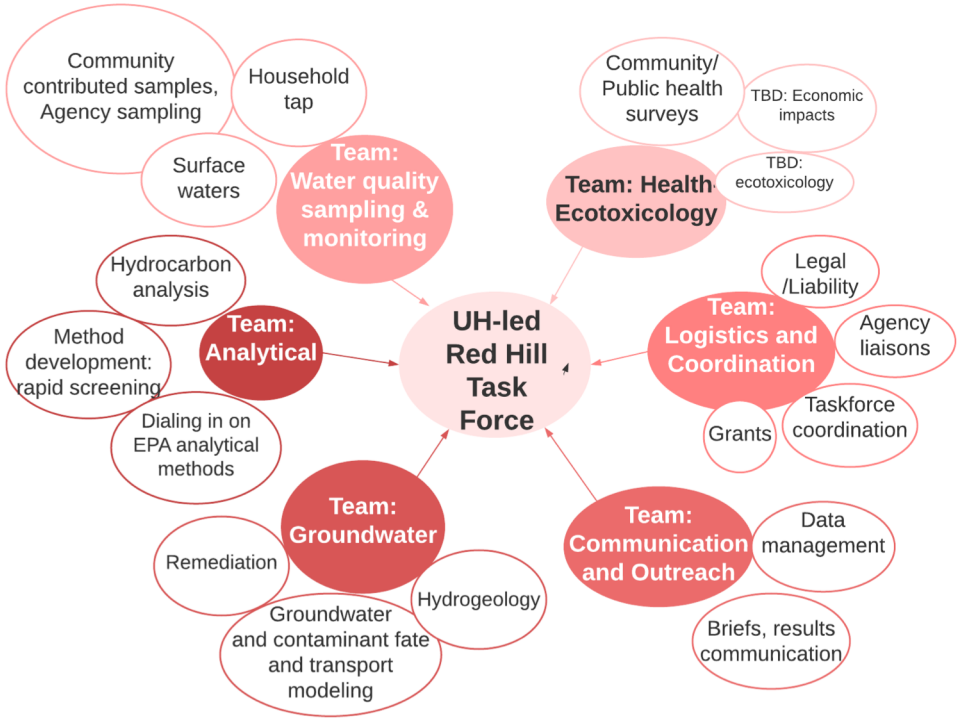
University of Hawai‘i Red Hill Response and Research

Water Resources Research Center
Presentation for Commission on Water Resource Management
February 15, 2022

UH Red Hill Task Force

Comprised of 56 faculty, student, staff and community members across different UH campuses, agency contacts (DOH, CWRM), other researchers



The UH Red Hill task force has been:

1) Water quality analysis

- develop increased on-island capacity for contaminant detection and water quality analysis of tap and environmental waters

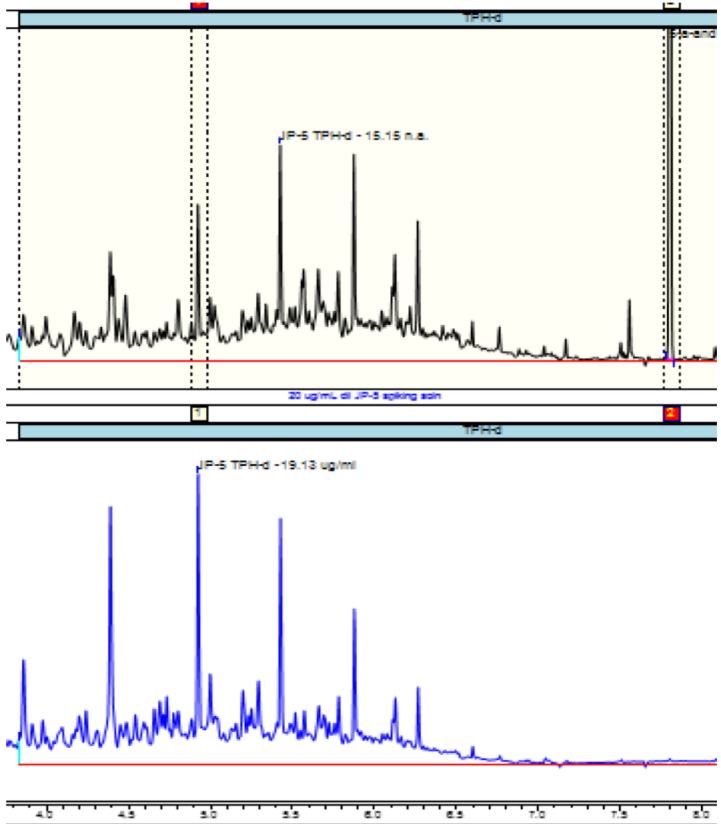
2) Coordinate relevant research

- hydrocarbon analysis
- surface water monitoring
- groundwater and contaminant fate and transport
- social science investigation
- human health and toxicology

1) **Water quality analysis:** EPA methods

WRRC analytical lab:

- WRRC lab is prepared to receive new GC/MS: groundwater screening for volatiles, TPH-g and potentially semi-volatiles; pending delivery this month, installation and training
- TPH-d GC-FID analysis method (EPA 8015D) is ready but sample extraction method requires further optimization (top: spiked extract, bottom:JP-5)

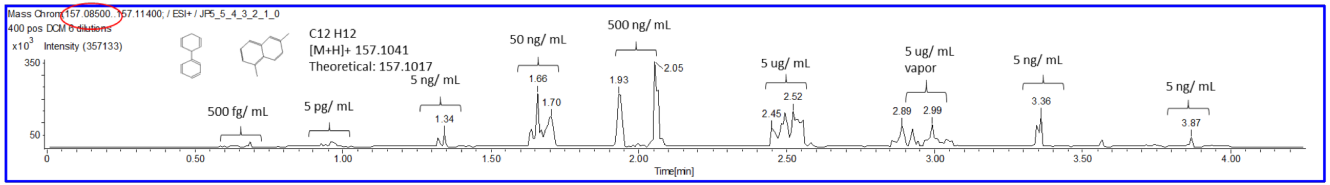


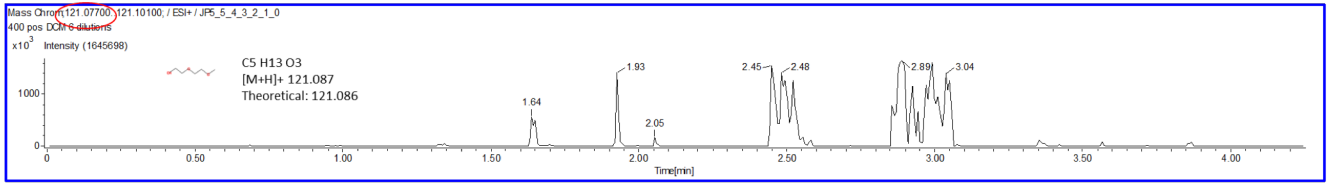
1) **Water quality analysis:** Direct analysis in real time mass spectrometry (DART-MS)

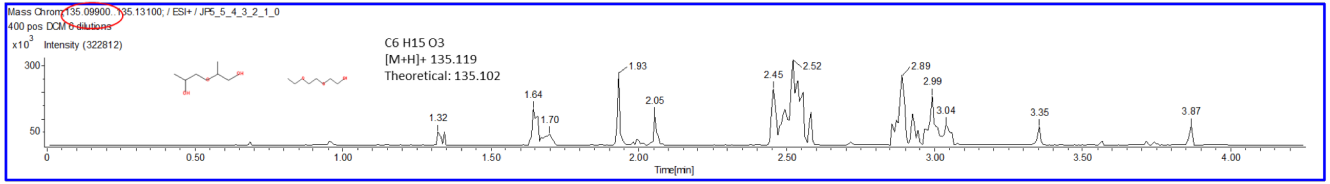
Yew Lab

Capable of doing rapid characterization of concentrated samples. Method could be used in combination with other MS or fluorescent methods as a way to detect chemical fingerprints that are specific for jet fuel. This may help to differentiate jet fuel from other common environmental contaminants found in tap water.

Extracted ion chromatograms for peaks of interest (157.104, 121.087, 135.119)
Able to reliably detect at 5 pg/ mL







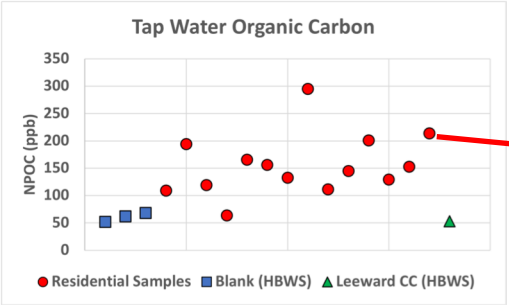
1) **Water quality analysis:** total organic carbon screening and fluorescence screening

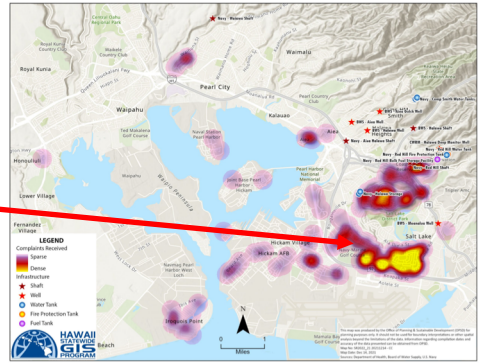
Total Organic Carbon Screening:
WRRC Analytical lab
- Non-purgeable organic carbon

3-D Fluorescence Screening:
Nelson Lab (SOEST) in coordination with Leeward CC and WRRC:
- Rapid scans (5 minutes/sample)
- Identified JP-5 region of interest
- Confirmed that the method can identify dilute JP-5
- limit of detection 10 ppb
- Verified for stream and community-contributed tap water

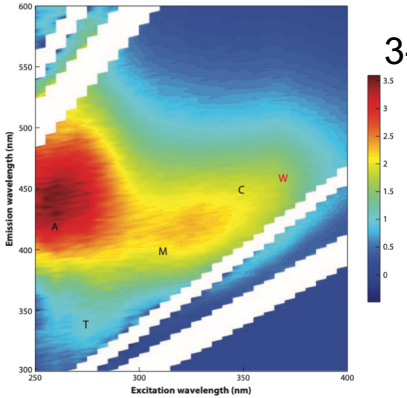
Sharma Lab (HIGP) assessing potential for similar optical methods for in situ borehole monitoring

Total Organic Carbon Content

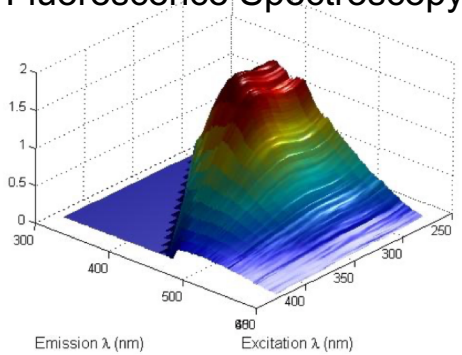




HI DOH heatmap of complaints

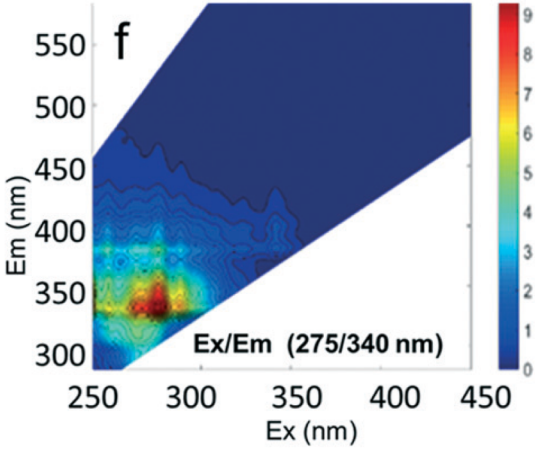


3-D Fluorescence Spectroscopy



1) **Water quality analysis:** 3-D Scanning Fluorescence Screening for JP-5

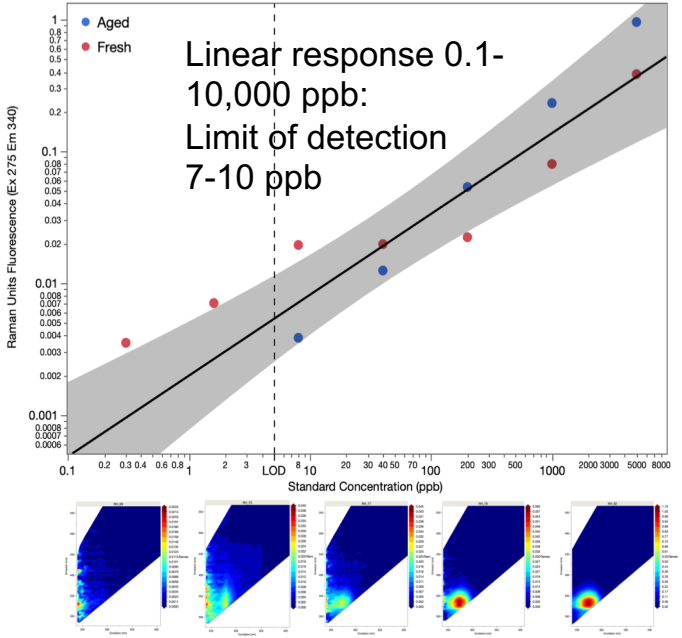
Widely used in industry and established in literature



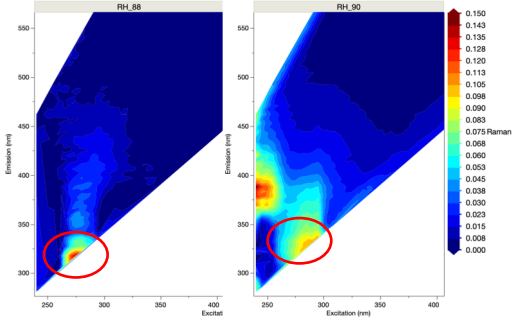
TPH-d (diesel) ~400 ppm in ultrapure water.

Mendoza, L. M., N. Mladenov, A. M. Kinoshita, F. Pinongcos, M. E. Verbyla, and R. Gersberg. 2020. Fluorescence-based monitoring of anthropogenic pollutant inputs to an urban stream in Southern California, USA. Science of The Total Environment 718: 137206.

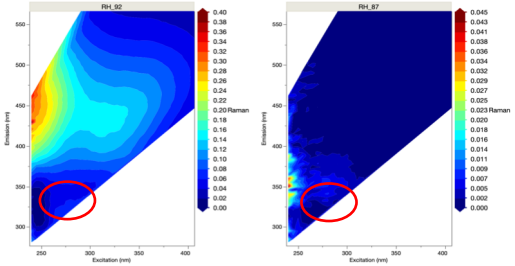
UH 3-D Fluorescence JP-5 Dilution Series



Example Positive Screens in Stream and Community Tap Samples (10-100 ppb)

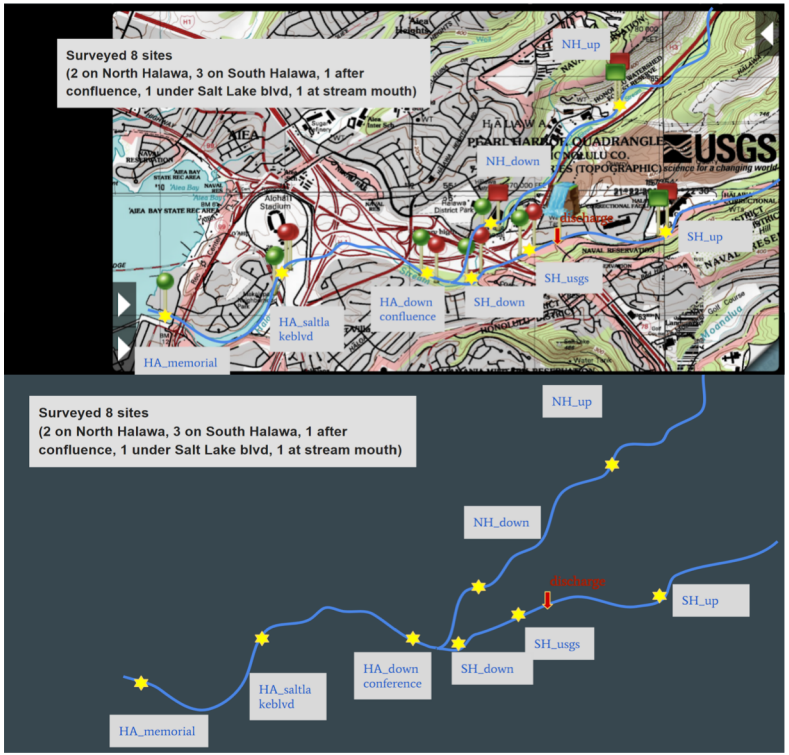


Example Negative screens in Halawa Stream (Left) and Community Tap (Right)



2) **Relevant research:** Surface water sampling

Tsang lab (Navy Co-op agreement): Hālawa Stream



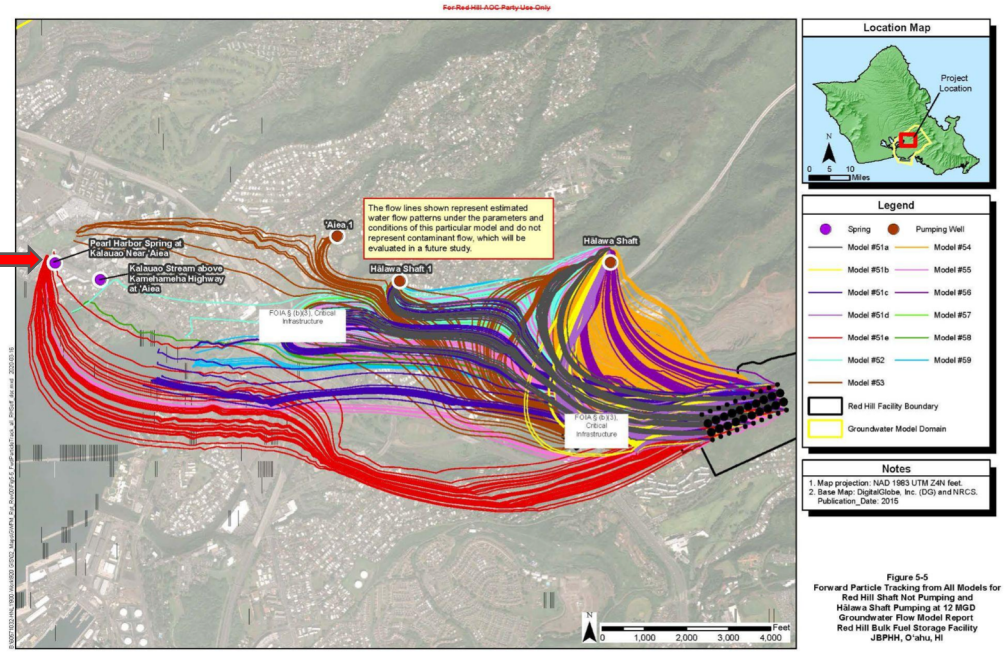
Survey 8 sites, pre- and post- discharge, and quarterly after.

- eDNA samples
- Water samples for contaminant* (Nelson/WRRC labs) and nutrient analyses
- Habitat documentation (stream width, stream depth, canopy, and picture of sites).
- Species visual survey (presences/absences, categories of abundance)

Collaborate with:
Pacific Biosciences Research Center
Commission on Water Resource Management
Division on Aquatic Resources

2) Relevant research: Surface water sampling

Dulai Lab/LeeCC: Sumida Farms (Kalauao Spring)



Existing monthly water quality monitoring project; added petroleum hydrocarbon screening to the suite of analyses

NAVFAC Hawai'i March 2020 Groundwater Flow Monitoring Report: Figure 5.5 Forward particle tracking from all models for Red Hill Shaft not pumping and Hālawa Shaft pumping at 12 mgd

2) Relevant research: Hydrogeology Investigations in the Moanalua and Pearl Harbor Hydrologic Units of the Honolulu Aquifer - Don Thomas Lab

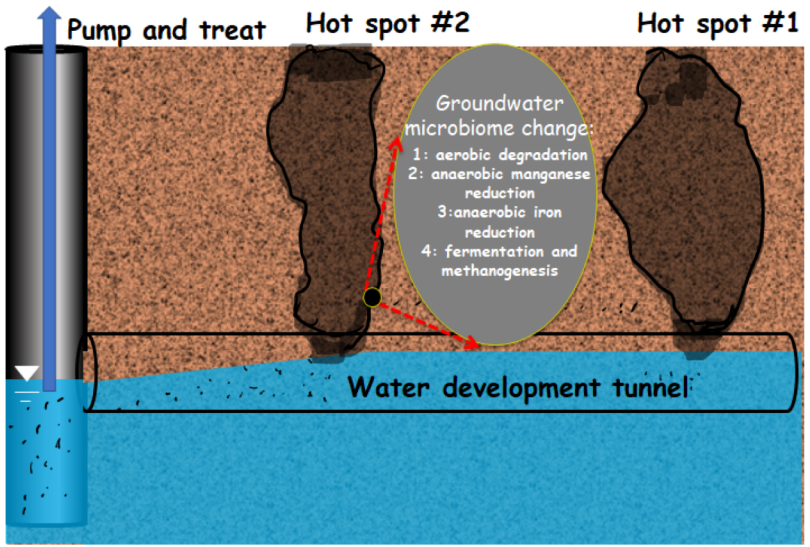
Investigation program cooperatively managed by UH and DOH subject matter experts

- Define key geologic structures that control groundwater flow in the Red Hill Bulk Fuel Storage Facility region
- Analysis of natural and anthropogenic tracers present in the groundwaters in the Red Hill region
- Define groundwater flow rates and directions using in-well logging surveys and regional scale tracer testing
- Conduct petrophysical testing to define how fuel moves toward the water table and how the fuel plume spreads once in the water table
- Provide a detailed conceptual model for groundwater flow
- Develop and refine numerical groundwater flow model that to characterize groundwater flow and contaminant transport (volumes and rates) from beneath the Red Hill fuel facility to any potential receptors in the surrounding region.

2) **Relevant research (pending):**

NSF-RAPID: Understanding Fine-Grained Temporal Dynamics of Groundwater Microbiome Impacted by Petroleum Hydrocarbons **Yan and Kirs labs**

- Previous studies often reported much delayed groundwater microbiome responses after petroleum spills.
- The configuration of the Red Hill well provides unique access to the groundwater microbiome.
- Objectives:
  - 1. Conduct groundwater sample collection and chemical analysis.
  - 2. Characterize the groundwater microbiome to track the temporal dynamics of key biogeochemical processes.
- Seeking collaboration with DOH/Navy for sample access.



WRRC Spring Seminar Series
Focus on Red Hill

THIS Friday Feb 18, 2pm HST

Biodegradation of Petroleum Hydrocarbons Controls Their Fate and Transport in Subsurface Environments

Dr. Tao Yan, UH Mānoa CEE/WRRC

Join Zoom Meeting: https://hawaii.zoom.us/j/97587948666
Meeting ID: 975 8794 8666
Passcode: 756016

For Information: Keri Kodama (kodamak8@hawaiʻi.edu)

2022 Spring Seminar Sponsored by:
Water Resources Research Center
University of Hawaiʻi at Mānoa

Friday, February 18, 2022 • 2 pm (HST)
ZOOM Meeting

BIODEGRADATION OF PETROLEUM HYDROCARBONS CONTROLS THEIR FATE AND TRANSPORT IN SUBSURFACE ENVIRONMENTS

Tao Yan

Exploration and consumption of petroleum hydrocarbons have led to frequent oil spills and contamination of aquatic and terrestrial ecosystems. Although every spill can have catastrophic consequences to the local ecosystem, contamination of groundwater aquifers represents the most direct and long-lasting threat to human health. This presentation will provide an overview of the current scientific understanding of microbial capabilities in degrading petroleum hydrocarbons. The dominant factor determining the fate of petroleum hydrocarbons in subsurface environments is biodegradation. We will discuss how the subsurface environmental conditions poses peculiar challenges to the biodegradation kinetics of petroleum hydrocarbons and contribute to their persistence. Finally, we will explore how biodegradation could potentially alter the transport behaviors of petroleum hydrocarbons and their degradation products, which presents unknowns and uncertainties to groundwater quality and human health.

Dr. Tao Yan is a professor at the Department of Civil and Environmental Engineering and Water Resources Research Center at the University of Hawaiʻi at Manoa. His research interests are in the areas of environmental health microbiology and has recently focused on the microbiological quality of Hawaiʻi's coastal water, wastewater infrastructure for further human health protection (including pandemic detection), bacterial antimicrobial resistance in natural and built environments, and biodegradation of recalcitrant organic compounds in the environment. He is a strong advocate and practitioner of the transdisciplinary education of the next generation environmental engineers, and has mentored numerous MS/PhD students and postdoctoral research fellows.

For more information contact:
Keri Kodama
kodamak8@hawaii.edu
808-956-3097

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Meeting ID: 975 8794 8666
Passcode: 756016

Meeting room will be open 10 minutes before event.

2) **Relevant research**: Social science investigation with affected communities

Purpose:

- Investigate the impacts of the Red Hill crisis on the well-being of the Navy Water System users
  - Economic and emotional
  - How individuals and families day-to-day activities have been affected
- Examine the perceptions, knowledge, attitudes, and behaviors towards the water contamination
  - Trust / lack of
  - Communication / source of information

Methods:

- Unstructured interviews / talk story with key informants
- Focus groups
- Online surveys

Federal Support for Task Force

- **Now:** ONR- Preliminary activities: Reallocation of funds from existing Office of Naval Research award to UH (VP Syrmos, PI)
- **Coming soon:** Navy- Purchase of triple quad GC/MS
- **Request submitted:** Navy- Additional laboratory equipment
- **Request submitted:** Navy- Hydrogeological study (Don Thomas)
- **Proposal invited:** NSF-RAPID project to study temporal dynamics of groundwater microbiome impacted by petroleum hydrocarbons (Tao Yan & Marek Kirs)
- **Request in preparation:** DoD- Hawaiʻi-USAPI Water Security Program
  - Address the long-term monitoring and research concerning the current Red Hill contamination
  - Comprehensive research and outreach to address water degradation in and near DoD facilities in Hawaiʻi and the USAPI
  - In Hawaiʻi, partner with CWRM, DOH, HBWS, and USGS-PIWSC
  - In USAPI, partner with ASPA (Amer. Samoa) and WERI (U. of Guam), USGS-PIWSC, and others

Mahalo