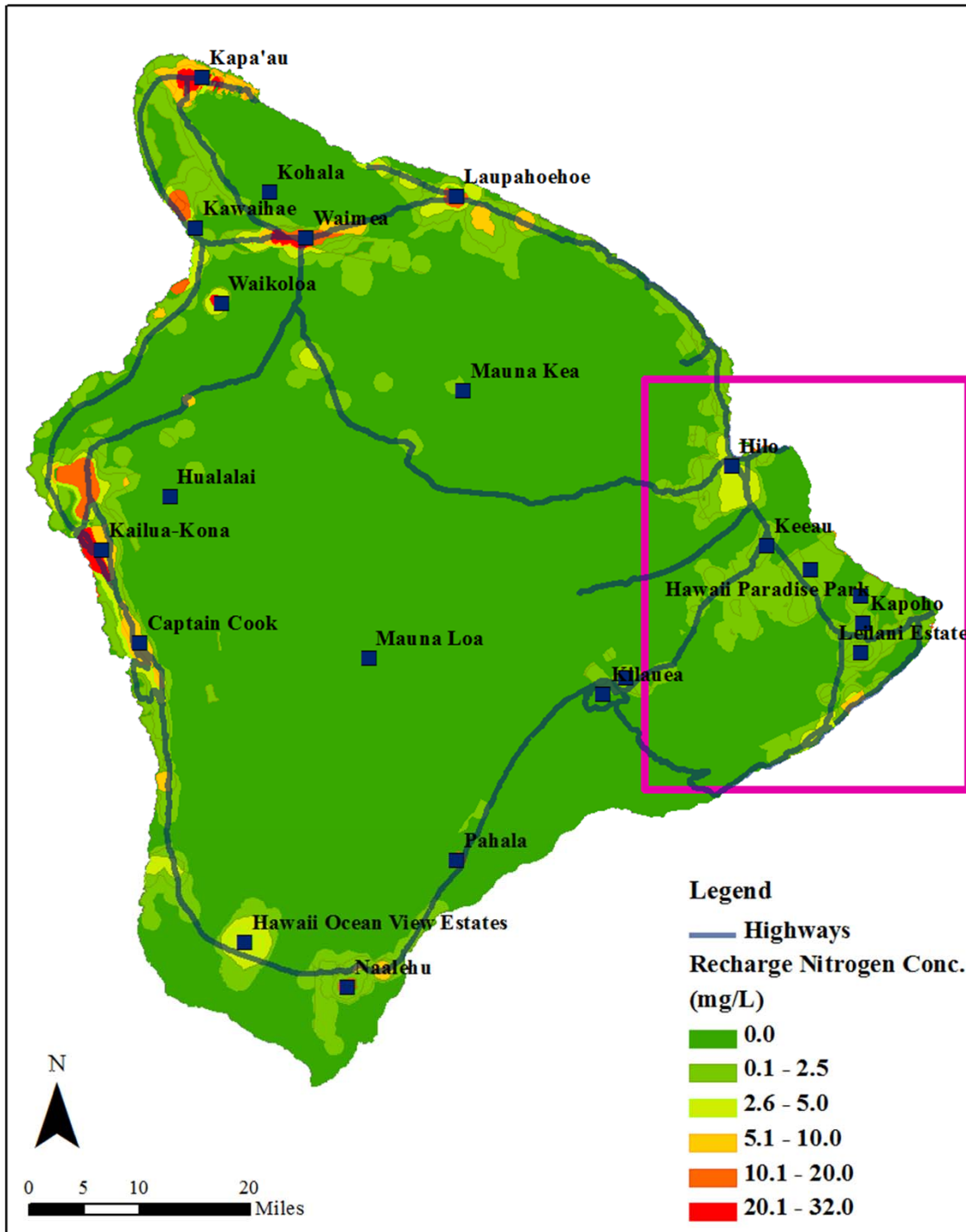




The OSDS Density in East Hawaii

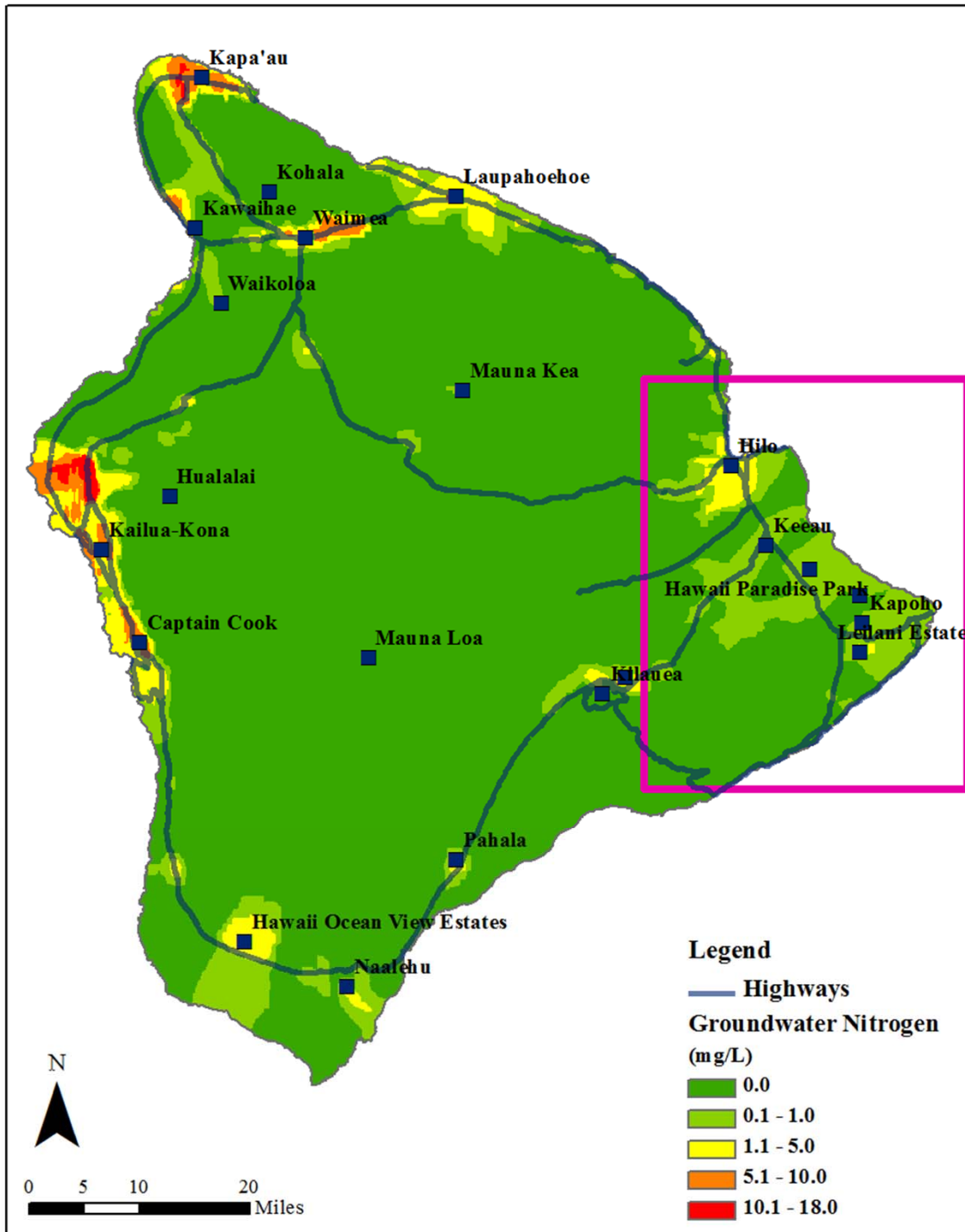
- Groundwater risk varies by OSDS density (Yates, 1985)
 - > 40 units/mi² – high density (1 unit per 16 acres)
- Hawaiian Paradise Park OSDS density ~ 300 units per square mile , or
 - One unit for every two acres

OSDS Impact and Groundwater



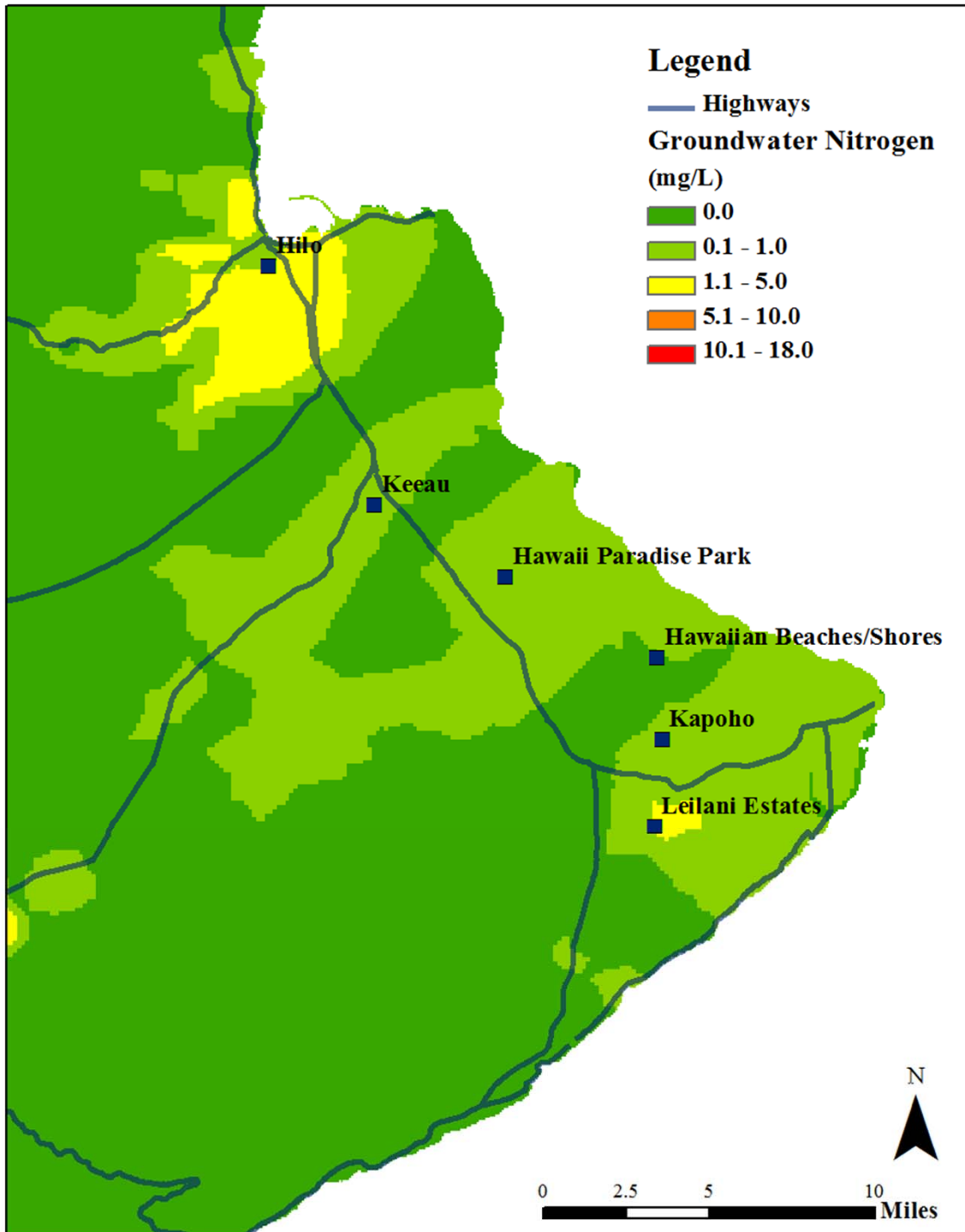
OSDS effluent mixes with the infiltrating rainwater

- Areas with high recharge dilute the effluent
- East Hawaii with its high recharge in significant dilution significant dilution
- The more arid West Hawaii experiences much less dilution



Modeled concentration of nitrogen in the groundwater from OSDS leachate

- Effluent diluted by:
 - Recharge, and
 - Inflow of up gradient groundwater
- Most of East Hawaii N is < 1 mg/L
- Some areas of West Hawaii N is > 10 mg/L



Modeled concentration of nitrogen in the groundwater from OSDS leachate

- Hawaiian Paradise Park ≤ 1 mg/L
- No area > 5 mg/L



The OSDS In Hawaiian Paradise Park

- Hawaiian Paradise Park
 - Approximately 4,500 residential ag. Lots
 - Consequently about 4,500 cesspools or septic systems
 - Potentially discharge up to 2.5 mill. gal. per day of effluent
 - More than 200 domestic supply wells (AKA sampling points)

The Hawaiian Paradise Park OSDS Study

The Research Questions

- Can quick screening methods be developed to screen groundwater for the presence of leachate?
- Is leachate from OSDS affecting the groundwater quality beneath rural communities?
- Does leachate from OSDS pose a health risk?

How Are Questions to be Answered?

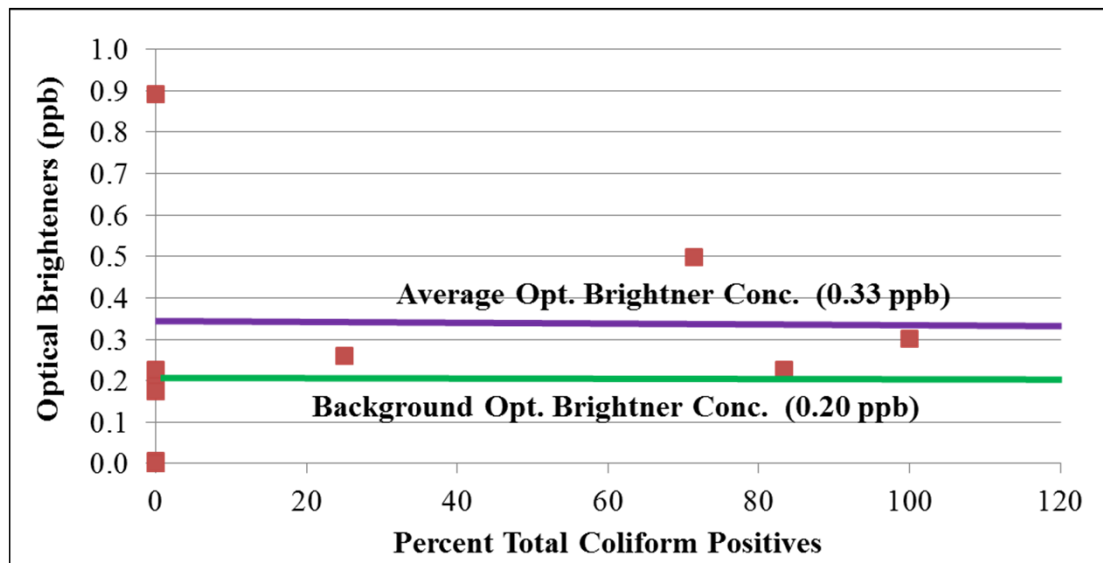
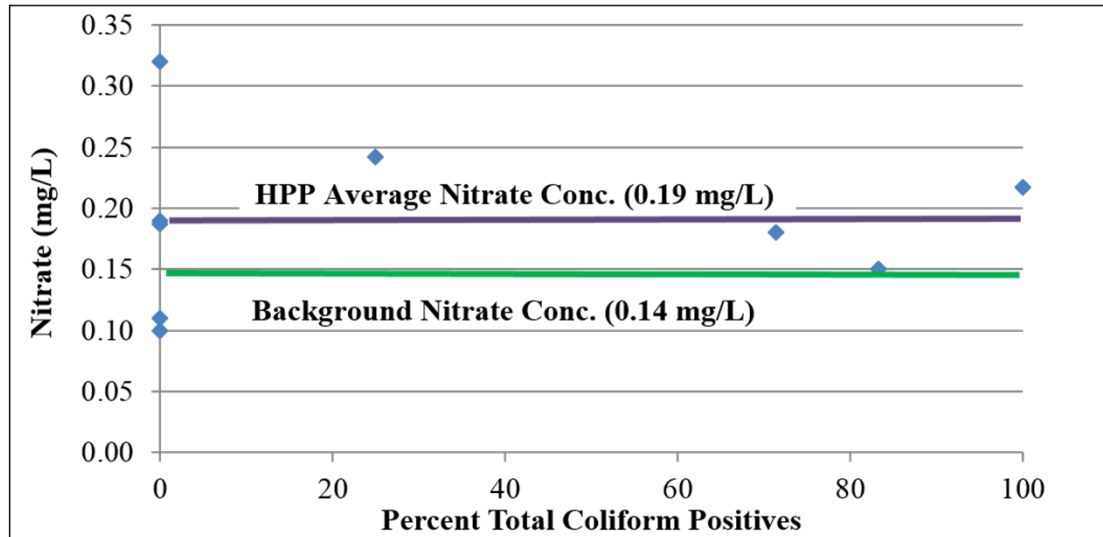
1. Characterize the physical characteristics (water quality parameters) of the HPP groundwater
2. Perform field analysis of inorganic indicators of wastewater
3. Perform field and laboratory analysis for fluorescence indicators of wastewater
4. Health risks – sample domestic wells for indicator bacteria

Screening Methods Evaluated

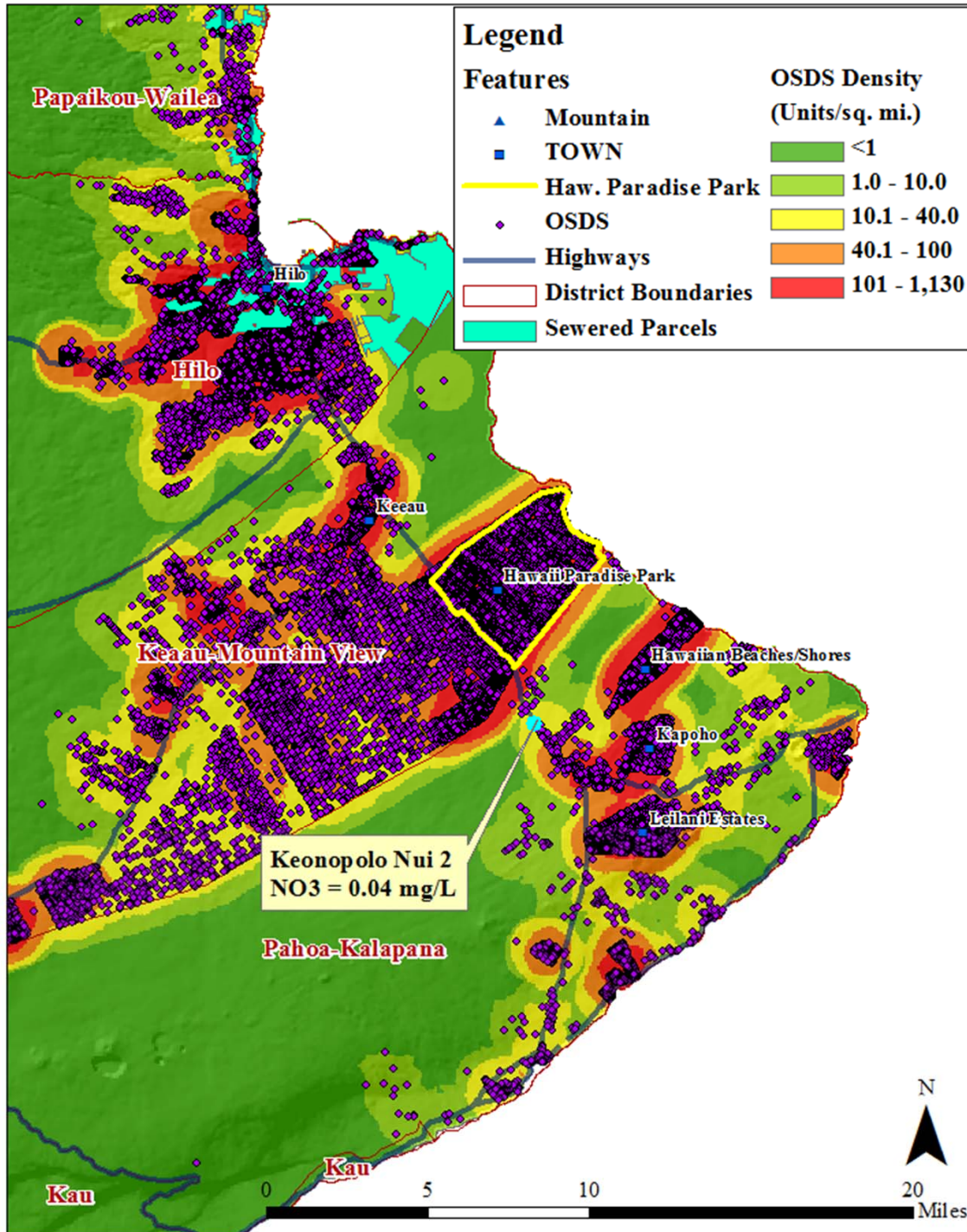
- Groundwater Chemistry
 - Water Quality Parameters
 - Temperature, specific conductivity, pH, oxidation/reduction potential
 - Water quality analyzer
 - Inorganic chemistry
 - Nitrate, phosphate, sulfate
 - Colormetric analysis – field colorimeter
- Bacteria
 - Total coliform
 - Fecal coliform (E. coli)
 - Positive/negative only
- Fluorescence
 - Optical brighteners – field fluorometer
 - 3-D fluorescence scans – laboratory spectrophotometer

Hawaiian Paradise Park
OSDS Study
Preliminary Results

Primary Wastewater Indicators



- Neither nitrate nor optical brighteners showed a correlation with total coliform detections
- Detection to bacteria used as a positive indicator of effluent
- Nitrate
 - Background conc. was measured at most upgradient well
 - High nitrate well was at a nursery
- Optical brighteners
 - Highest conc. From well with no total coliform positives (sampled 3 times)
 - Many optical brightener concentrations less than that of upgradient well

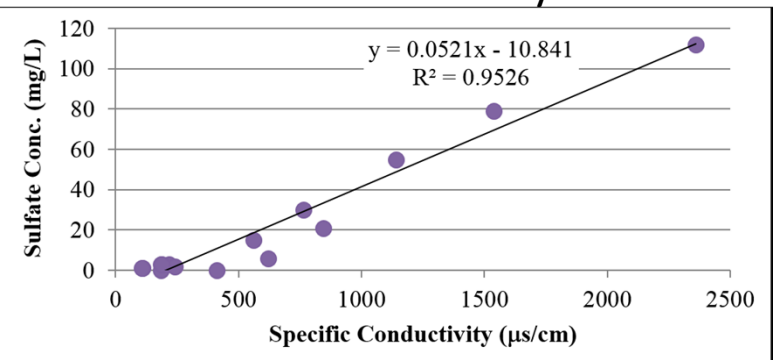
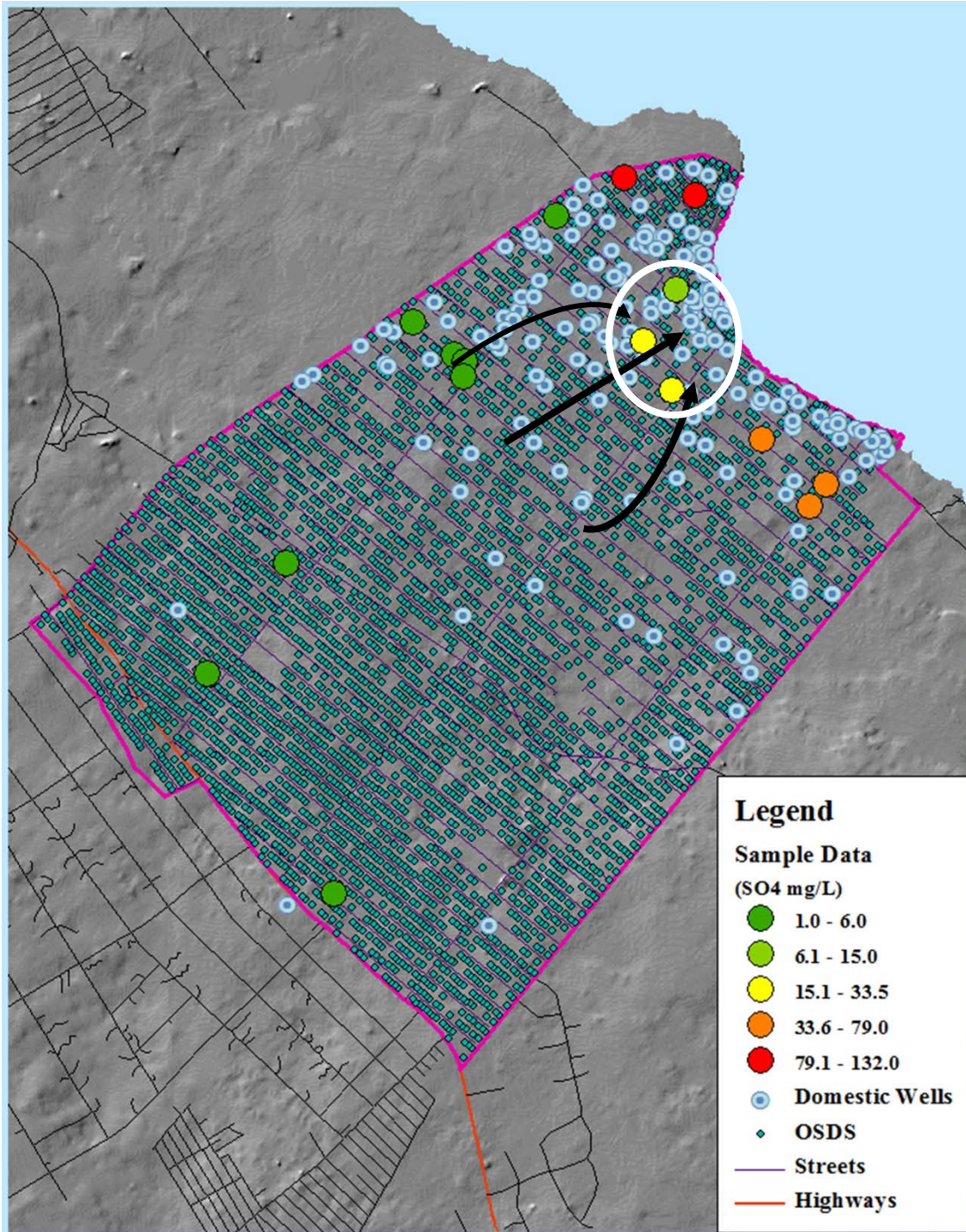


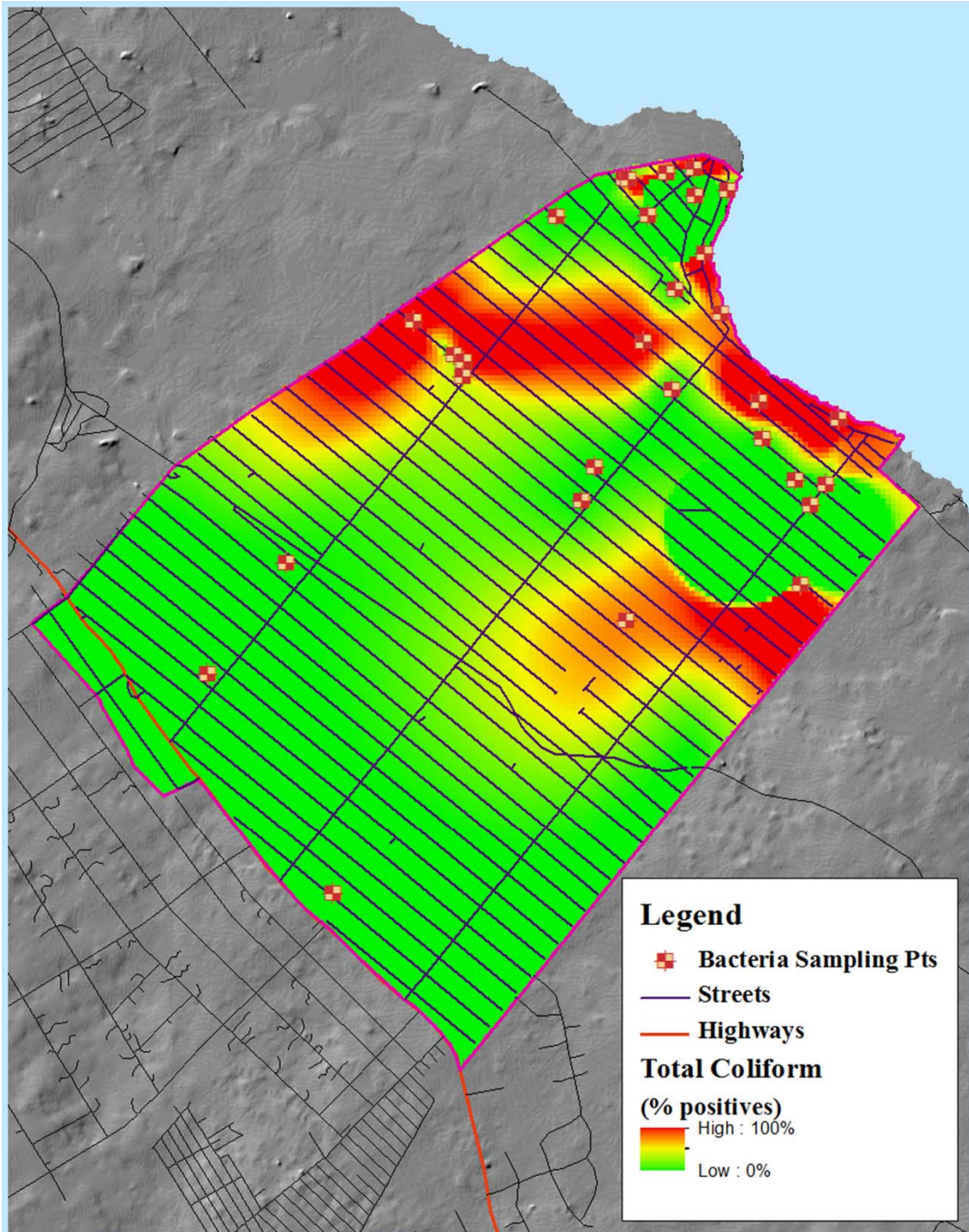
Many OSDS Above Hawaiian Paradise Park

- Orchidland
- Hawaiian Acres
- Ainaloa
- Municipal well – Keonopoko Nui 2
- NO₃ = 0.04 mg/L

Sulfate (SO₄) as an Indicator of Ground water flow Direction

- Zone of fresher water near coast
 - Indicated by lower SO₄ concentrations
 - Higher SO₄ concentrations indicate greater seawater contribution
- Apparently driven by the gentle coastline embayment
- Need to investigate what well construction factors may influence well chemistry



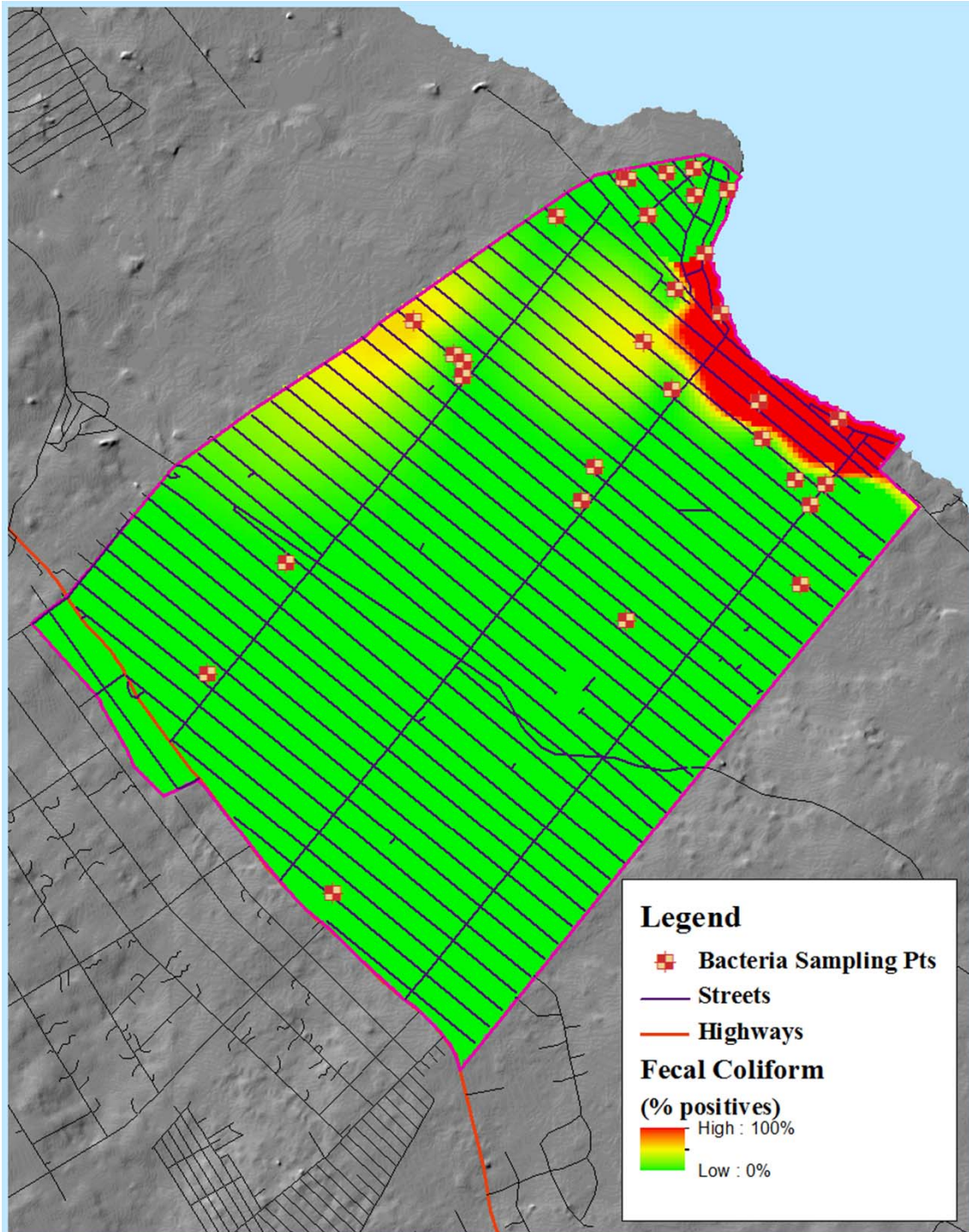


Frequency of Total Coliform Positives

- Results from current project and bacteria sampling in 2010 & 2011
- Higher frequencies:
 - Near the coast,
 - Near the high groundwater flow area,
 - However, insufficient data for reliable statistics
- Also need to consider well construction factors

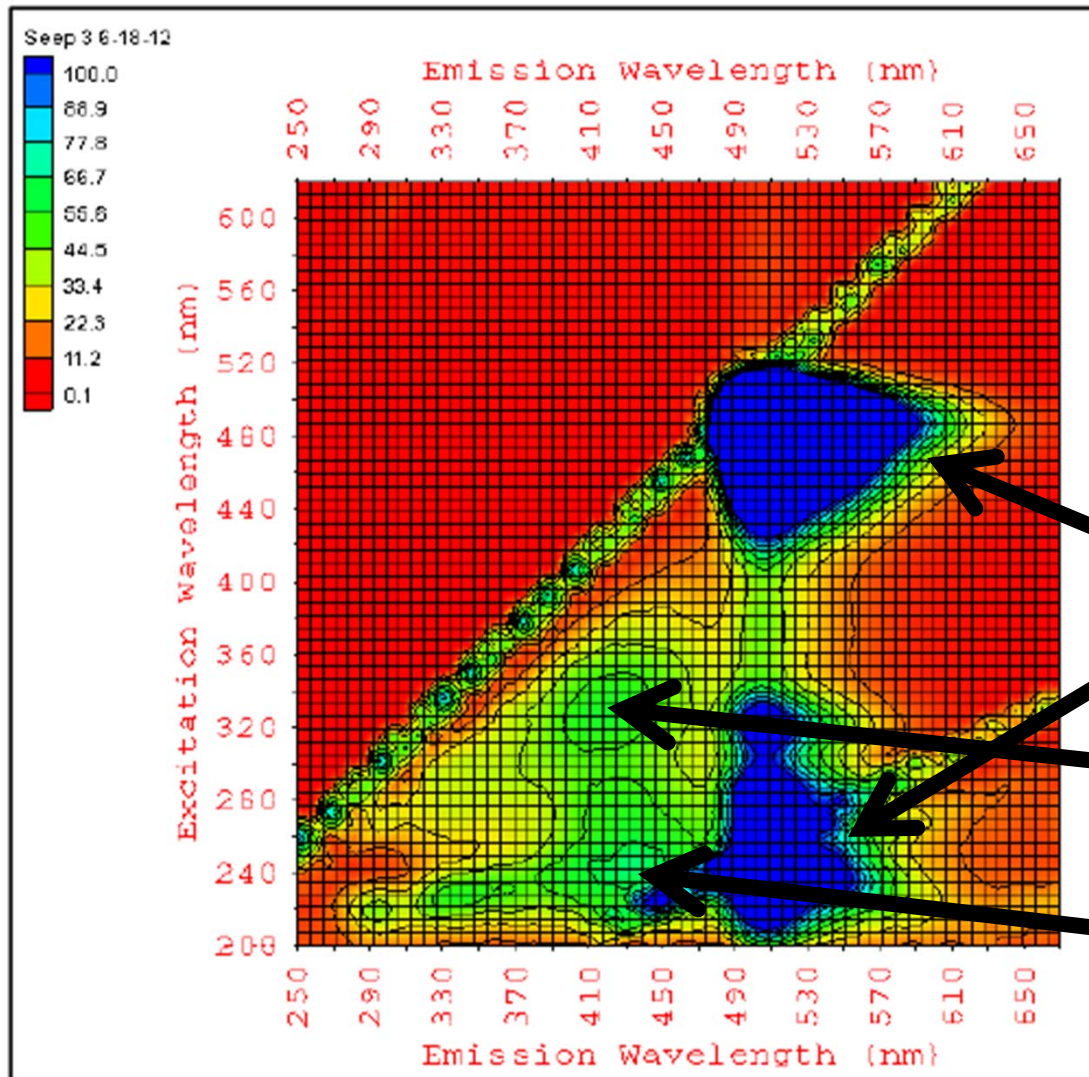
Frequency of Fecal Coliform Positives

- Almost exclusively near the coast
- Also need to consider well construction factors



Hawaiian Paradise Park
OSDS Study
Future Work

Do 3-D Fluorescence Scans



- Wastewater fluorophores
 - Optical brighteners
 - Organic acids
 - Other organic material
 - Spent radiator fluid

Tracer dye fluorescence

Fluorescence in the
Fluvic acid wavelength

Fluorescence in the
Humic acid wavelength

Mass Spectrometer Scans

- Pharmaceuticals
- Other emerging contaminants

Hawaiian Paradise Park
OSDS Study
Summary

Summary

- HPP provides a dense population of OSDS and monitoring points
- Dilutions by ambient groundwater flow and recharge
- This dilution makes any OSDS signal difficult to detect with field equipment
 - No adverse impacts to chemical water quality have been found
 - Under these conditions no reliable screening method has been found
- Positive detections of indicator bacteria show that a potential health risk exists and residents should filter and disinfect their water
- Further indicators of wastewater signals are being evaluated

Thank You!

Questions?