Hawaii Department of Health Functional Equivalent Discharge Strategy

Workshop #4

August 26, 2024

The mission of the Department of Health is to protect and improve the health and environment for all people in Hawai'i.

Agenda for Today

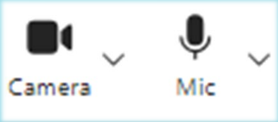
TIME	TOPIC
9:00am – 9:15am	Meeting Kickoff: Welcome and Objectives
9:15am – 9:45am	Evaluating Functional Equivalency Factors
9:45am – 10:35am	Ranking Functional Equivalency
10:35am – 10:50am	Open Forum: Other Thoughts on Criteria and Prioritization for Permitting
10:50am – 11:00am	Next Steps and Thank You
11:00am – 11:15am	"Hallway Chat" – open time for anyone to stay to chat for a few minutes with DOH and others

Meeting Approach and Ground Rules

- **Collaborative, Inclusive Environment**
  - Be respectful and listen to others.
  - No organizational or personal attacks.
  - Meeting is not being recorded.
  - Please ask questions as we proceed.

- **Active Participation Encouraged**

  - Use “Raise Hand” button to indicate you would like to speak.
  - Use “Chat” function with any questions or to share a comment.
  - Turn on your camera if able and willing to do so when speaking.
  - Mute your mic when not speaking.
  - Please identify yourself when you speak.



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What type of organization do you represent?

ⓘ Start presenting to display the poll results on this slide.

Meeting Approach and Ground Rules

- **Helpful Mindsets**
  - Share your experiences and wisdom.
  - Be open-minded and solution-oriented.
  - If clarification is needed, just ask for it!



This meeting is not being recorded

Welcome and Objectives

Welcome and Objectives

- Last meeting:
  - NPDES permit overview
  - Water quality-based effluent limitations
  - Potential permit tools (compliance schedules, zones of mixing, variances)
- Today:
  - Reminder of SCOTUS factors for FE discharges and discuss applicability in Hawaii
  - Consider the factors and discuss how they relate to developing criteria for determining FE discharges in Hawaii
  - Gain stakeholder feedback on FE factors and how they relate to prioritization of permitting efforts

  - Overall, doing this work to protect aquatic life, human health, and other beneficial uses of State waters.




Overall Goals of Hawaii's FE Strategy

- **Identify potentially affected facilities.**
- **Prioritize facilities for regulatory coverage.**
- **Develop permitting strategy that…**
  - Acknowledges both general permits (for similar types of facilities) and individual permits may be needed.
  - Requires facilities to make the decision to seek permit coverage in accordance with the longstanding principles of the NPDES program.
  - Includes FE discharge determination criteria for applicability.
  - Creates regulatory certainty for potentially affected facilities.
  - Addresses the new FE requirement using DOH's current limited resources.
  - Creates cross-programmatic consistency between affected DOH programs regarding UIC, wastewater reuse, NPDES permits, OSDS approvals, etc.
  - Promotes "no discharge" alternatives, such as wastewater reuse.
- **Determine what is needed to support the permitting strategy (e.g., revisions to statutes and rules, resources).**

Evaluating Functional Equivalency Factors

Problem Statement

SCOTUS decision states underground injection facilities must get an NPDES permit if there is a Functional Equivalency to a point discharge

- Only provided very general guidance on what constitutes a functional equivalency
- US District Court for the District of Hawaii provided some further direction but basis for determining functional equivalency still very vague

Our job is to develop a basis for determining Functional Equivalency

- Functional Equivalency has already been legally established for the Lahaina WRF
  - Provides a reference point for determining Functional Equivalency

SCOTUS FE FACTORS

- Transit time
- Distance traveled
- Nature of material through which pollutant travels
- Extent to which the pollutant is diluted or chemically changed as it travels
- Amount of pollutant entering the navigable waters relative to the amount that leaves the point source
- The manner by which the pollutant enters the navigable waters
- The degree to which the pollution maintains its specific identity

Additional US DC-Hawaii Factors

- Volume of injection reaching the navigable waters
- Impact to the ecosystem

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[Beginning of Session] What do you think are the MOST USEFUL FACTORS for Hawaii in determining if a FE discharge exists that should be prioritized for permitting? (Select up to 4)

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Transit Time

SCOTUS, < many years a NPDES permit may be required

US DC-Hawaii suggests 2 * 9-10 (i.e., 18-20) months travel time was sufficient to support an NPDES permit requirement but did not exclude longer travel times

Important but difficult factor to quantify

Directly related to:

- Distance
- Groundwater velocity

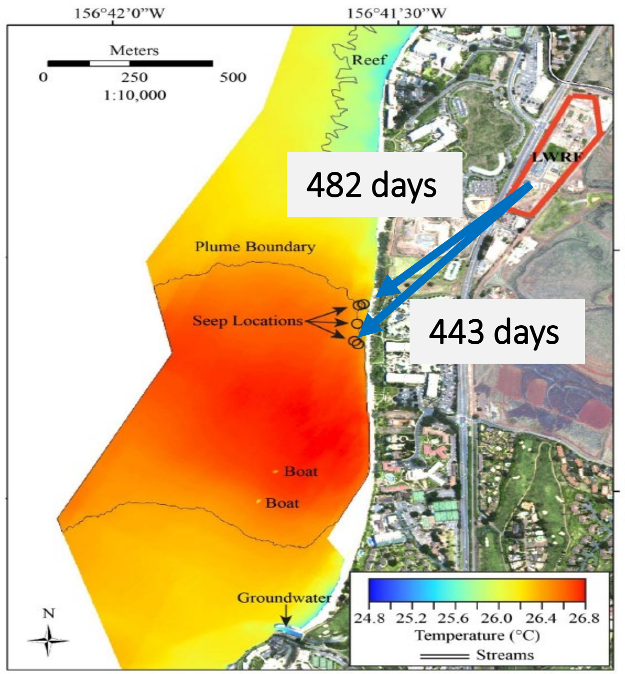


Figure ES-5: Aerial TIR sea surface temperature map thermal anomaly at North Kaanapali Beach.
The TIR plume is > 575 m (1886 ft) in width (from the shoreline to the edge of the flight line). There is less than 0.6°C temperature variation within the plume area. The lagoon emptying into the ocean at the southern end of the figure is fed by cold groundwater. Submarine spring (seep) locations are shown on the map correspond to small-scale and semi-isolated thermal anomalies.

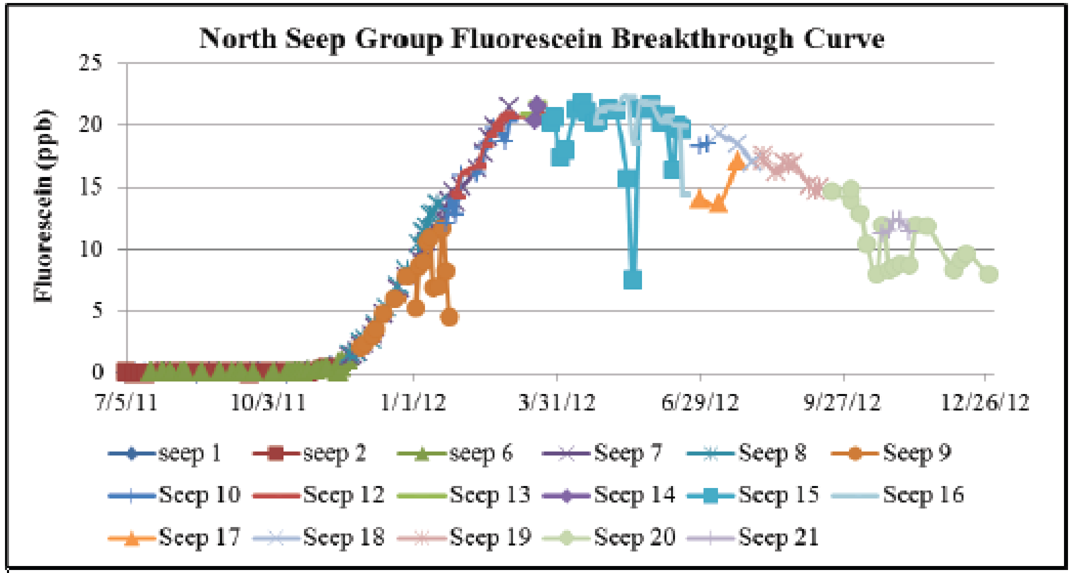


Figure 4-14: The FLT breakthrough curve measured at the NSG for each submarine spring.

Figure 4-5: Mixing fluorescein in 55 gal. drums.

Groundwater Velocity

Can be directly measured by a tracer test

- May be difficult and expensive to conduct
- No guarantee of detecting tracer in receiving waters

Factors affecting groundwater velocity

- Aquifer material (geology)
- Ambient groundwater flow
- Absence/presence of caprock
- Pumping or injection rate

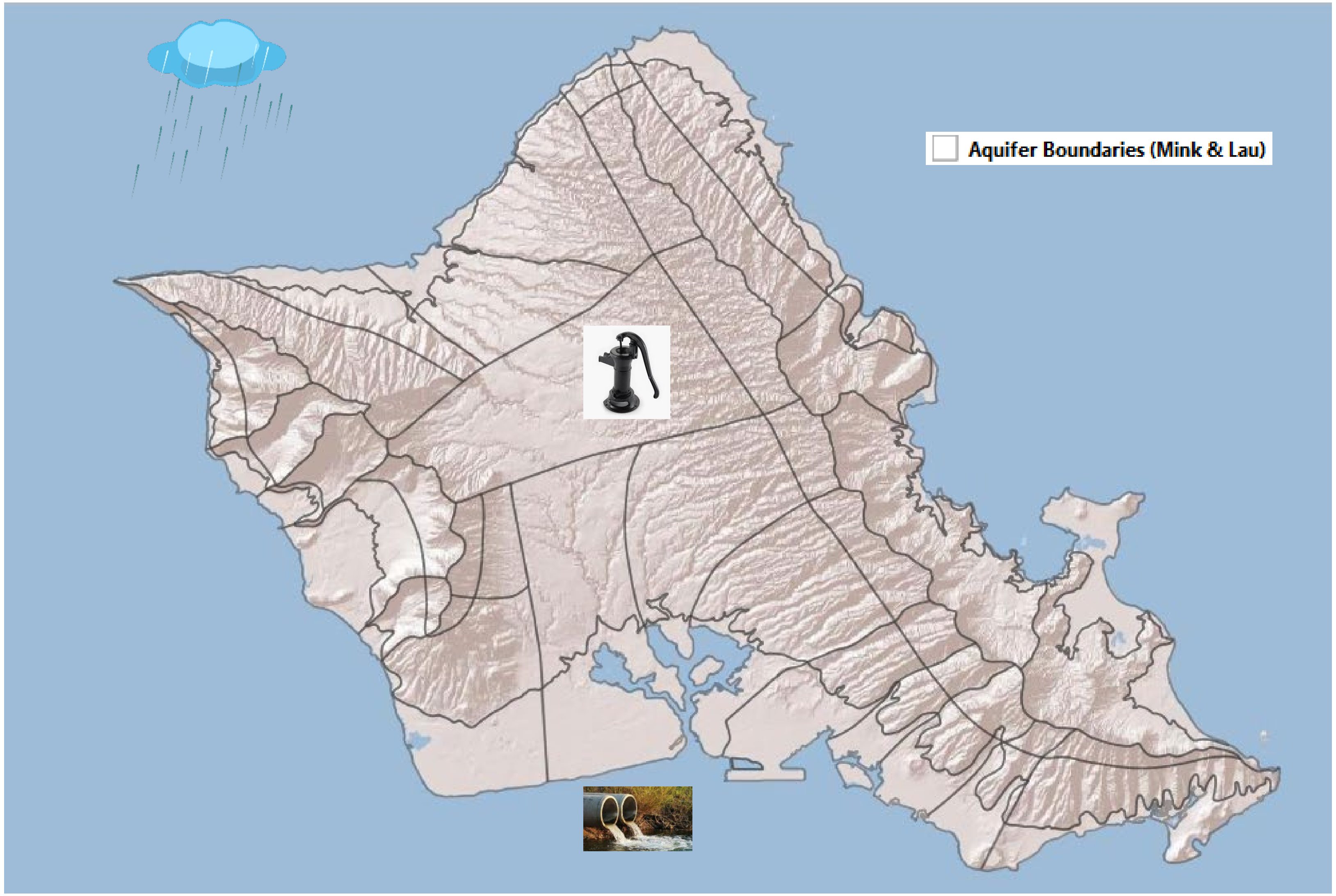
Very wide range of velocities depending on hydrologic / geologic conditions

Figures from Glenn et al., 2013

Range of groundwater velocities measured by tracer tests

Study	Geology	Coastal Setting	**Distance (m)**	Mean Vel (m/d)	Time (d)	Reference
Lahaina GW Tracer Study	Tracer dye test in sewage injection wells. Coastal; submarine spring in thin caprock Forced injection at 3 mgd; Mean velocity based on time for 50% of the mass to discharge	Confined Groundwater	821-932	1.7-2.1	443-482	Glenn et al., 2014
USGS Waipahu Tracer Test	Bromide tracer test to municipal production well pumping at 2.5 mgd	N/A, Aquifer Test	119	11.9	10	Gupta et al., 1990
Wheeler Army Airfield Tracer Test	Natural gradient test, two observation wells	N/A, Aquifer test	33 & 160	0.7 & 1.6	47 & 100	AFCEE, 2007
Puako, West Hawaii Island	Natural gradient tracer test	Unconfined, no caprock, moderate groundwater flow	~30	3-4	7.5-10	Abaya et al., 2018 & Wiegner et al., 2021
Hilo Bay, East Hawaii Island	Natural gradient tracer test	Unconfined, no caprock, high groundwater flow	~200	130	1.5	Waiki, 2022

Groundwater Velocity



Distance Traveled

- SCOTUS, < 50 miles
- US DC-Hawaii – 1.5 miles x 2 (=3 miles)
- Can be directly measured, distance and transit time are related
- State of Hawaii Nearshore Sewage Pollution Study showed nitrate impacts from residential wastewater algal tissue nitrogen chemistry regardless of distance

Lava tube in Hawaii Lava Tubes - Hawaiʻi Volcanoes National Park (U.S. National Park Service) (nps.gov)

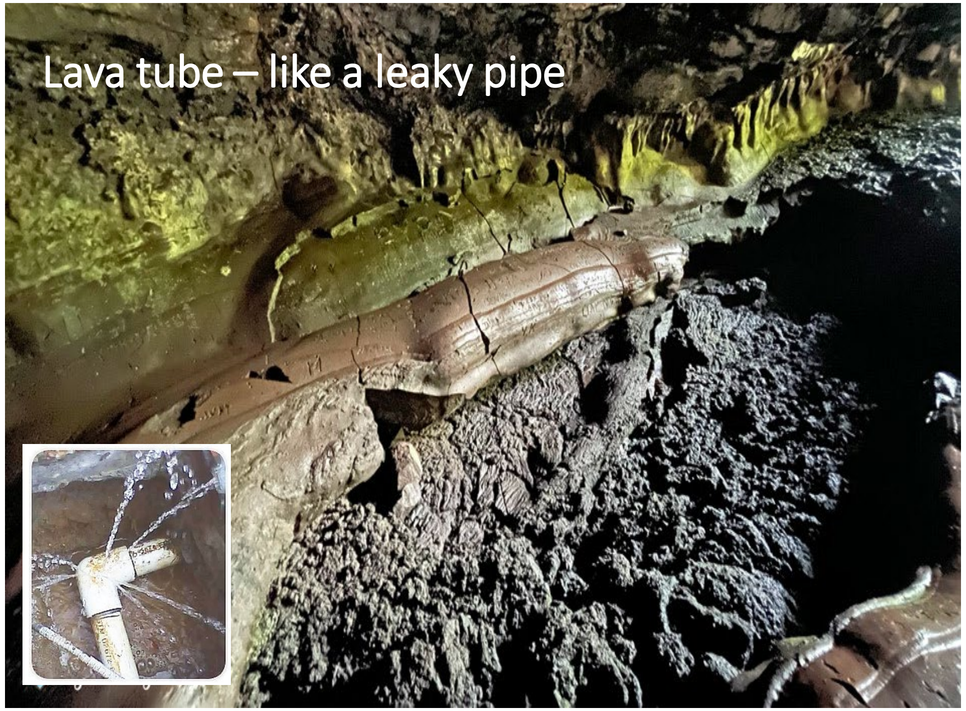
Nature of material through which the pollutant travels

US DC-Hawaii – determining factor is how closely the aquifer material resembles a pipe, but other factors must be considered

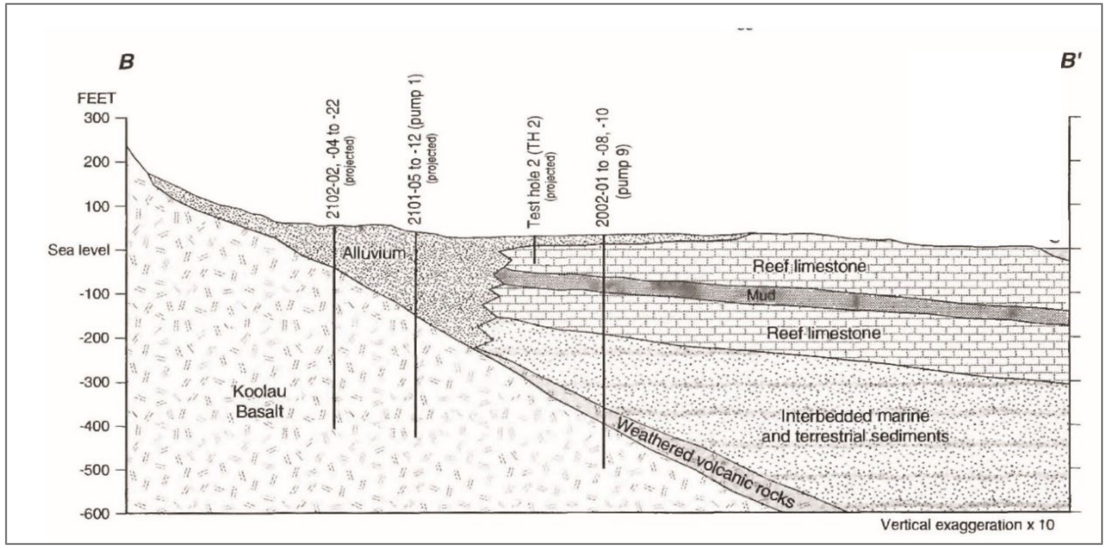
Degree of resemblance to a pipe

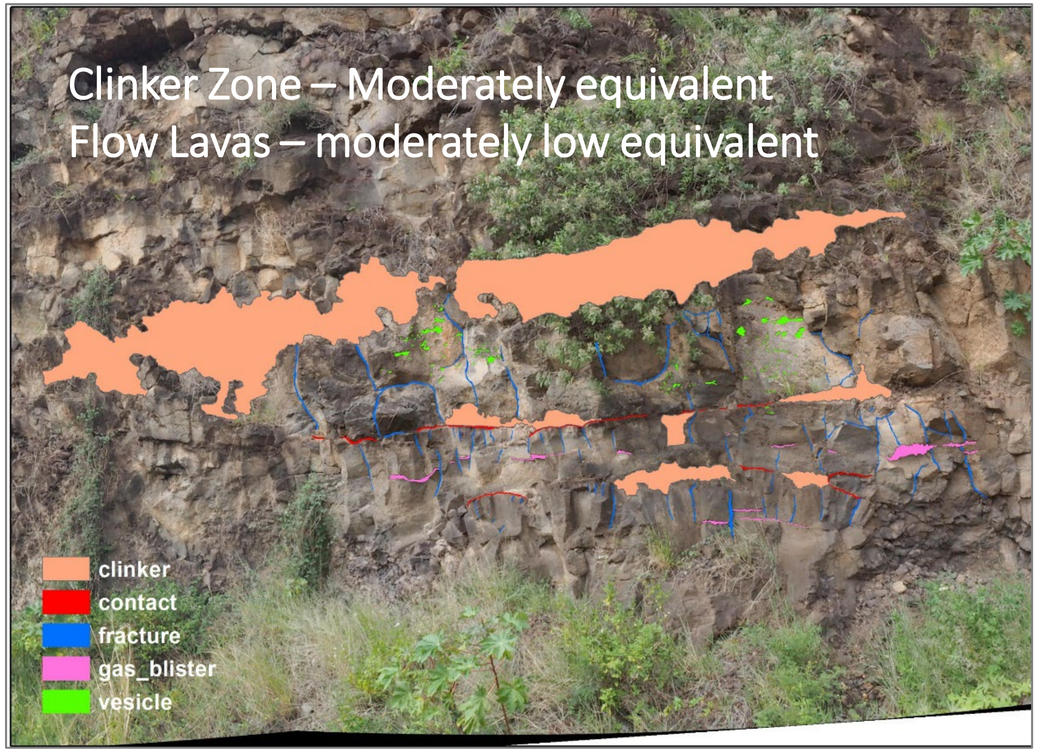
- Lava tube – High
- Flow lavas – Medium
- Sedimentary formations
  - *Karst – High*
  - *Unconsolidated – Low*

Sub-surface features may be difficult to assess



- Sediments – low equivalency
- Reef Limestone – high equivalency due to karst features





Karst

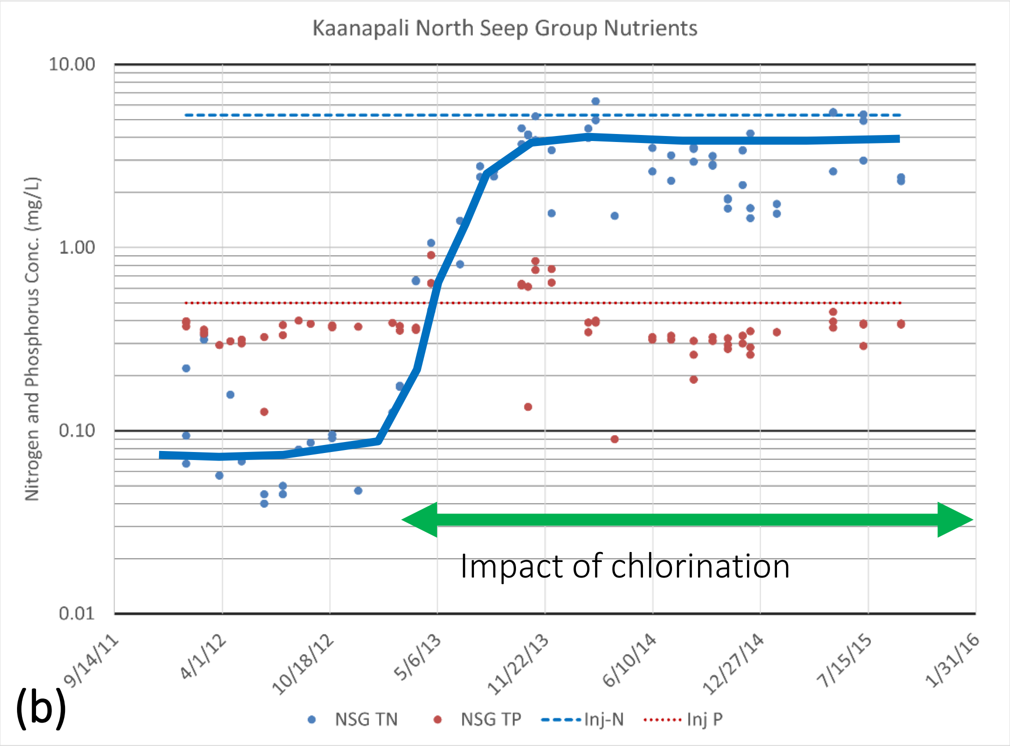
Extent to which the pollutant is diluted or chemically changed

US DC-Hawaii based this factor on how much the pollutant concentration was decreased in transit

Ruled in Maui Co.'s favor on this factor due to demonstrated dilution and denitrification

Can be assessed by:

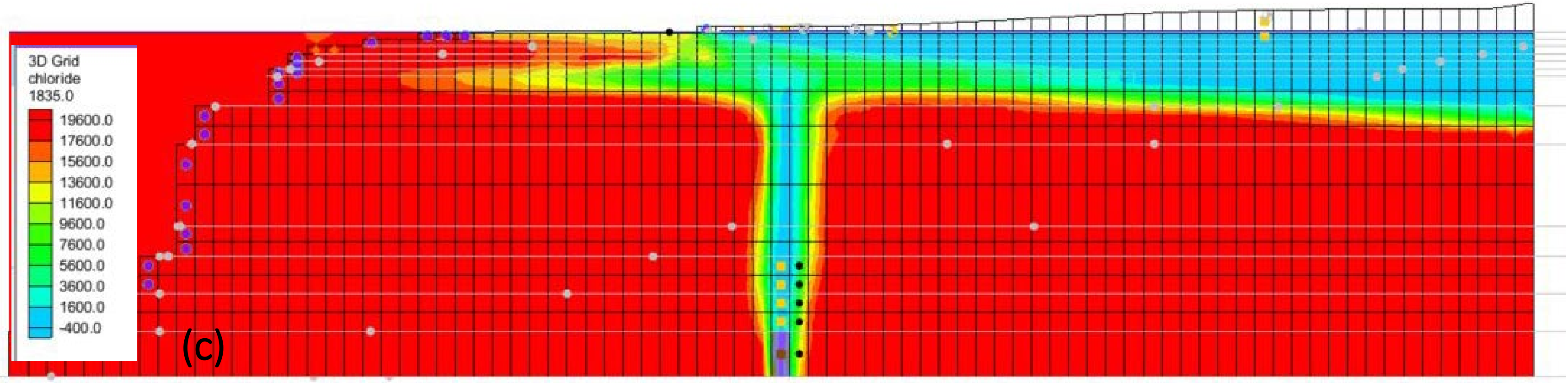
- Direct measurement if representative seeps can be found
- Dilution can be estimated by computing ambient groundwater flow per unit length of shoreline
- Numerical models



Can assess dilution and chemical change by sampling if a good seep can be found (a).

Numerical modeling can assess multiple factors including dilution and chemical change. This cross-sections (c) shows the dilution of freshwater injected into saline water.

Sampling at Kaanapali shows N reduction due to denitrification before chlorination and no N reduction after chlorination disrupt denitrification (b).



The amount of pollutant entering navigable waters relative to that injected

For Lahaina, US DC-Hawaii considered wastewater the pollutant and 100% of the injected wastewater eventually enters navigable waters.

However, logic and previous workshops concluded that pollutant/contaminant load should be considered.

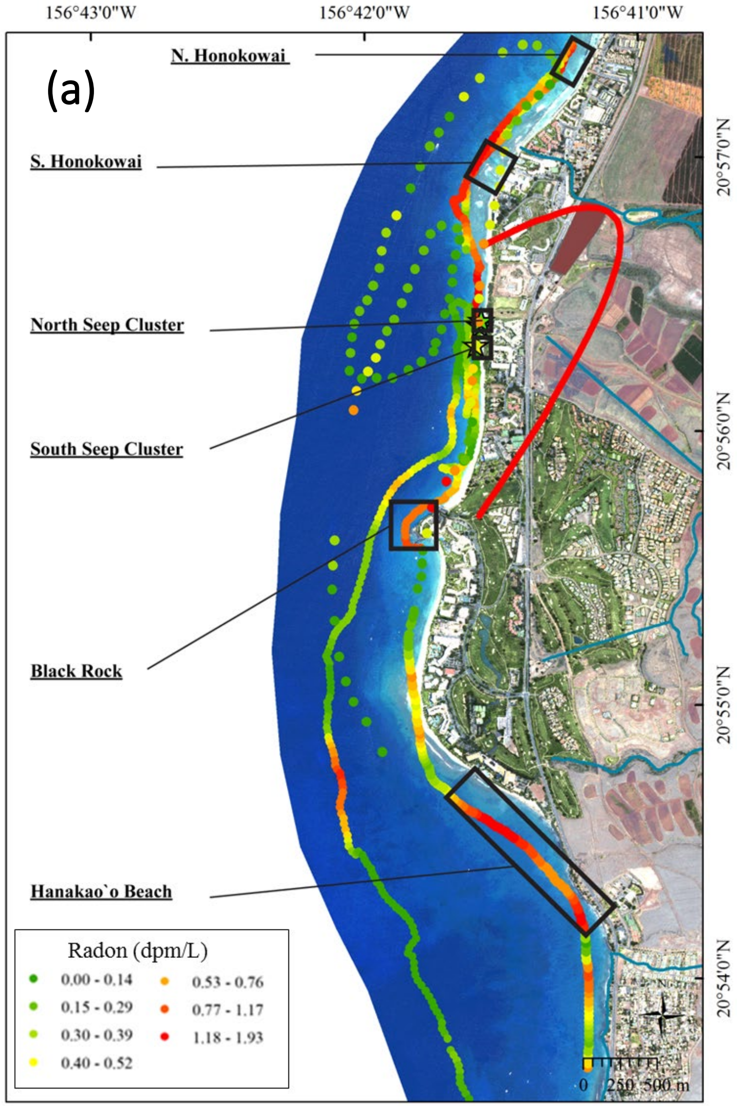
We assess load under Volume

Can be measured at point of injection and potentially at a point of ocean entry if representative seep can be found.

Sampling sea floor discharge of injectate is very difficult

Examples:

Total groundwater flow can be measured using dissolved radon technology. However, doesn't discriminate between ambient groundwater and injectate (a)



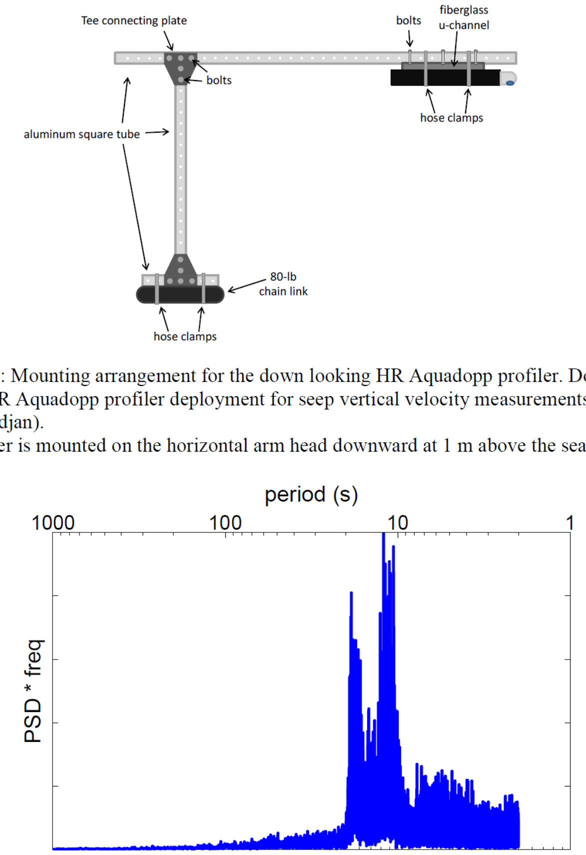


Figure 3-1: Mounting arrangement for the down looking HR Aquadopp profiler. Down-looking HR Aquadopp profiler deployment for seep vertical velocity measurements (sketch by J. Sevadjan).
The profiler is mounted on the horizontal arm head downward at 1 m above the sea floor.

Figure 3-2: ADCP vertical velocity spectral analysis graph. Spectral analysis of vertical velocities from the Oct. 17-19, 2012 deployment.
The two peaks in the vertical velocity spectra are at periods $T \sim$ 10-13 s and 18-21 s, likely due to a combination of shorter- and longer-period surface swell.

Point measurements of water velocity can be measured with instruments such as an Acoustic Doppler Profiler (b).

However, many limitations such as the ACP measures velocity but not volume, velocity decays rapidly over short distances from the seep.

The manner by or area in which the pollutant enters the navigable waters

This refers to direct versus diffuse discharges

Maui Co. contended that the majority of the LWRF discharge was diffuse so was not equivalent to a point discharge

- US DC-Hawaii did not accept this argument because diffuse or direct, the discharge still occurred relatively close to the submarine springs
- This situation may be different under differing geologic and distance from the coast conditions
- Will relate to material through which pollutant travels and distance from the coast

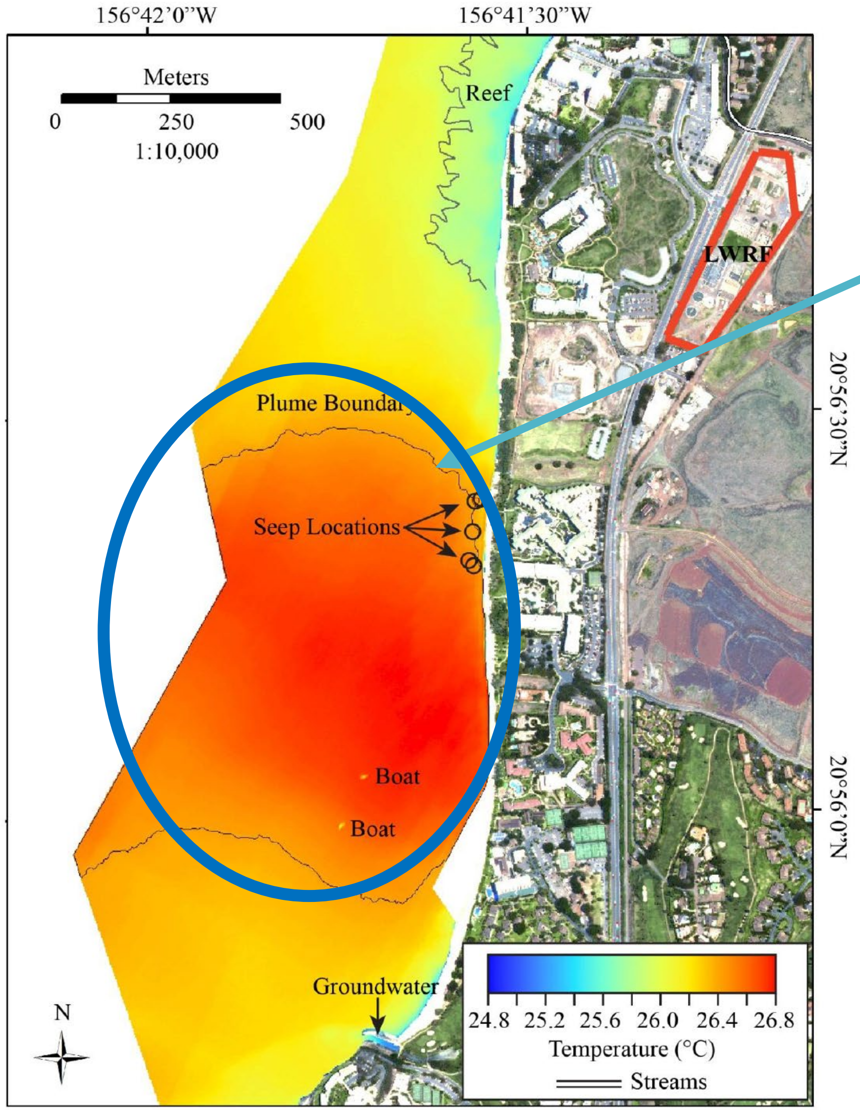


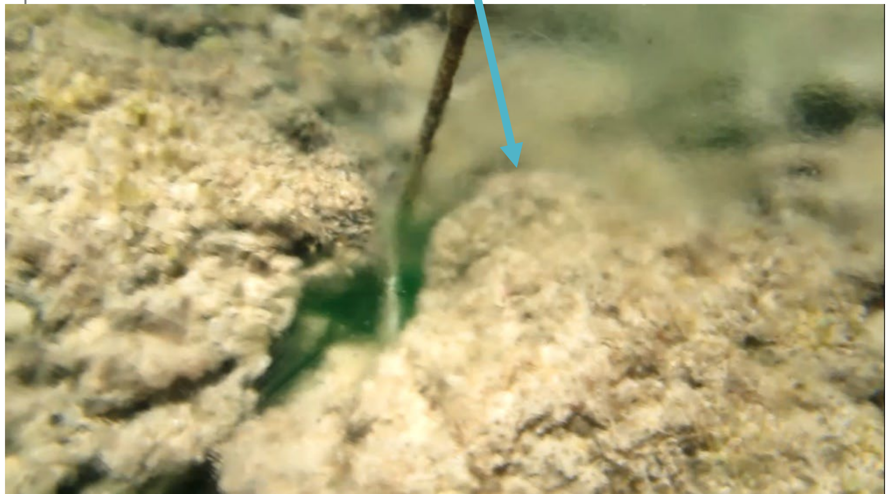
Figure ES-5: Aerial TIR sea surface temperature map thermal anomaly at North Kaanapali Beach.

The TIR plume is > 575 m (1886 ft) in width (from the shoreline to the edge of the flight line). There is less than 0.6°C temperature variation within the plume area. The lagoon emptying into the ocean at the southern end of the figure is fed by cold groundwater. Submarine spring (seep) locations are shown on the map correspond to small-scale and semi-isolated thermal anomalies.

Diffuse

versus

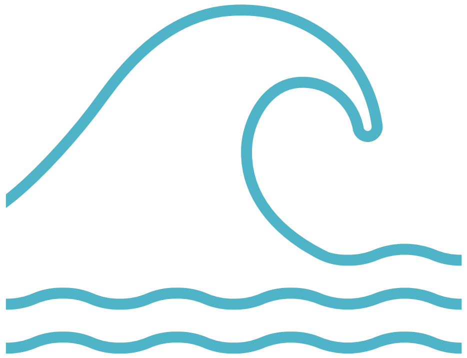
Point Discharge

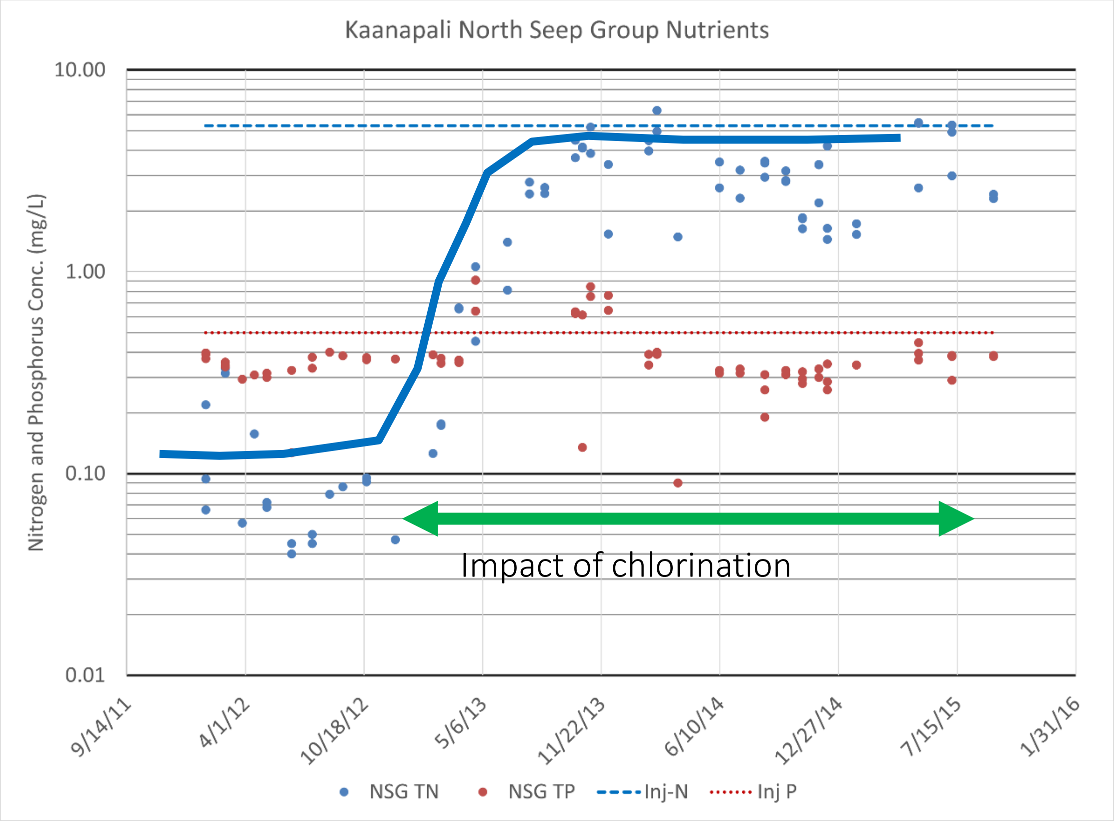


The degree to which the pollution maintains its specific identity

US DC-Hawaii viewed the LWRF injectate as mixture of contaminants with the wastewater itself being the pollutant.

- While some contaminants will degrade or be diluted, the pollutant (wastewater) still maintains its identity.
- Regulators need to settle on a definition of identity.
- The easiest first pass would be to follow the US DC-Hawaii example and define wastewater rather than individual species as the pollutant.





As previously discussed, chemical transformation/degradation can occur during transit. At Lahaina degradation by denitrification significantly reduces the N load to the nearshore waters.

However, point discharge sampling sites such as are present at Lahaina may not be available elsewhere making transformation/degradation difficult to confirm.

The volume of the pollutant reaching navigable waters

Added by US DC-Hawaii

Consider:

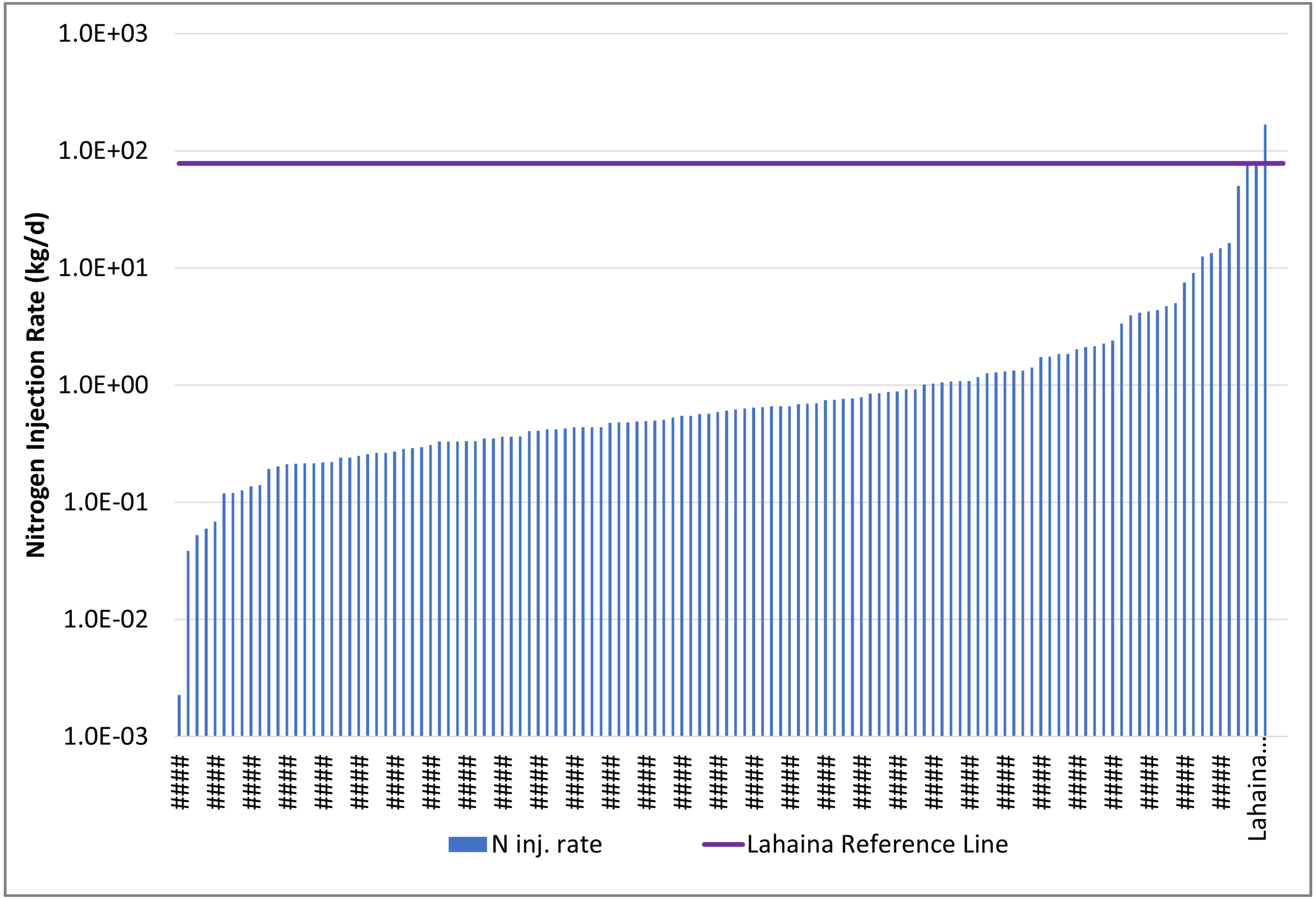
- Absolute injection volume
- Amount that can be accounted for at a point discharge

- Amount injected can be obtained from permits and reports
- Amount accounted for at a point discharge is extremely difficult
  - *But all will eventually reach navigable waters unless extracted*

Refine definition to something manageable:

→ Mass of primary pollutant injected

Nitrogen



The nitrogen injection mass range covers multiple orders of magnitude.
This is an important candidate for FE ranking.

Impact to the ecosystem

US DC-Hawaii concluded that the impact to the ecosystem could neither be confirmed nor denied and was not a consideration in the judgement.

However, previous FE Strategy meetings have identified this as an important factor. Also:

- Recent research conducted in Hawaii (Goves et al., 2023) show a strong inverse relationship between wastewater discharge with a one-year time of travel to the coast and the coral's ability to recover from a bleaching event
- The State of Hawaii Nearshore Sewage Pollution Study showed a strong relationship between the nitrogen uptake by coastal algae and the density of upslope wastewater discharges

Coastal Algae in Hawaii

Pristine groundwater seeps support native algae on Hawai'i's coasts (smartwatermagazine.com)

Article

Coral reefs benefit from reduced land–sea impacts under ocean warming

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Open access

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Coral reef ecosystems are being fundamentally restructured by local human impacts and climate-driven marine heatwaves that trigger mass coral bleaching and mortality[1]. Reducing local impacts can increase reef resistance to and recovery from bleaching[2]. However, resource managers lack clear advice on targeted actions that best support coral reefs under climate change[3] and sector-based governance means most land- and sea-based management efforts remain siloed[4]. Here we combine surveys of reef change with a unique 20-year time series of land–sea human impacts that encompassed an unprecedented marine heatwave in Hawai'i. Reefs with increased herbivorous fish populations and reduced land-based impacts, such as wastewater pollution and urban runoff, had positive coral cover trajectories predisturbance. These reefs also experienced a modest reduction in coral mortality following severe heat stress com...

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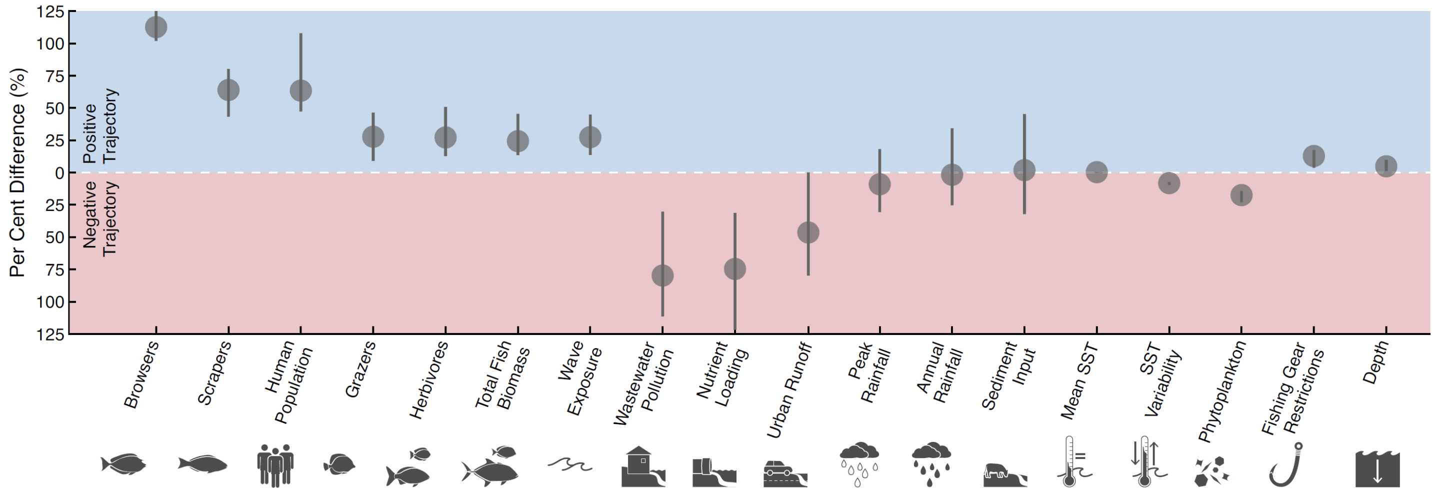
Coastal areas contain some of the most biologically ... ductive marine ecosystems on Earth[6]. But with four t... tion density living within 20 km of the ocean compa... the world[7], **direct human impacts on local scales ar...** restructuring these important marine communities[8]... also affected by stronger and more frequent disturb... human-induced climate change[9]. These human stress... acute on tropical coral reefs where up to 90% of the loc... along the shoreline[10]. Land-based stressors, such as w... tion, combine with sea-based stressors, such as overf... natural ecological feedbacks on reefs[11]. Corals are fu... prolonged periods of anomalously warm ocean tempe... marine heatwaves[12], that can cause mass coral bleachi... and fundamentally transform reef assemblages[14,15].

Reducing human impacts on local scales to mai... integrity has been the guiding model of coral reef ...

[1]Pacific Islands Fisheries Science Center, National Oceanic and Atmosp... UK. [3]Pacific Islands Regional Office, National Oceanic and Atmospheric... Conservancy, Honolulu, HI, USA. [6]Cooperative Institute for Marine and ... University, Hilo, HI, USA. [8]School of Geographical Sciences and Urban ... Pacific Island Network Inventory and Monitoring, Hawai'i National Park, ... [12]SymbioSeas, Carolina Beach, NC, USA. [13]Hawai'i Division of Aquatic Re... [15]Hawai'i Department of Health, Honolulu, HI, USA. [16]School of Ocean ... ✉e-mail: jamison.gove@noaa.gov; g.j.williams@bangor.ac.uk

Goves et al. (2023) found that wastewater loading within a one-year time of travel to the coast was a dominant factor in retarding recovery trajectory from coral bleaching events.

This suggests that impact to ecosystems needs to be an important ranking parameter.



Extended Data Fig. 3 | Per cent difference in mean drop-one jackknife values of local human impacts and environmental factors between positive and negative trajectory reefs. The per cent difference ((V1–V2)/[(V1+V2)/2]; dots) was quantified by taking the ratio of the mean in drop-one jackknife values between positive ($n = 10$) and negative ($n = 8$) trajectory reefs (*sensu*)[88]. Upper and lower bars represent the respective maximum and minimum per cent differences. Blue and red shaded regions indicate factors that were greater on reefs that had positive and negative trajectories, respectively. Zero line represents equal values. Outliers that fell outside a threshold of ±2 standard deviations of the median were removed prior to analysis. See Fig. 1b for reef locations and Fig. 2d for mean absolute differences in factor values. See Methods, Extended Data Table 1, and Supplementary Information for detailed information on local land-sea human impacts and environmental factors.

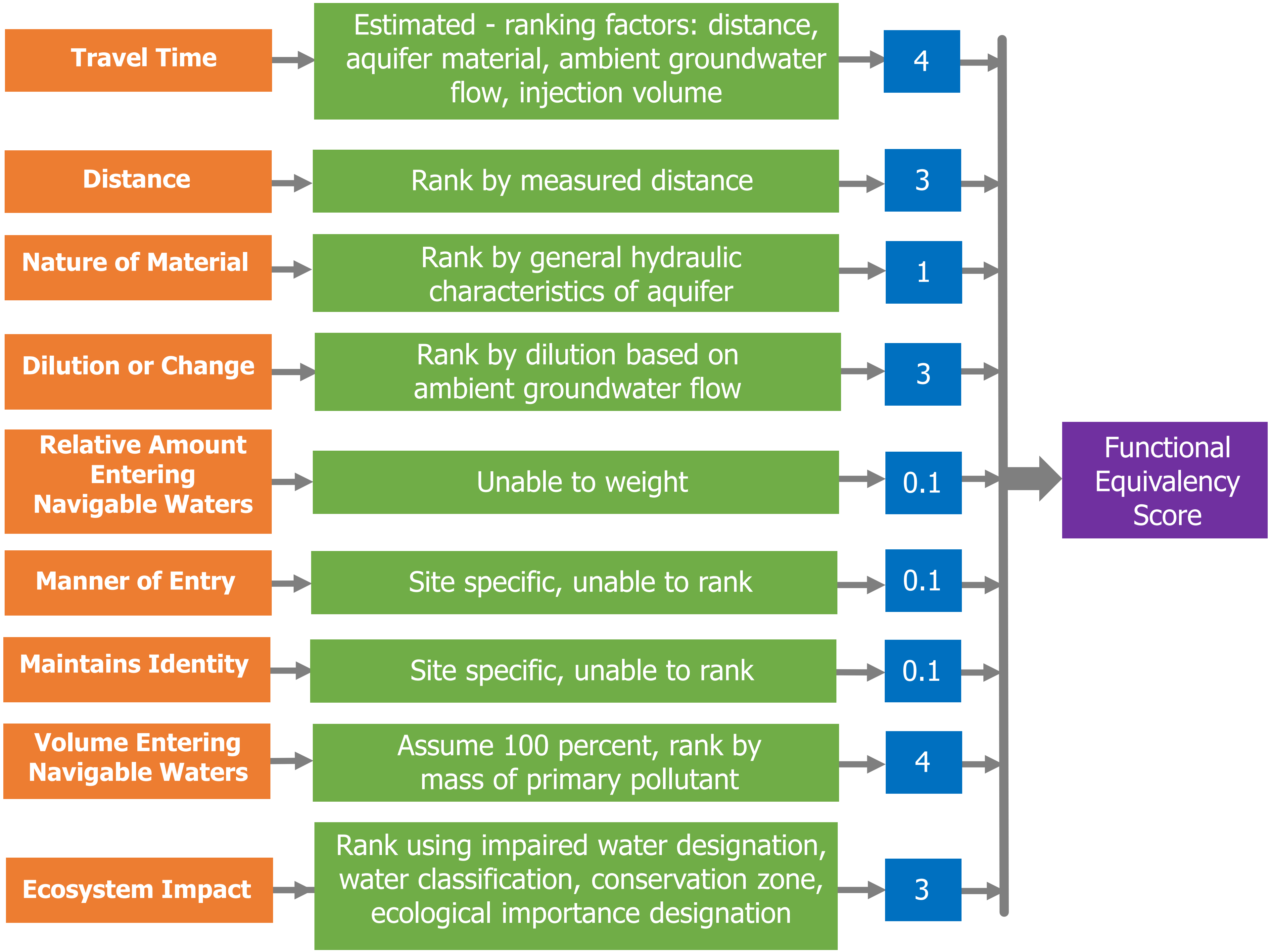
Ranking Functional Equivalency

Approach to evaluate Functional Equivalency

- Rank UIC permittees based on FE factors
- Lahaina provides point of reference since FE has legally been established for this facility
  - Facilities below the Lahaina reference line may still be a FE discharge
- Determine which FE Factors can be evaluated without a site-specific investigation
  - Do relative ranking for these factors
- Sum the rankings for final FE Ranking Score

Assessing factors

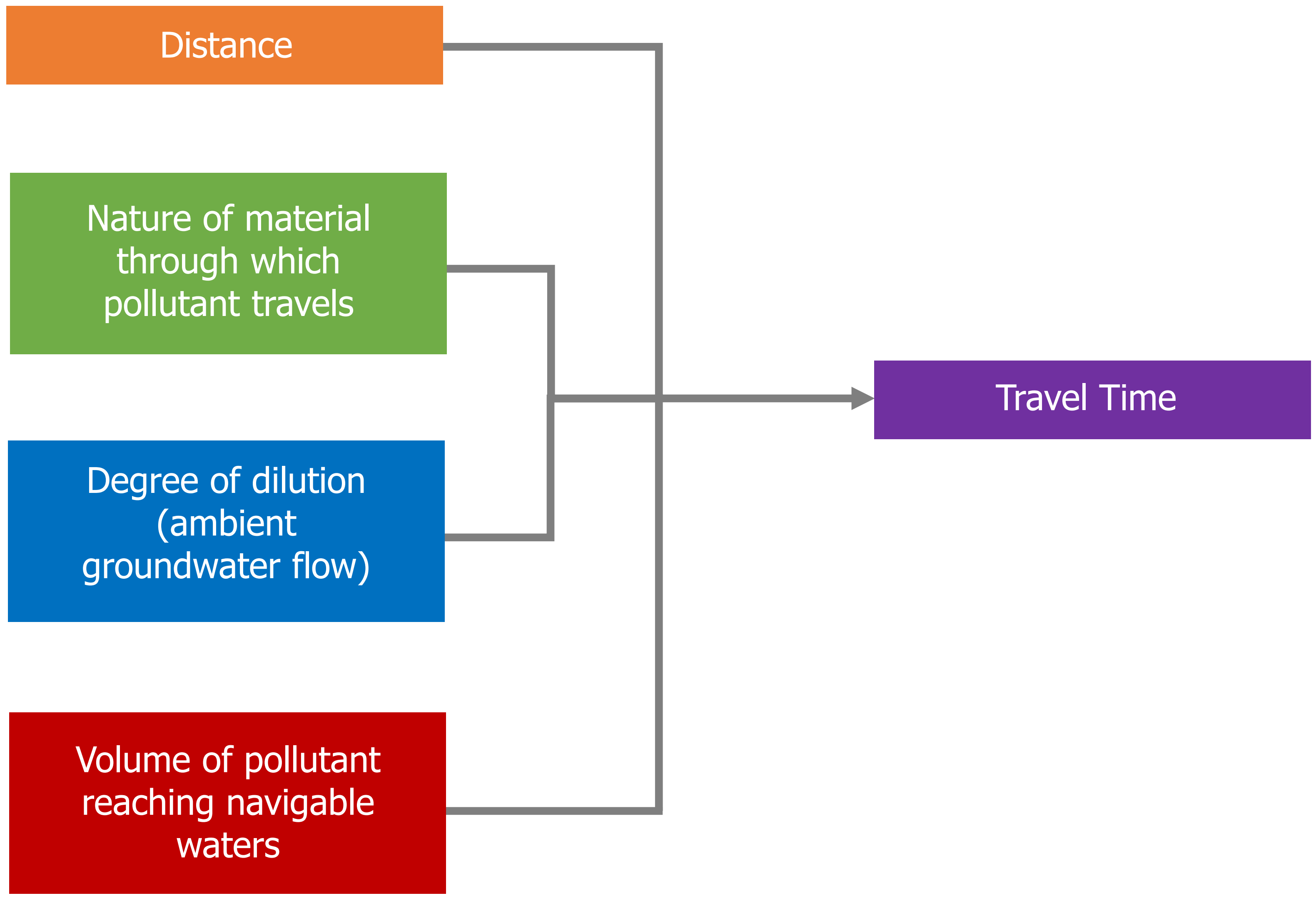
Directly measured factors	**Distance** **Volume entering navigable waters** (since equal to volume injected) **Amount** (pollutant load) **Material**
Calculated	**Dilution factor**
Qualitative assessment	**Travel time** **Manner enters navigable waters** **Maintains identity** **Eco-system impact**
Deemed non-verifiable factors by the US DC-Hawaii	


Travel Time
Estimated - ranking factors: distance, aquifer material, ambient groundwater flow, injection volume
4
Distance
Rank by measured distance
3
Nature of Material
Rank by general hydraulic characteristics of aquifer
1
Dilution or Change
Rank by dilution based on ambient groundwater flow
3
Relative Amount Entering Navigable Waters
Unable to weight
0.1
Manner of Entry
Site specific, unable to rank
0.1
Maintains Identity
Site specific, unable to rank
0.1
Volume Entering Navigable Waters
Assume 100 percent, rank by mass of primary pollutant
4
Ecosystem Impact
Rank using impaired water designation, water classification, conservation zone, ecological importance designation
3
Functional Equivalency Score

Evaluating Transit Time

- This is site-specific and difficult to measure.
- Can estimate relative travel times using governing factors.
  - *Distance*
  - *Aquifer characteristics*
  - *Ambient groundwater flow*
  - *Injection rate*
- Sum factor rankings and divide by four.
- This approach does result in double counting since the parameters used are also FE factors.

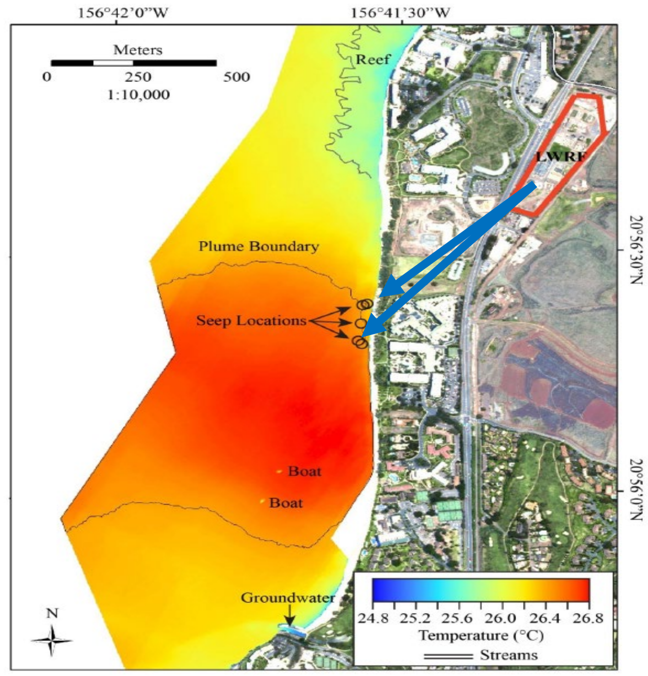
Inter-relationship between factors



Evaluating Distance Traveled

GIS computed direct line from injection well to shoreline.

Does not account oblique groundwater travel paths such as occurs with the Lahaina WRF.



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Evaluating Nature of Material through which the Pollutant Travels

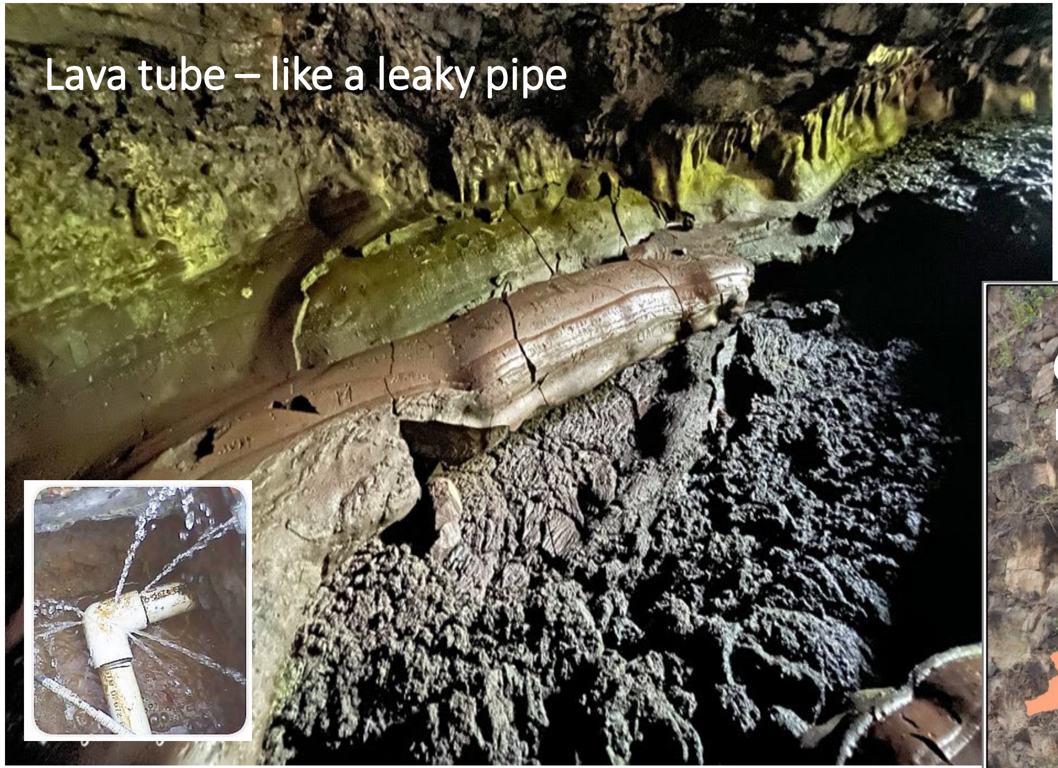
Ranking for similarity to pipe conduit

- Flow lavas where unconfined, high, score=5
- Reef deposits and limestone, high, score=4

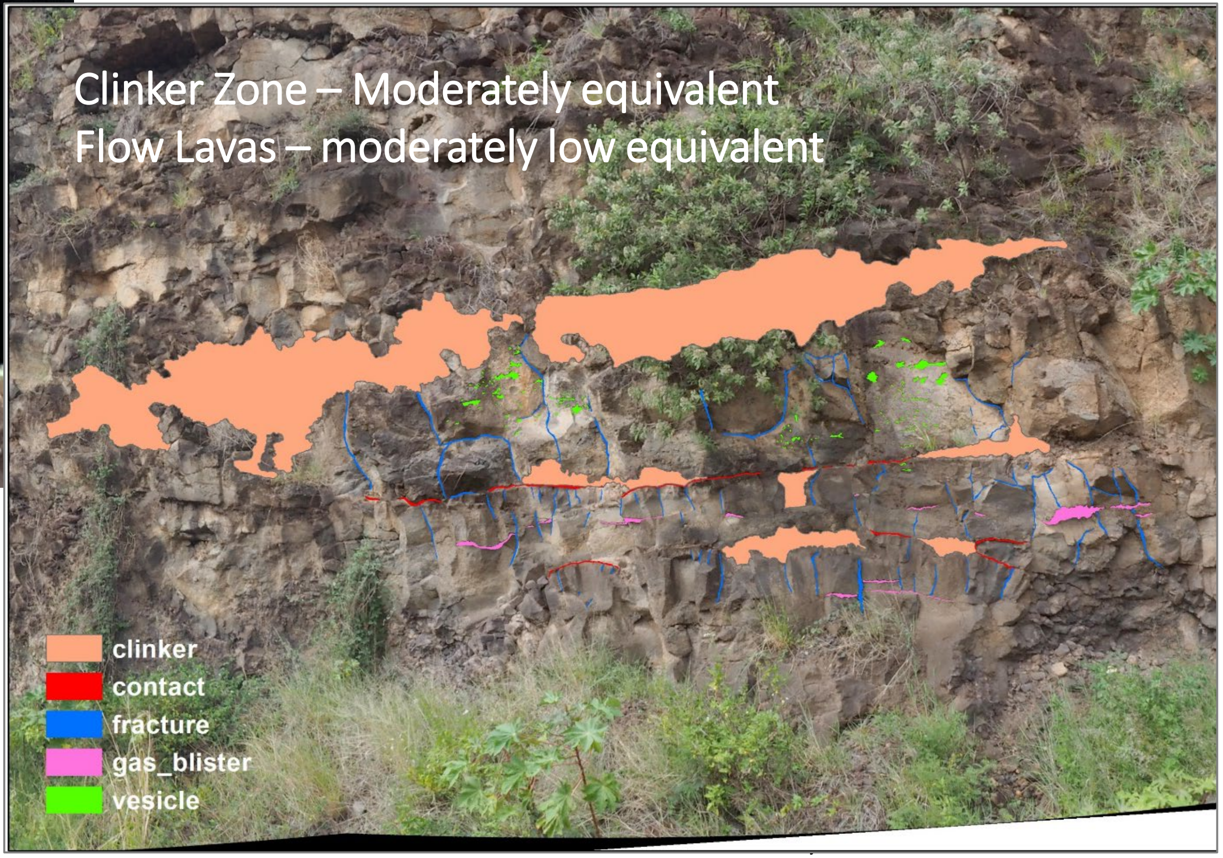
  Karst possible
- High level dike confined aquifers, low, score=2
- Sedimentary where groundwater is confined, low, score=1
- All others, medium, score=3

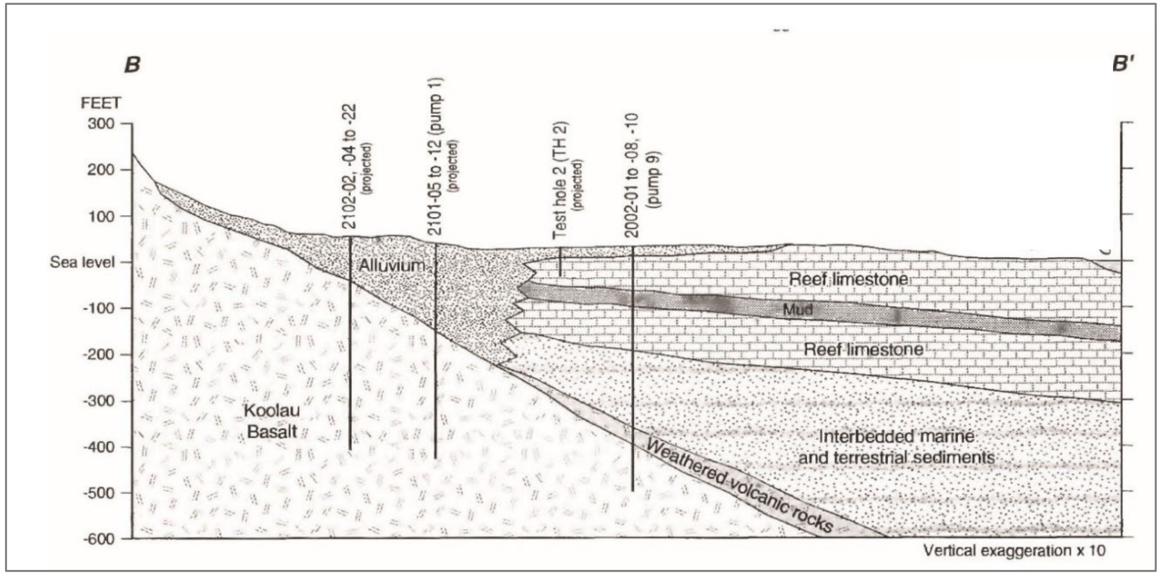
NOTE: Material also influences transit time

Hawaii Reef [Coral Reefs | Hawaii Wildlife Fund (wildhawaii.org)]



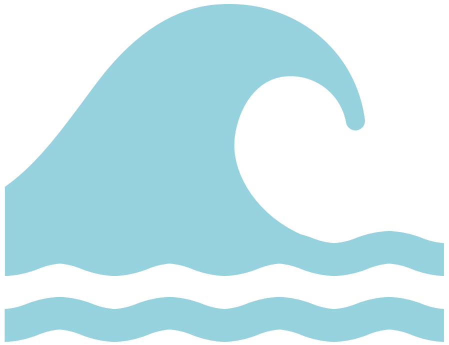
Sediments – low equivalency
Reef Limestone – high equivalency due to karst features

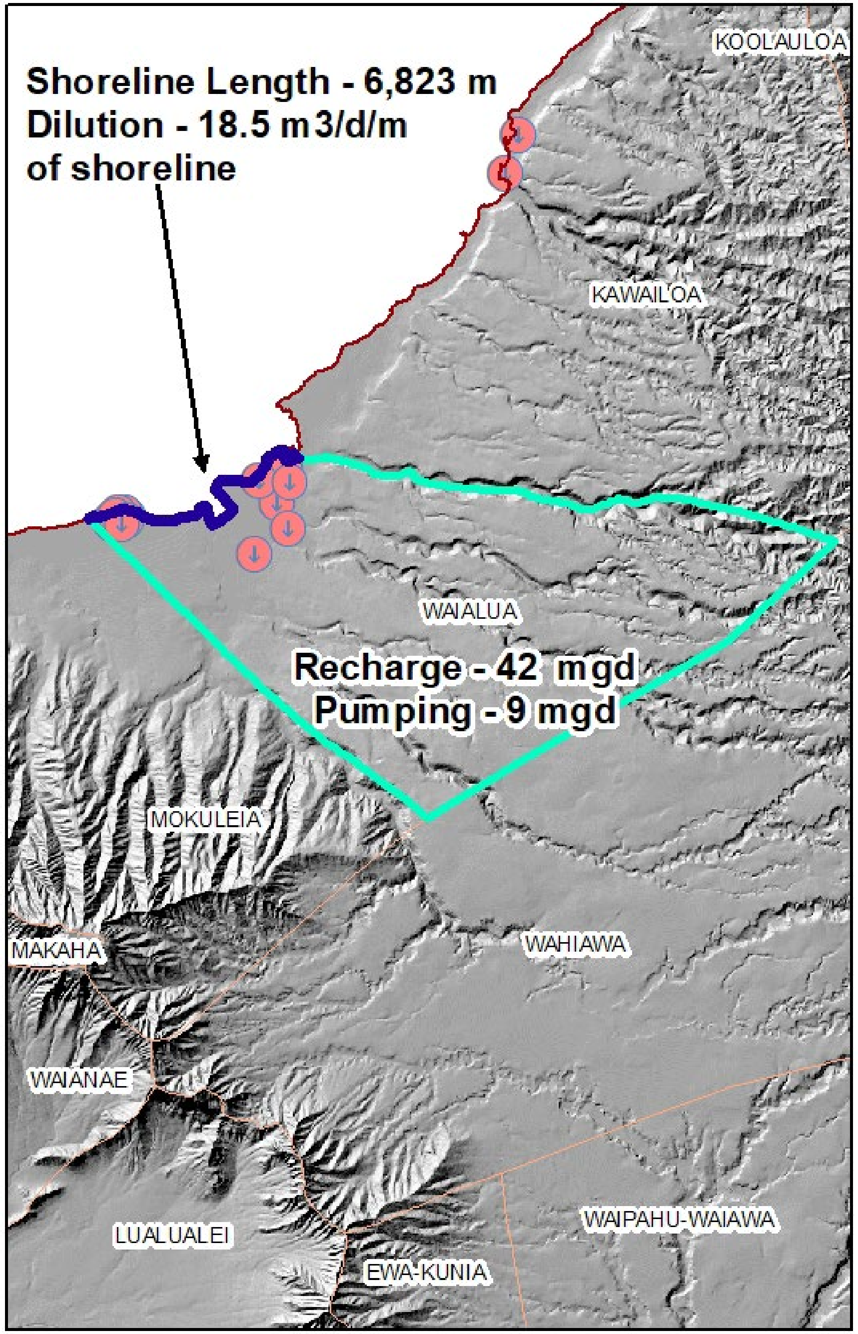




Evaluating extent to which the pollutant is **diluted** or chemically changed

- Evaluation of chemical change/degradation is site specific and difficult.
- Can evaluate dilution by ambient groundwater flow using easily available hydrologic data.
  - Shore line length of an aquifer
  - Recharge rate into the aquifer
  - Pumping from the aquifer





- Use dilution by ambient groundwater discharge at shoreline
- Provides magnitude of ambient groundwater flow that mixes with injectate
- Dilution = (recharge - pumping) / shoreline length
- Example Waialua Aquifer System
  - Recharge = 42 million gal/day
  - Including 29.4 mgd flow from the Wahiawa Aquifer
  - Pumping = 9 mgd
  - Shoreline length = 6,823 m
- Dilution = 18.5 m^3/d/m of shoreline
- Chemical change or degradation not considered in this ranking

Evaluating the amount of pollutant entering navigable waters relative to that injected

Requires calculating the ratio of the pollutant injected to which can be accounted for that enters navigable waters must be determined.

US DC-Hawaii considered wastewater the pollutant and concluded that 100% of the injected wastewater eventually enters navigable waters.

Based on US DC-Hawaii interpretation all injection enters navigable waters making the ratio always equal to one; **not used in this ranking approach**

The manner by or area in which the pollutant enters the navigable waters

- Apparently, this refers to direct versus diffuse discharges.
- Unable to constrain the amount of direct versus diffuse discharges.
- This factor is not considered.

The degree to which the pollution maintains its specific identity

- US DC-Hawaii viewed the LWRF injectate as mixture of contaminants with the wastewater itself being the pollutant.
- Using this interpretation all injectate will maintain its identity.
- This factor is not considered.

The volume of the pollutant reaching navigable waters

Using previous interpretations by the US DC-Hawaii, all injectate eventually enters navigable waters

Rank by mass of primary pollutant injected

This ranking system evaluates wastewater injection and uses nitrogen as the primary pollutant

Amount that can be accounted for at a point discharge

Estimated injected mass of nitrogen using UIC permit applications, UIC data reports, available technical reports, and representative values based on the level of treatment

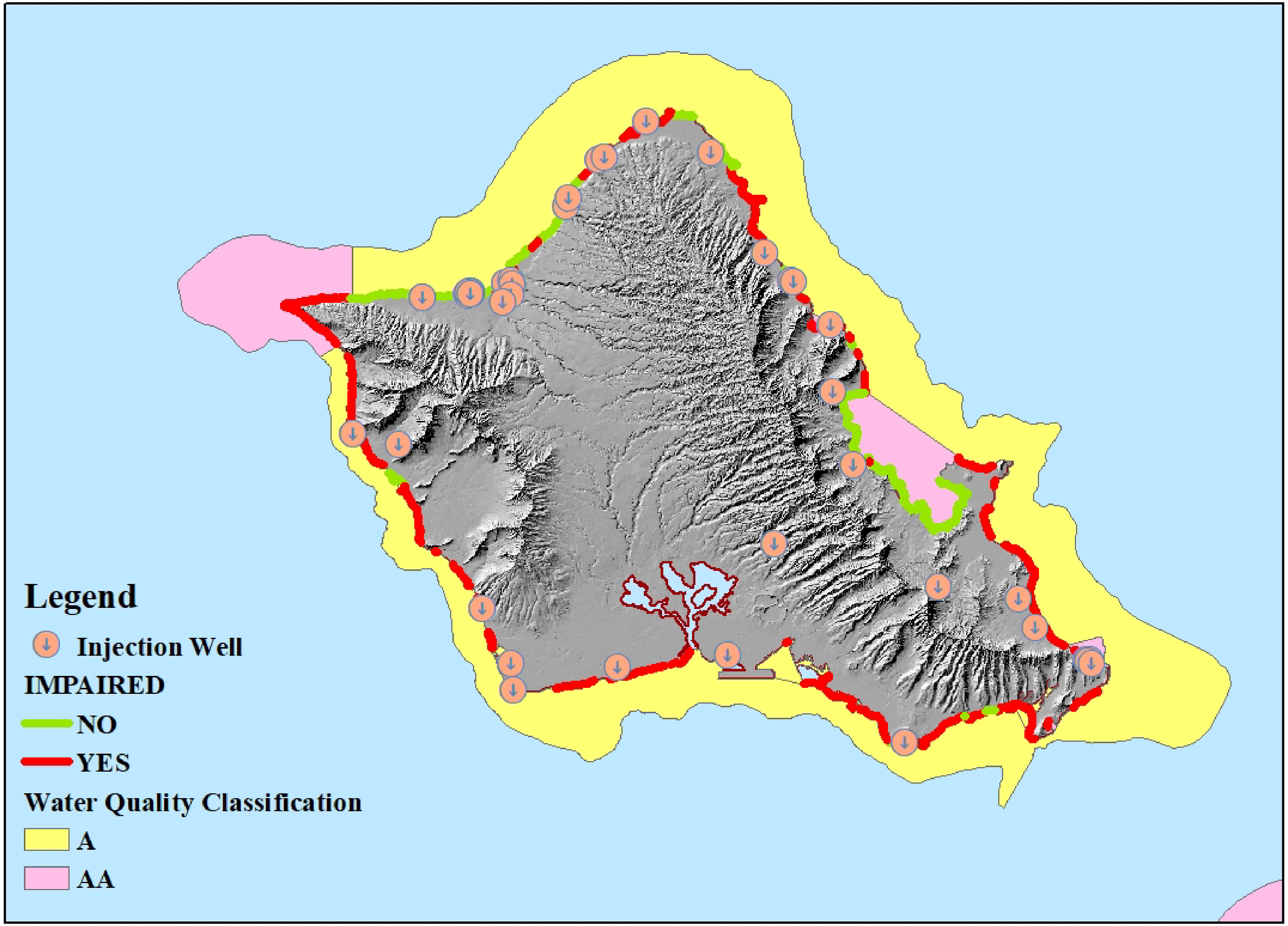
Evaluating Ecosystem Impact Potential

Approach for ranking the potential for adverse ecosystem impact is based on:

- Classification of the receiving waters

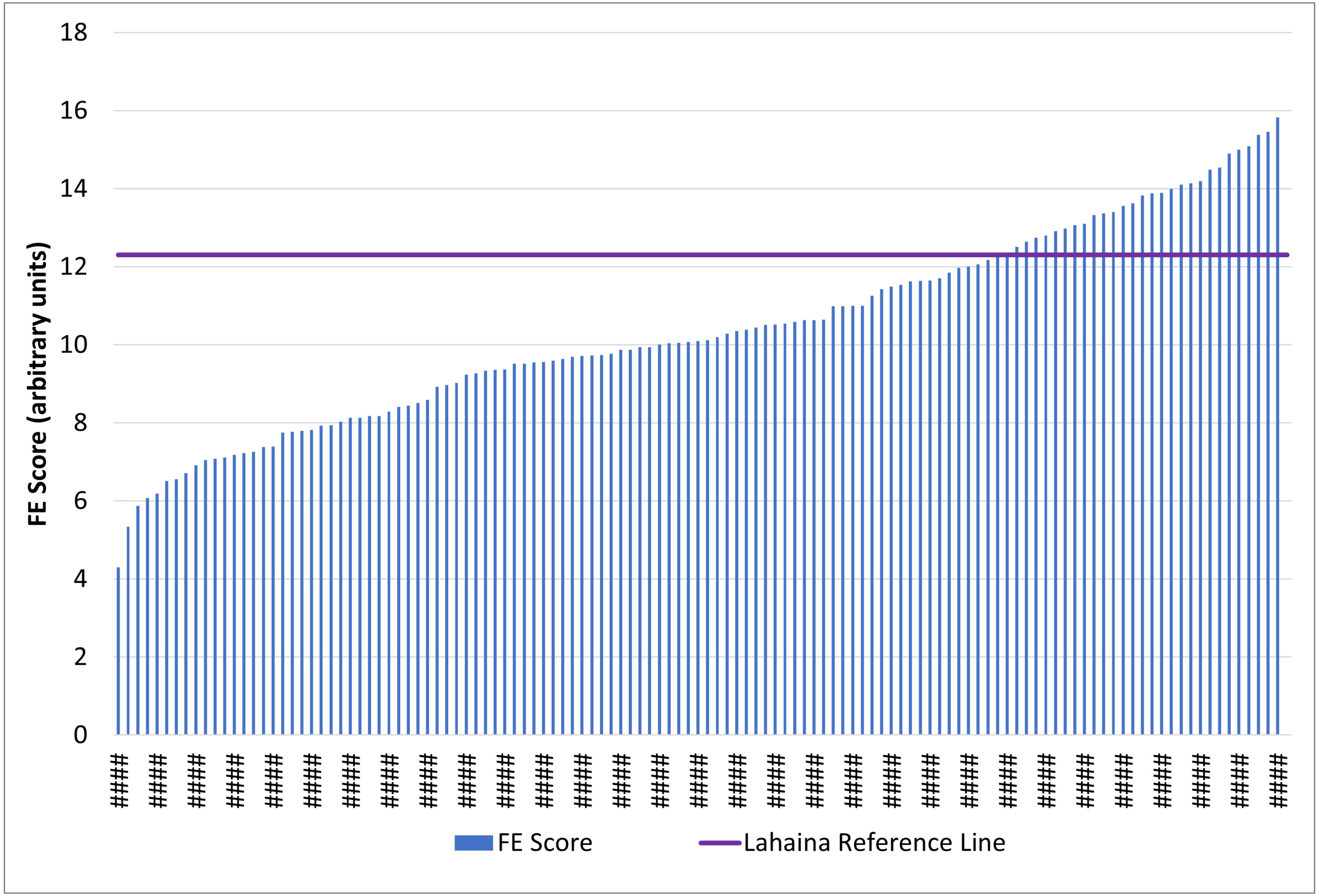
  Class AA higher score than Class A
- Finding of impaired waters
- Finding of impaired beaches

Impaired beach in Hawaii impaired beach



Ecological impact factor map of Oahu and location of wastewater injection wells

Example of Functional Equivalency Ranking



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[End of Session] What do you think are the MOST USEFUL FACTORS for Hawaii in determining if a FE discharge exists that should be prioritized for permitting? (Select up to 4)

ⓘ Start presenting to display the poll results on this slide.

Open Forum –

Questions & Additional Ideas

Next Steps

- Continue to:
  - Receive and consider feedback on FE factors and potential criteria (post-event survey, direct communication with DOH)
  - Work with FE factors and facility inventory data
  - Work on characterizing Hawaii's overall FE discharge strategy
- Stakeholder workshops conclusion on September 19, 2024

Anticipated Timeline and Topics
(through September 2024)

May 21 – Intro and background

July 2 – Additional strategies

July 31 – Permitting options, feasibility of compliance

August 26 – Potential criteria and prioritization

September 19 – Stakeholder process wrap up and next steps

Slido Link to Provide Feedback

Join at

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THANK YOU!

FE Strategy Workshop #4

August 26, 2024