USGS
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Pacific Islands Water Science Center

# Introduction to the U.S. Geological Survey Hydrologic Network in the Pacific Islands

Chris Curran – Assistant Center Director for Hydrologic Data
U.S. Geological Survey

Presentation to the State of Hawai‘i Commission on Water Resource Management

August 15, 2023

U.S. Department of the Interior
U.S. Geological Survey

*Halawa Stream Moloka‘i – (1917-2023)*

# USGS – Our Focus and Structure

"As the Nation's largest water, earth, and biological science and civilian mapping agency, we collect, monitor, analyze, and provide science about natural resource conditions, issues, and problems. Our diverse expertise enables large-scale, multidisciplinary investigations and provides impartial scientific information to resource managers, planners, and our customers."

Mission Areas

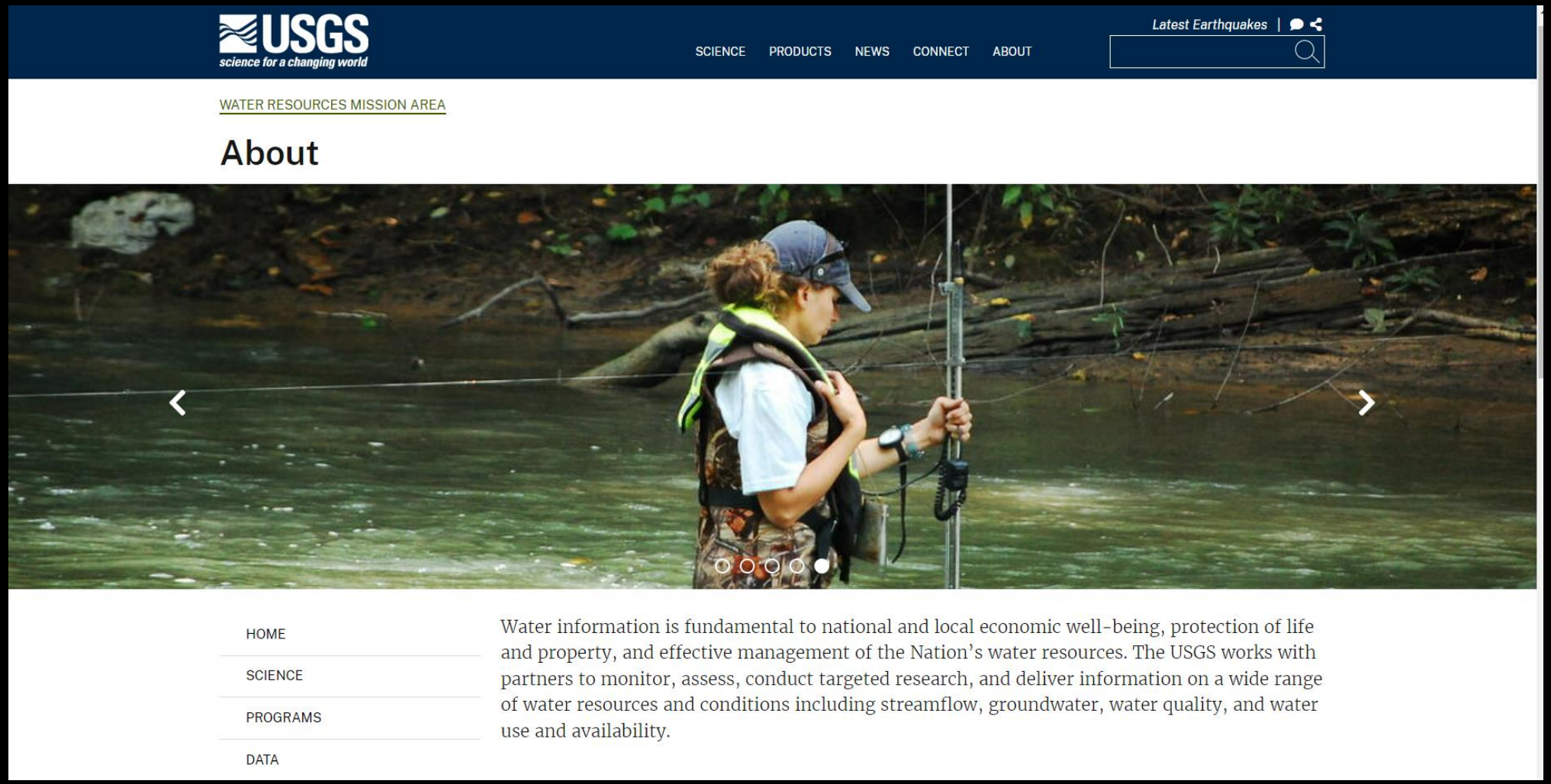



| Core Science Systems | Ecosystems | Water Resources | Natural Hazards | Energy & Minerals |
|---|---|---|---|---|

Mission Areas | U.S. Geological Survey (usgs.gov)

USGS

# Water Mission Area




[Water Resources - About | U.S. Geological Survey (usgs.gov)]

# USGS Pacific Islands Water Science Center (PIWSC)

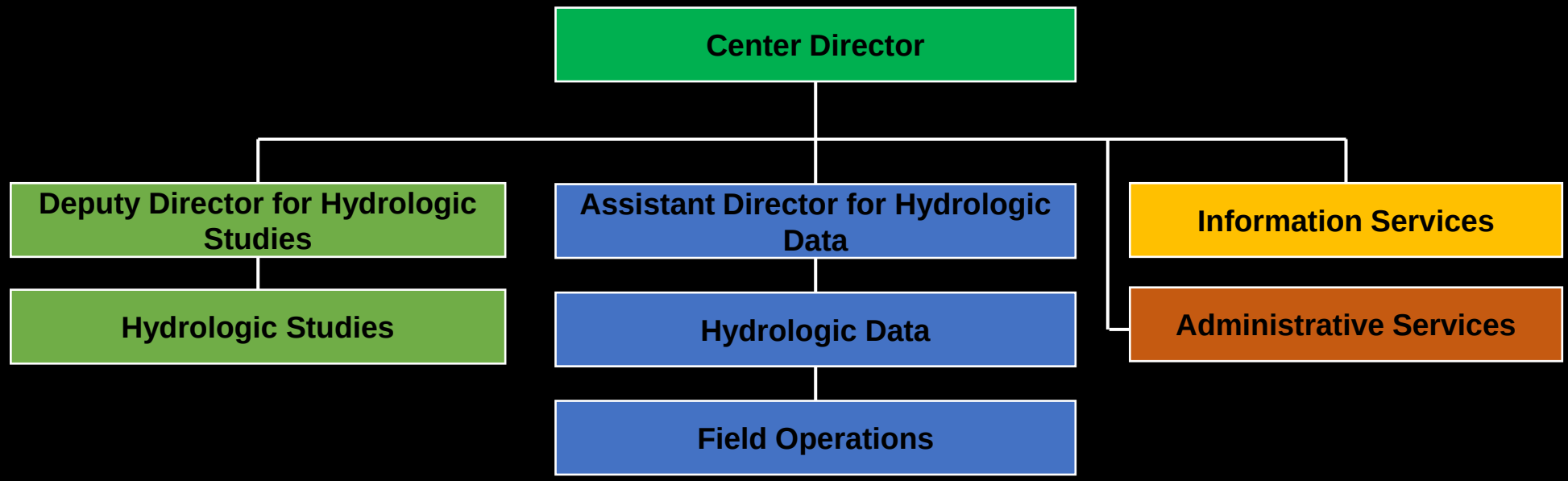

Ford Island and Pearl Harbor, Oʻahu

NOAA Daniel K. Inouye Research Center

PIWSC Staff

USGS

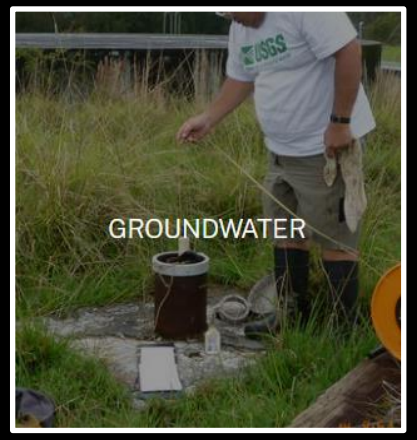
# PIWSC Organizational Chart

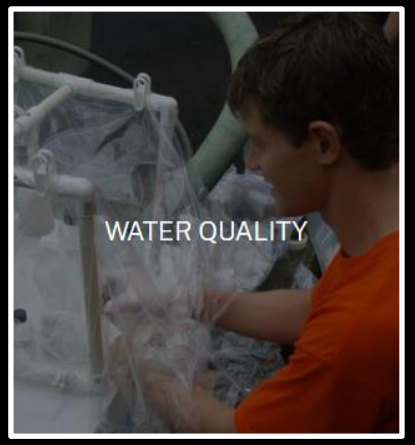


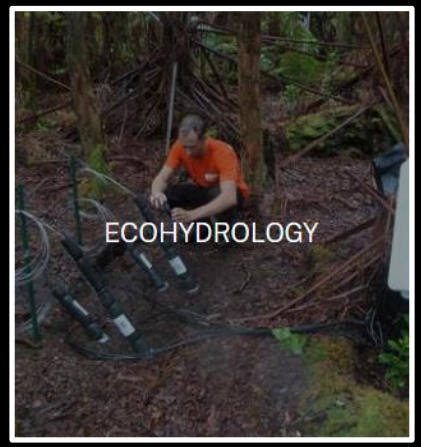
# PIWSC Mission

Mission and Vision

- Collect, analyze, and disseminate impartial hydrologic data for wise management of water resources in Hawai‘i, Guam and U.S. Affiliated Pacific Islands.
- Conduct studies to increase hydrologic understanding and inform resource-management decisions.
- Maintain publicly available real-time and historical data bases and publish unbiased peer-reviewed data and science.
- Partner with Federal, State, and local agencies, and other public organizations to assure our work is relevant and useful.



Pacific Islands Water Science Center - Science | U.S. Geological Survey (usgs.gov)

USGS

# USGS PIWSC Science Focus Areas

Focus Areas:

- Hydrologic monitoring;
- Quantity and variability of streamflow;
- Groundwater availability/sustainability;
- Water quality (surface water and groundwater).

Climate variability and change are factors that can influence each of these science focus areas.

Rainfall gaging station at 1,000 ft altitude Moanalua, O‘ahu

Pesticide sampling, Waihe‘e Stream, O‘ahu

Streamflow measurement, Wailuku River at Pi‘ihonua, Hawai‘i

Conductivity, temperature and depth profiling at deep monitoring well EX-9, Guam

# Importance of Hydrologic Monitoring

USGS has been collecting hydrologic data in Hawai‘i since the early 1900s and in Guam since the 1950s.

These data are:

- Used to assess long-term trends in streamflow, groundwater levels and water availability;
- Used to assess changes in water use;
- Used by emergency managers during floods to help protect life and property;
- Collected based on nationally consistent; methods
- Publicly accessible USGS Water Data for Hawai‘i.

Poamoho Rain Gage near Wahiawa, O‘ahu

Streamflow measurement at Waihe‘e River near Waihe‘e, Maui

Groundwater-level measurement at Tripler Army Medical Center, O‘ahu

USGS

# Examples of Stream Gages

Heʻeia Stream at Haʻikū Valley near Kāneʻohe, Oʻahu

Mānoa-Pālolo Canal at Mōʻiliʻili, Oʻahu

Heʻeia Stream at Haʻikū Plantations Drive, Oʻahu

Right Branch Lāwaʻi Stream near Umaʻuma Road, Kauaʻi

USGS

# Why Stream Gages are Needed

Stream gages provide information on the quantity and variability of the flow of water in streams.

In Hawai‘i, this information is used by water managers and decision makers to:

- Provide reliable in-stream water to support drinking water and agricultural uses;
- Manage water rights and establish in-stream flow standards;
- Regulate the diversion of surface water, especially during low-flow conditions;
- Plan, forecast and provide warnings about floods and droughts;
- Operate reservoirs and waterways for hydropower;

USGS

# Why Stream Gages are Needed

(Continued):

- Assess freshwater quality and regulate the discharge of pollutants;
- Protect endemic freshwater species and their habitats;
- Ensure water availability for important cultural practices;
- Design reservoirs, roads, bridges, drinking water and wastewater facilities;
- Document impacts to water resources from changing land use;
- Monitor long-term trends in streamflow to understand the impacts of competing water uses and impacts associated with a changing climate.

USGS

# Maintaining Stream Gages

USGS hydrographers visit gages approximately every 8 weeks, or sooner if:

- An urgent repair is needed;
- Conditions warrant an unscheduled streamflow measurement (such as during high flow or when there is an obvious calibration problem).

Site visits generally include:

- Manual measurements of stage (water level in stream) and streamflow, so that stage-discharge ratings can be checked and recalibrated if needed;
- Trimming of vegetation to maintain access;
- Maintenance of instruments and shelter (paint, change batteries, repair/replace equipment);
- Periodic surveying to verify the elevation of reference points and staff plates.

Site visit at Wailuku Stream gage

Trail to Hanalei River gage

USGS

# Aviation Support

- PIWSC operates 17 gages that require aviation support with favorable flying conditions to access these sites.
- USGS requires a strong Aviation Safety Program that meets the federal Office of Aviation Safety (OAS) standards.
- PIWSC helicopter operations are ‘special use’ and require personal protective equipment, pilot & aircraft OAS certification, and allow the use of unimproved landing zones (LZs).

Unimproved LZ

Sling load training

Sling load of materials for a new gage installation on Kaua‘i

# New Stream Gages in 2023

Hakalau Stream,
Hawai‘i Island

Manowai‘ōpae Stream,
Hawai‘i Island

Waikapū Stream, Maui

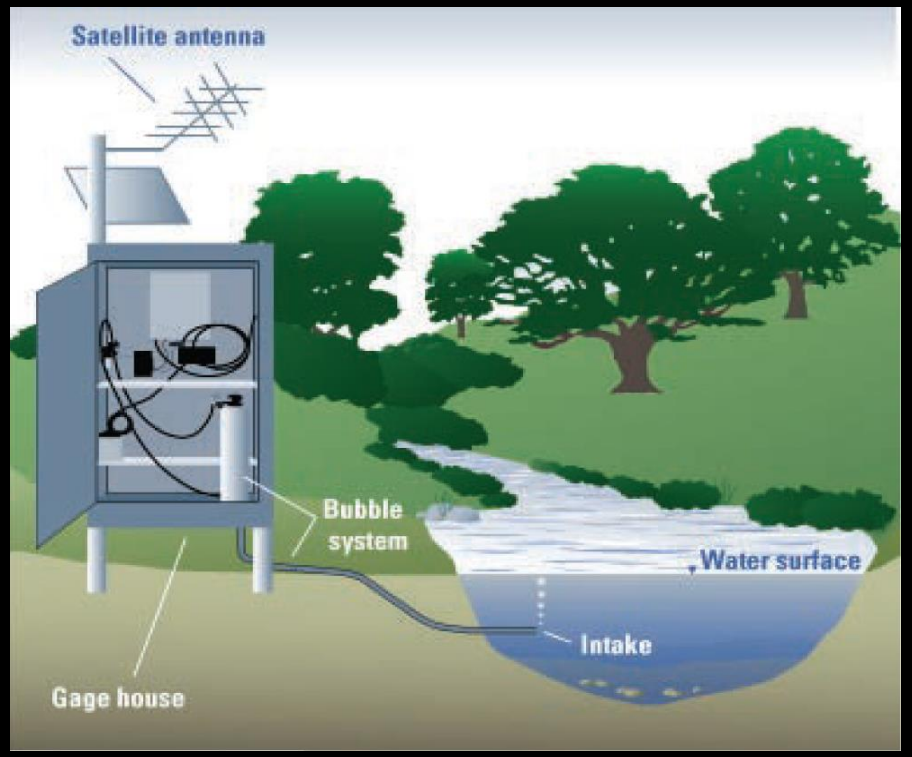
Planned for install in 2023:

- East Fork Kawela Gulch, Moloka‘i – a low-flow stream gage ready for upgrade to a real-time station;
- Honokōhau rain gage, Maui – co-located with a stream gage.

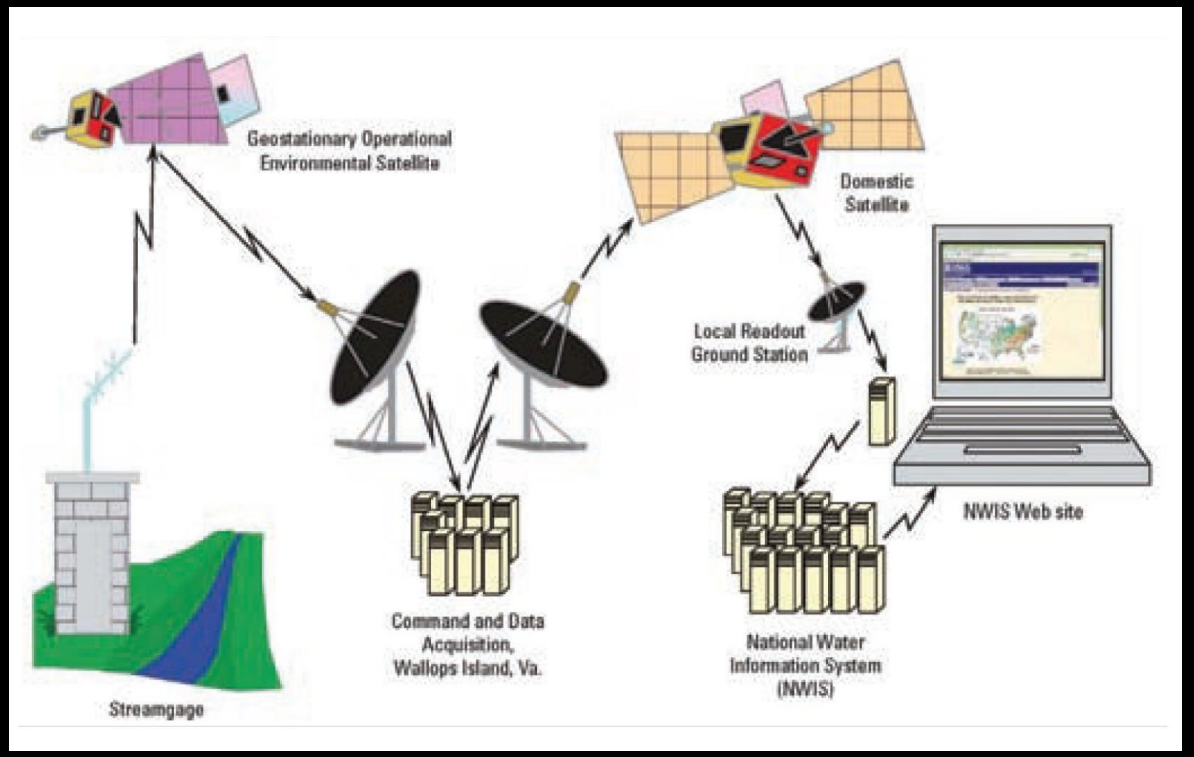
USGS

# How does a Real-Time Stream Gage Work?

Streamgaging Basics | U.S. Geological Survey (usgs.gov)




A stream gage measures and records the water level (called stage or gage height) of a stream or river.

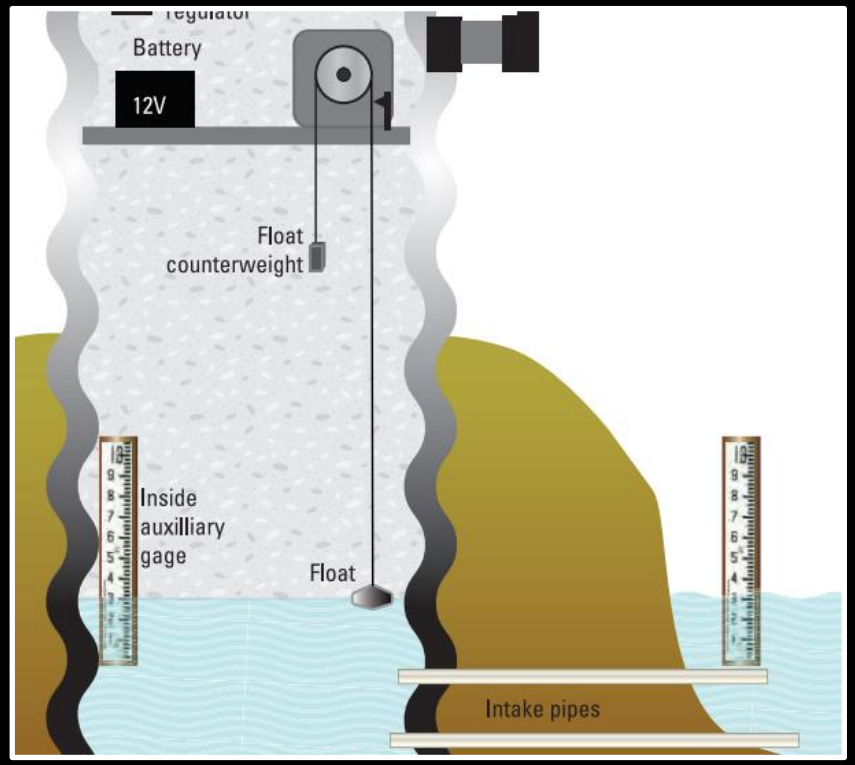


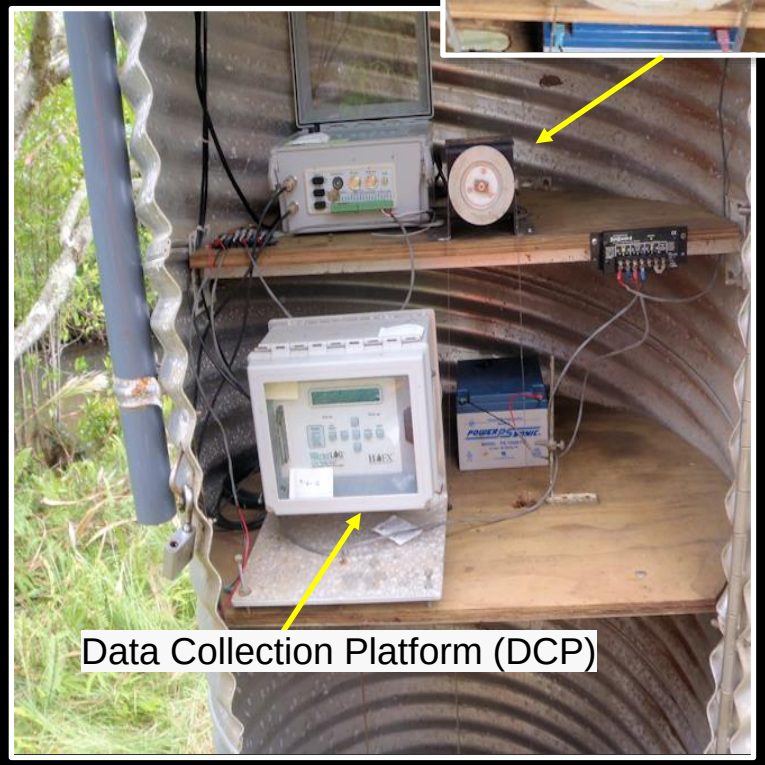

Data from the stream gage are transmitted via satellite to ground stations and relayed to USGS servers that host NWIS Web, a publicly accessible database.

# Stream Gages Measure Stage

*Continuously, usually every 5-15 minutes*

Method 1: Float & pulley system with shaft encoder



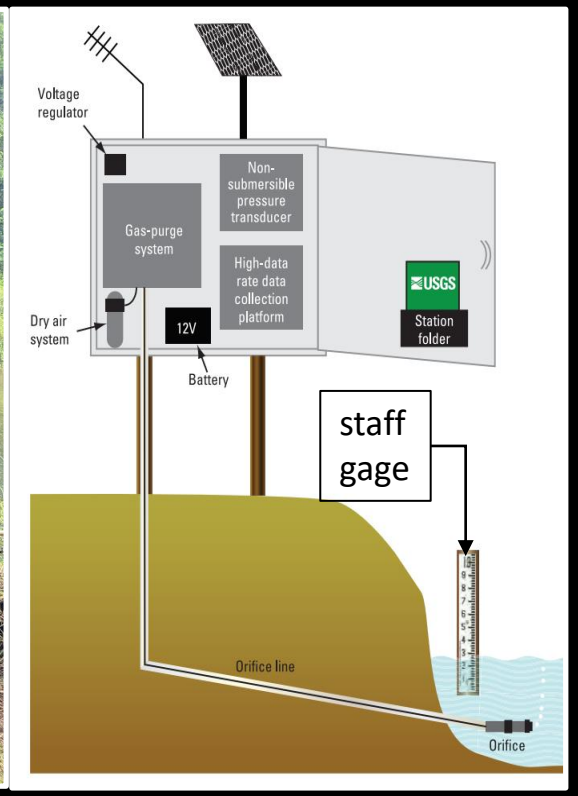




Hālaulani Stream near Kīlauea, Kaua‘i

# Stream Gages Measure Stage

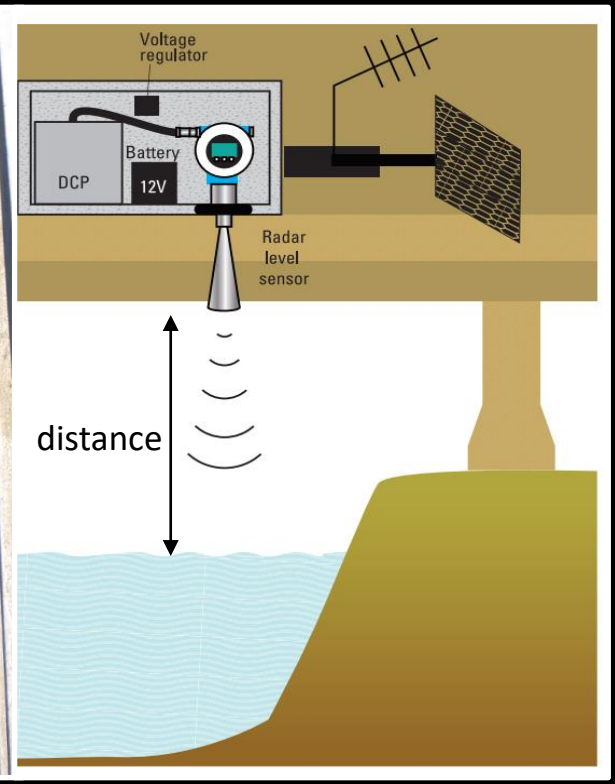
*Continuously, every 5-15 minutes*

## Method 2: Pressure sensors



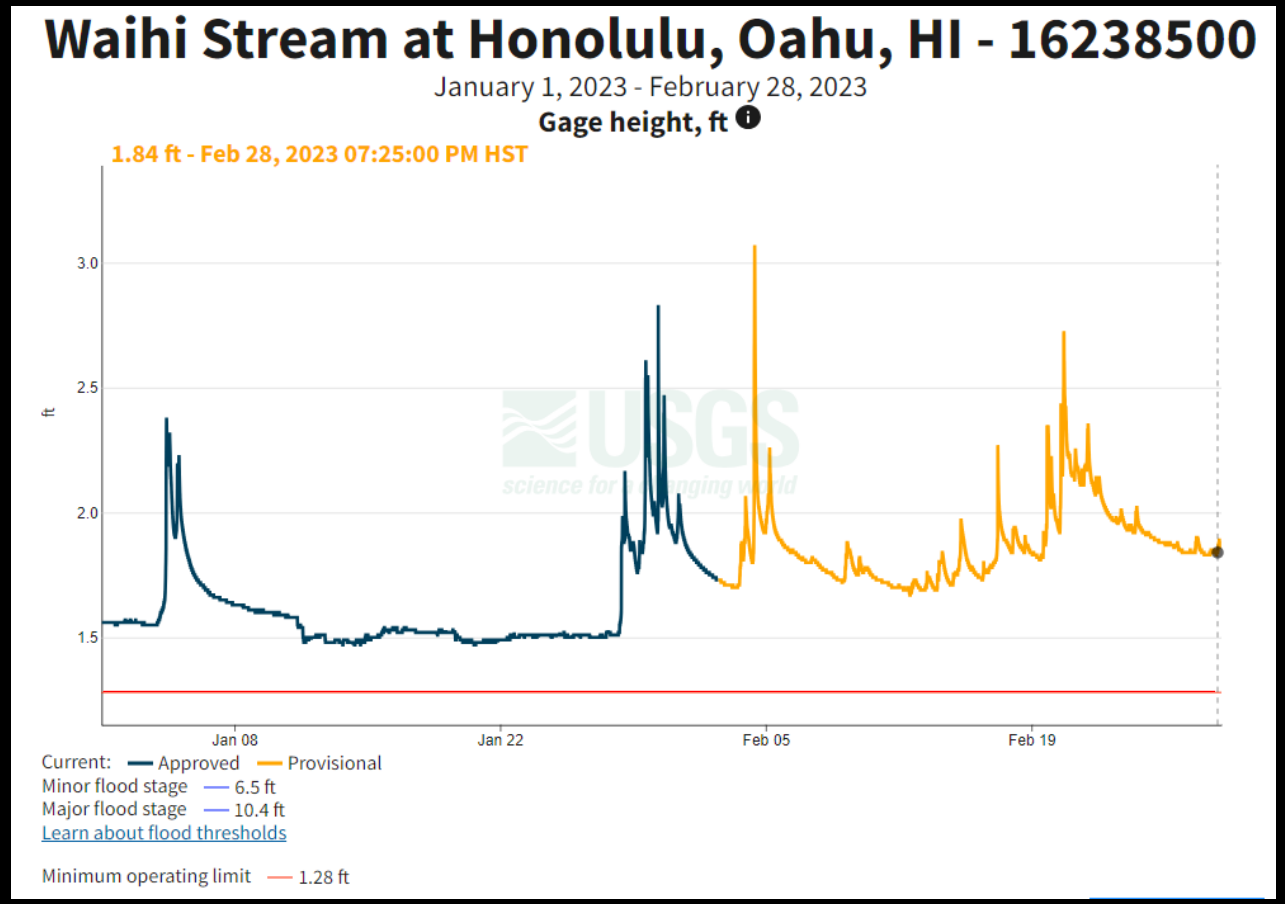

Hanalei River near Hanalei, Kaua‘i

## Method 3: Radar




Wailuku River at ‘Īao Valley Road, Maui

# Time-Series Stage Data from a Stream Gage




Data status:

- Approved data (blue) have been fully reviewed and are considered final, published values;
- Provisional data (gold) have not been reviewed for quality assurance and values are subject to change pending final review.

Stage thresholds:

- Flood stages (light blue) are determined by the National Weather Service;
- Minimum operating limit (red) is determined by the depth of the sensor in the stream.

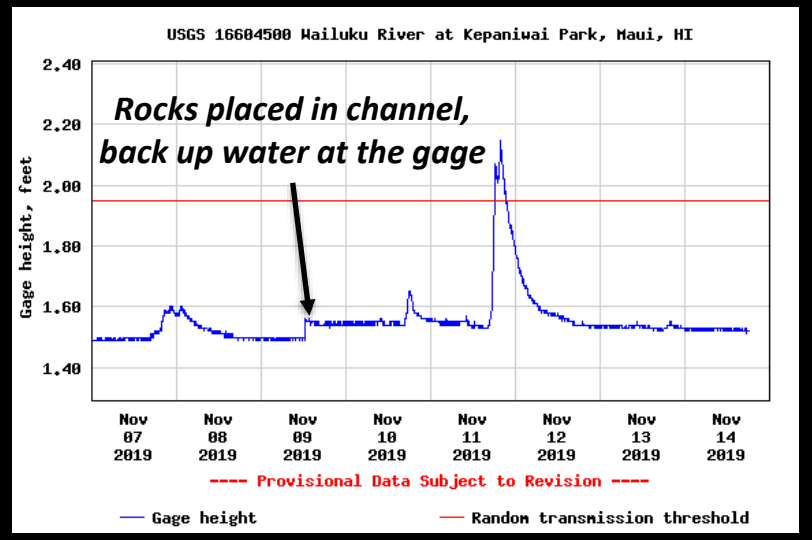
# Changes in Stage Caused by Sediment or Debris

Reporting accurate, real-time stream data is very challenging, and data can have errors.

Changes to the shape of the stream channel near a gage can change the stage of the stream, while the flow of water in the channel remains the same.

Common sources of channel changes that affect the accuracy of real-time stream data are:

- Shifting rocks or vegetation in the channel during periods of high streamflow;
- People moving rocks in the stream;
- Changing vegetation growth in the stream;
- Trees or other debris falling in the channel.



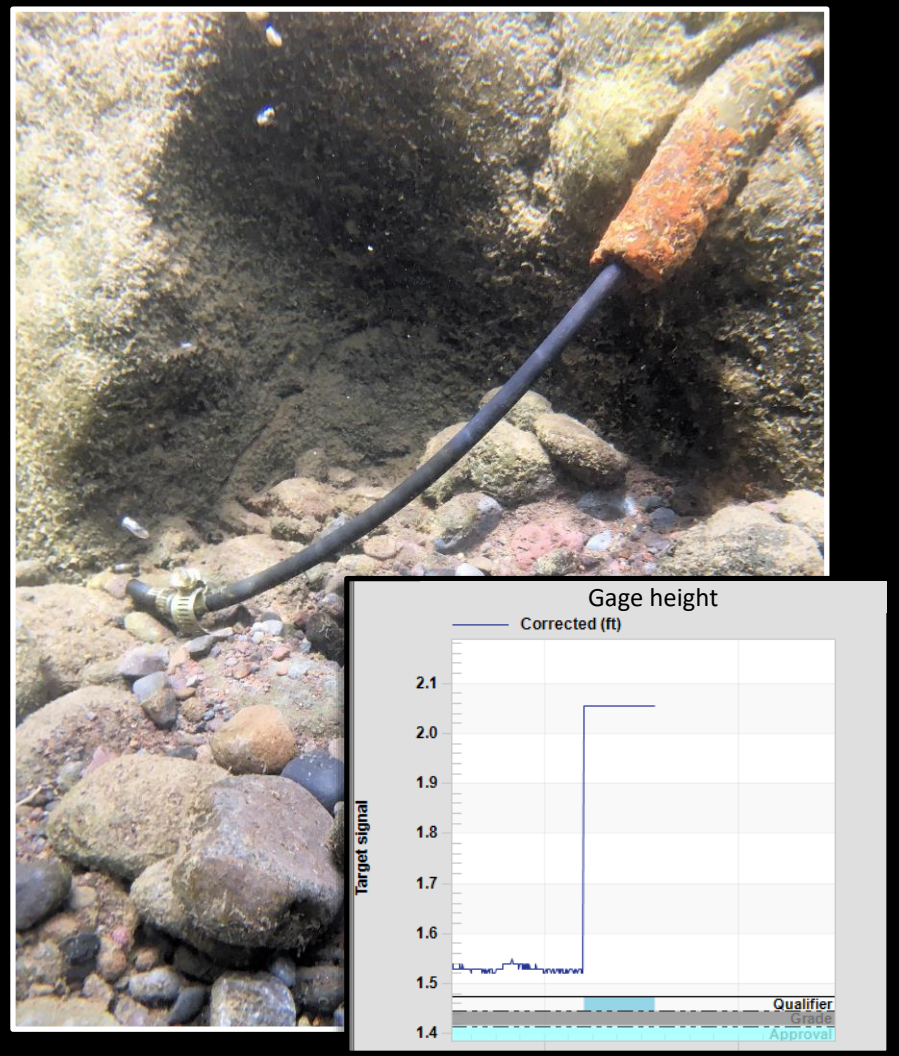

# Change in Stage Caused by Equipment Issues

While real-time stage data are very accurate most of the time, equipment issues in sensors, telemetry or related to power can occur.

Readings from sensors that use pressure to measure stage are more susceptible to problems, which include:

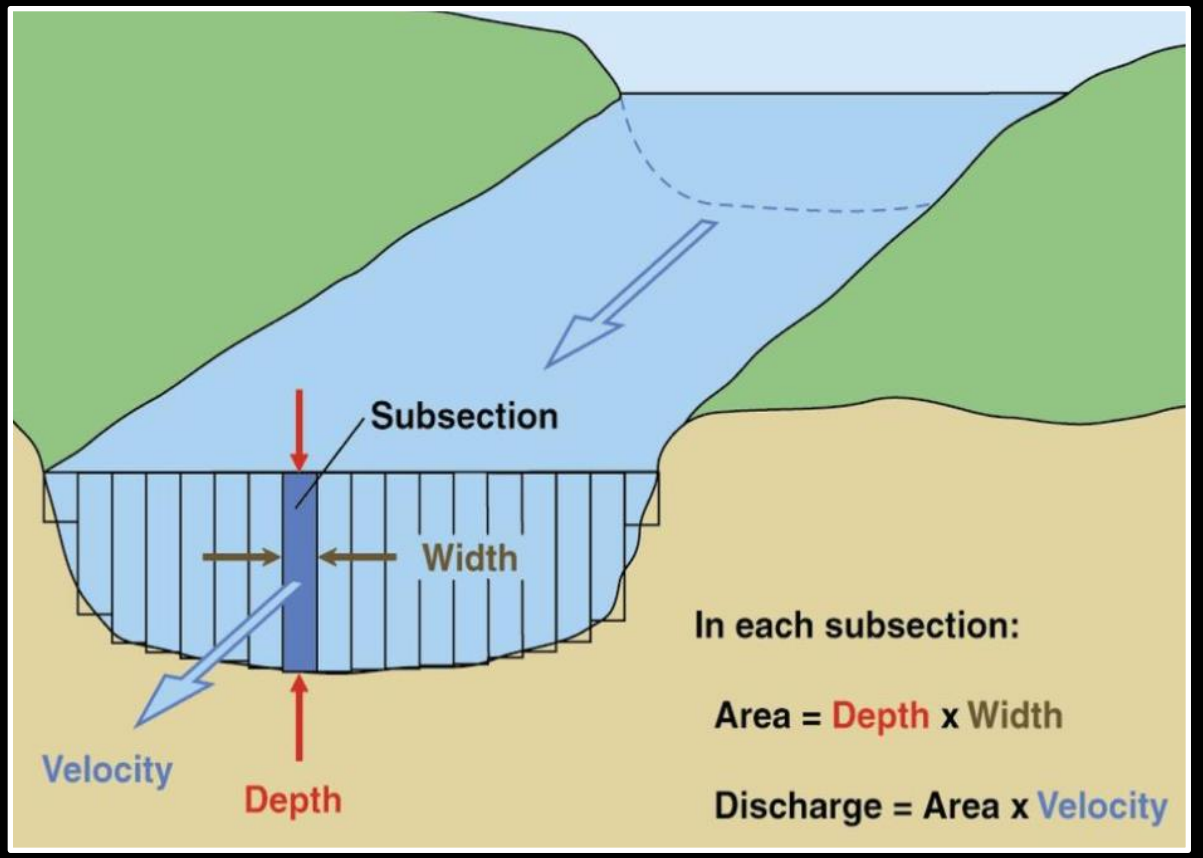
- Being moved;
- Being buried or plugged by vegetation/debris;
- Leaks in air-purge transducer systems;
- Temperature or air-pressure compensation issues.

Real-time data are reviewed daily for accuracy. Suspect data are usually flagged within 24-hours and staff usually respond on site within 72-hours.



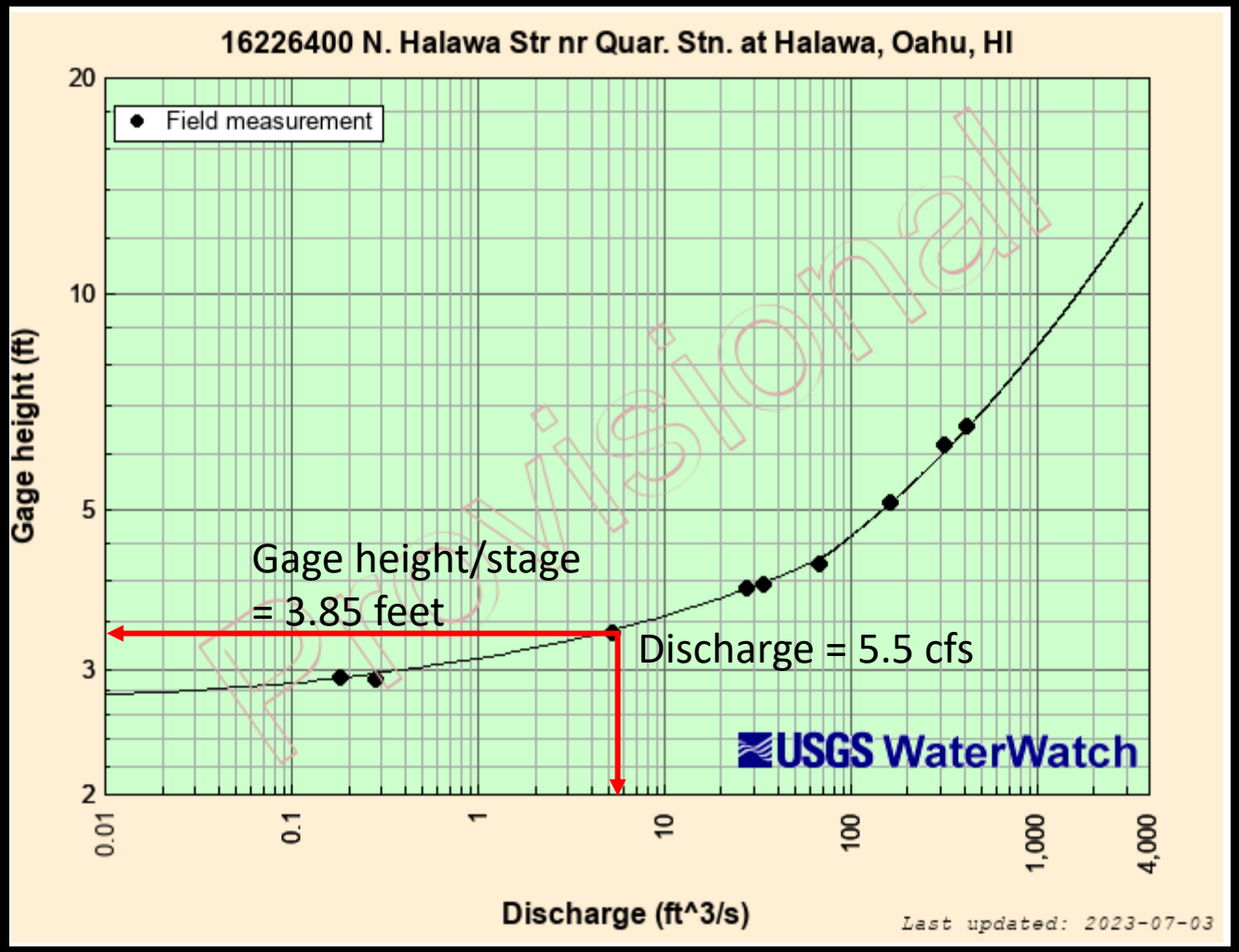
# How do Hydrographers Measure Discharge?

Hydrographer measuring discharge at Waiāhole Stream, O‘ahu



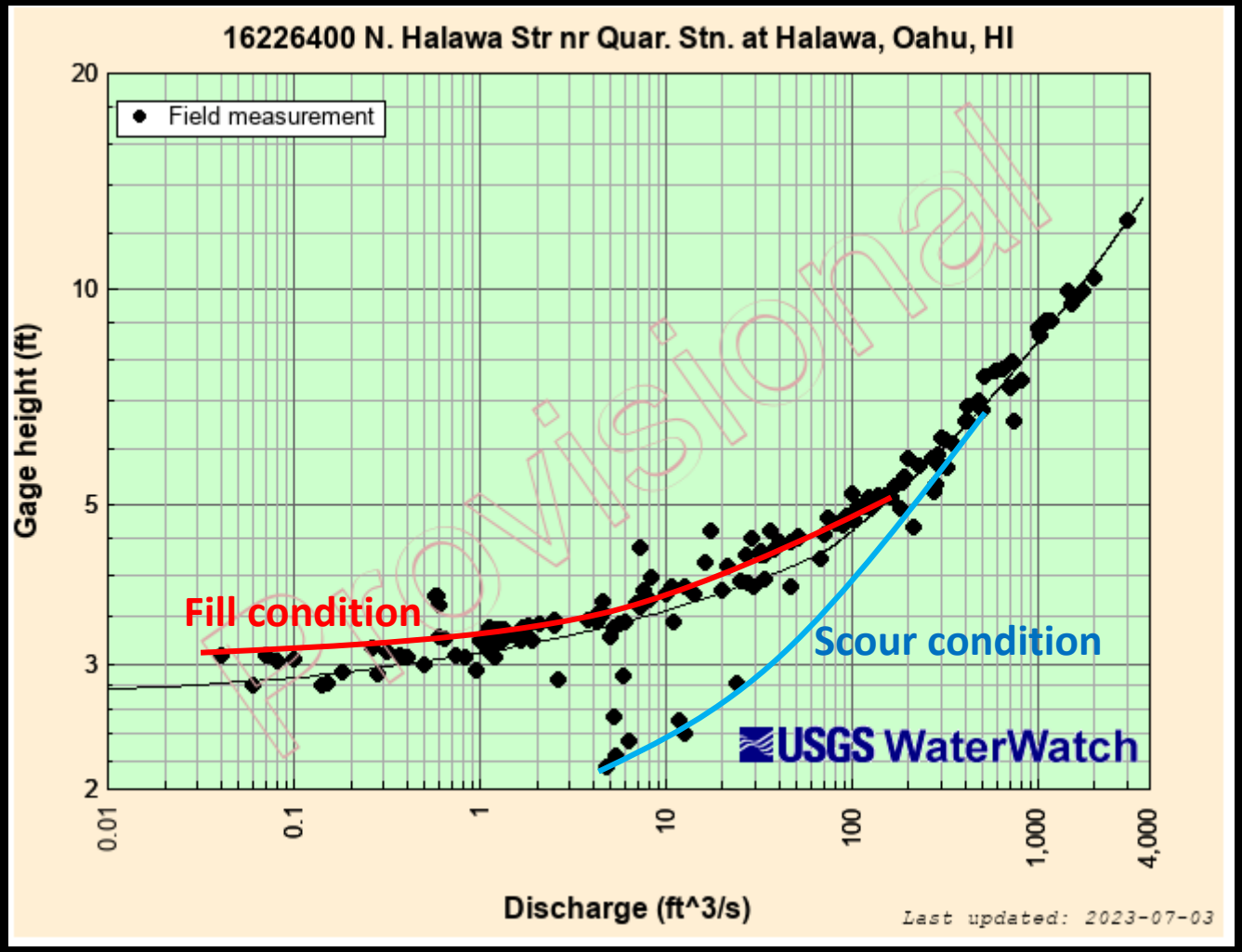

Streamgaging Basics | U.S. Geological Survey (usgs.gov)

# How are Stage and Discharge Related?



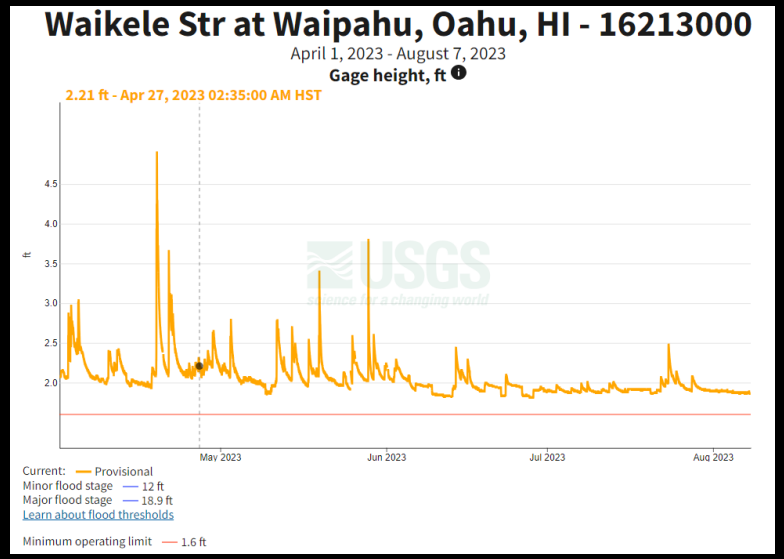

[USGS WaterWatch -- Streamflow conditions]

# Rivers and Streams are Dynamic and Change with Time



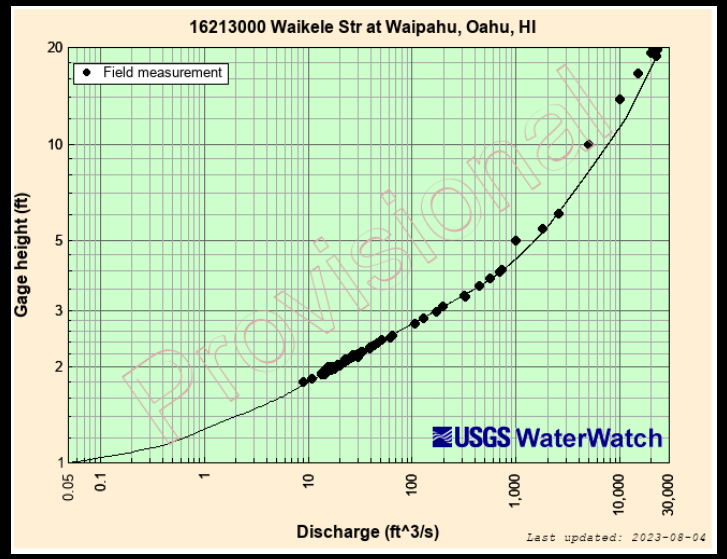

USGS WaterWatch -- Streamflow conditions

# Computing a Time Series of Discharge




Time-Series of Stage

+




Stage -Discharge Rating Curve

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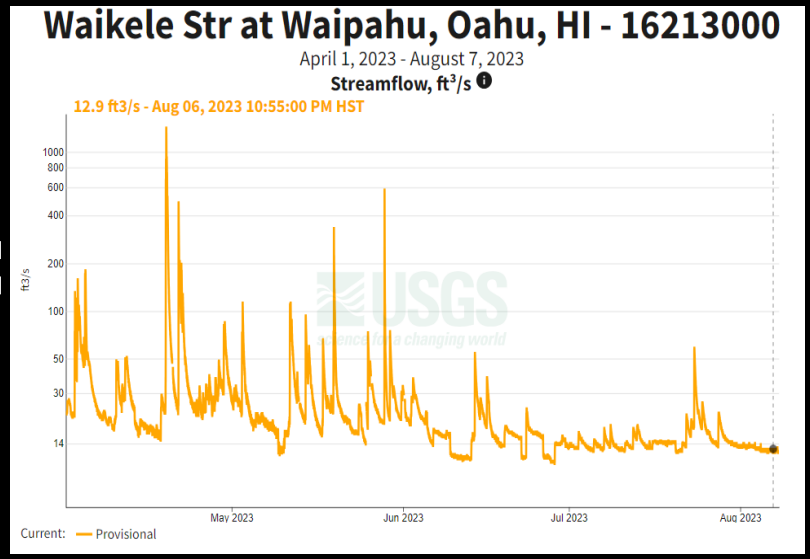



Time-Series of Discharge

# Screening Provisional Real-Time Data

Regular and frequent review of provisional online data is a high priority:

- Every weekday morning, hydrographers review the provisional data at their assigned gages and evaluate potential issues such as unexpected power drops, missed transmissions or unusual values;
- Unexplained data issues are reported to the Field Operations Chief and communicated to the Local Database Manager (LDM) as needed;
- Data that are considered suspect are flagged by the LDM and not displayed until they can be verified in the field, corrected or estimated;
- If warranted, unscheduled site visits to correct gage issues are planned and performed. The response time depends on gage access, landowner permissions, and  flight schedules for off-island or helicopter sites.

# Workflow for Data Processing and Review

1. Immediately following site visits (usually within 48-hours), streamflow measurement and information from gage inspections are downloaded to the USGS database.

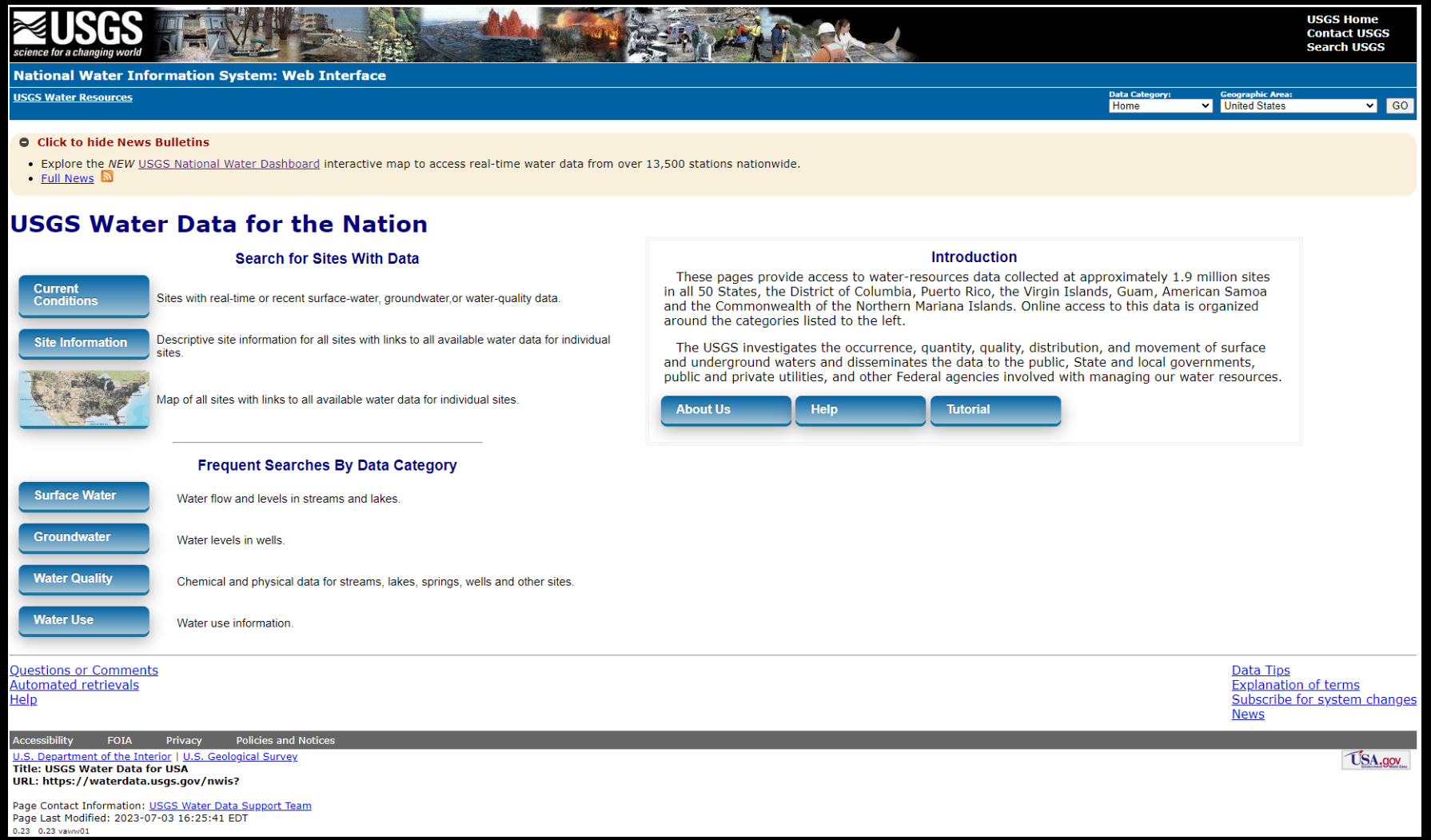
2. A hydrographer analyzes the time series record, applying information learned from the site visit to adjust the provisional record of stream gage height (stage). The streamflow measurement is used to verify or recalibrate the stage-discharge rating. The provisional streamflow record is computed – usually within 3 weeks.

3. A senior hydrographer reviews the gage inspections, streamflow measurements and stage-discharge rating to determine if adjustments to the streamflow record were warranted and correctly applied. After review, within 150 days for most sites, the record is either approved or sent back to the analyzer.

4. Annually, an independent, senior hydrologist with knowledge of the stream reviews the entire record and performs an audit on the time-series record and all field measurements. If errors are found in the audit, the record is returned to the analyzer and approver; revisions may be applied after consult with a 2nd senior hydrologist.

USGS

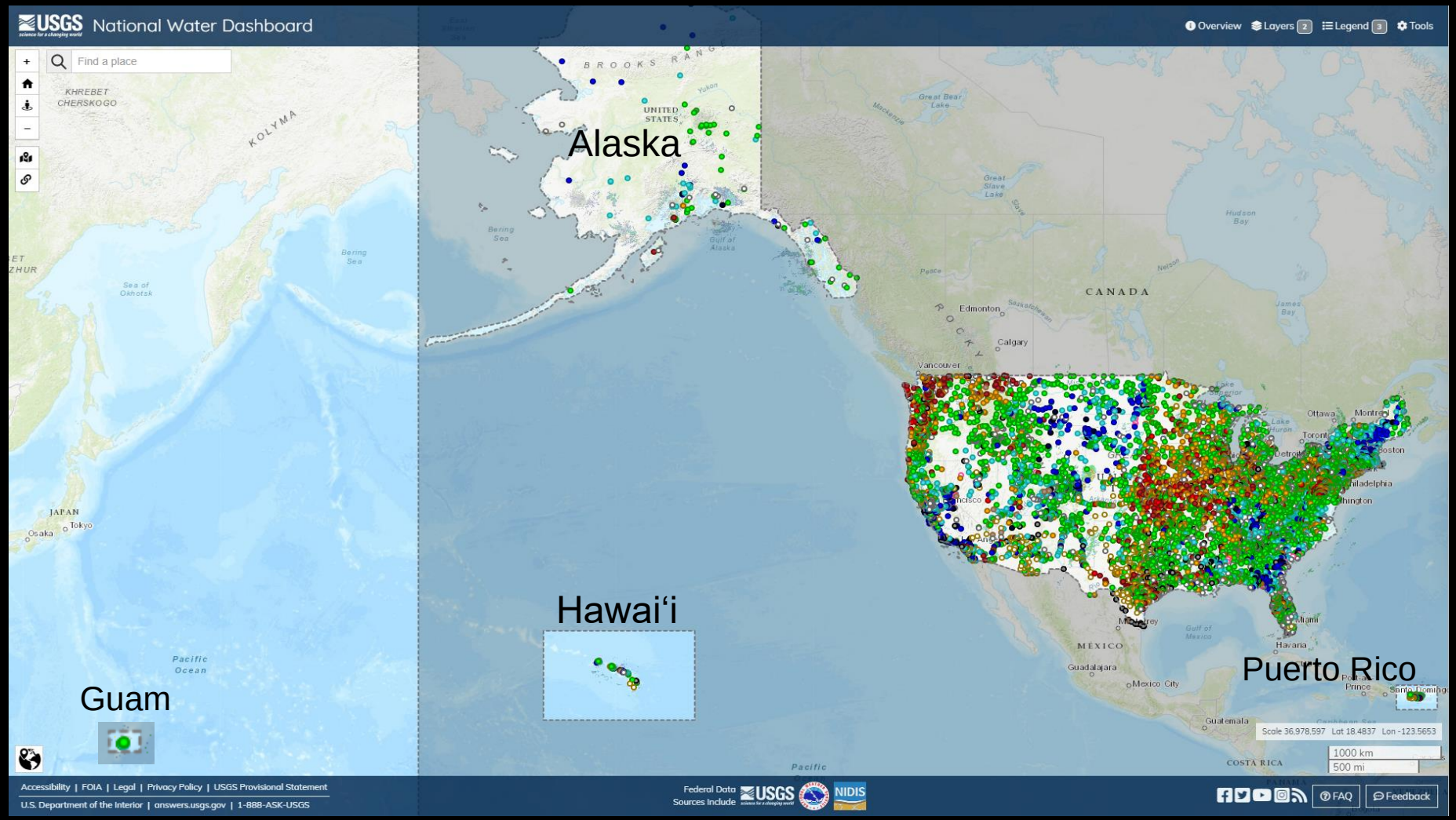
# Data Availability

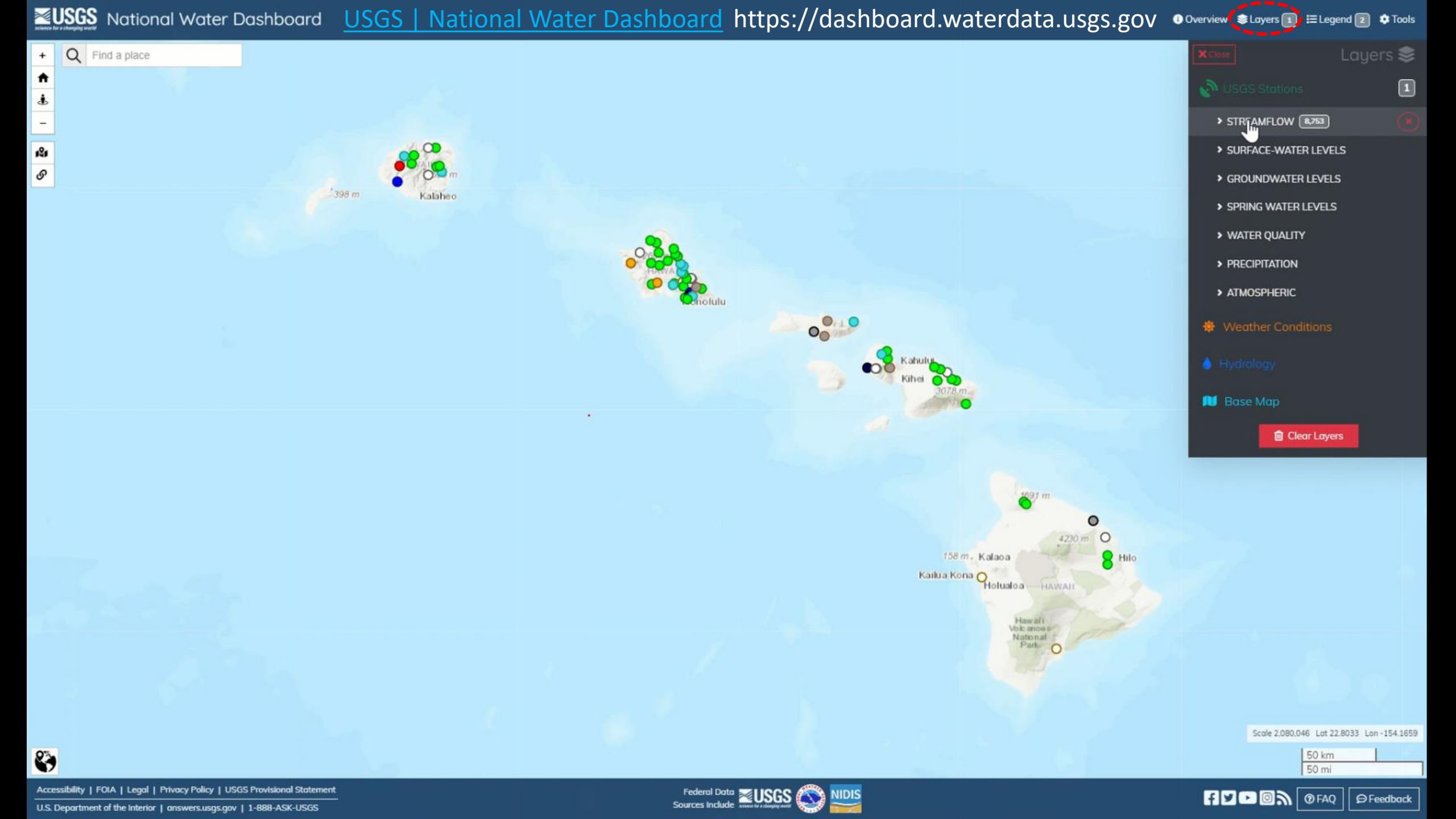


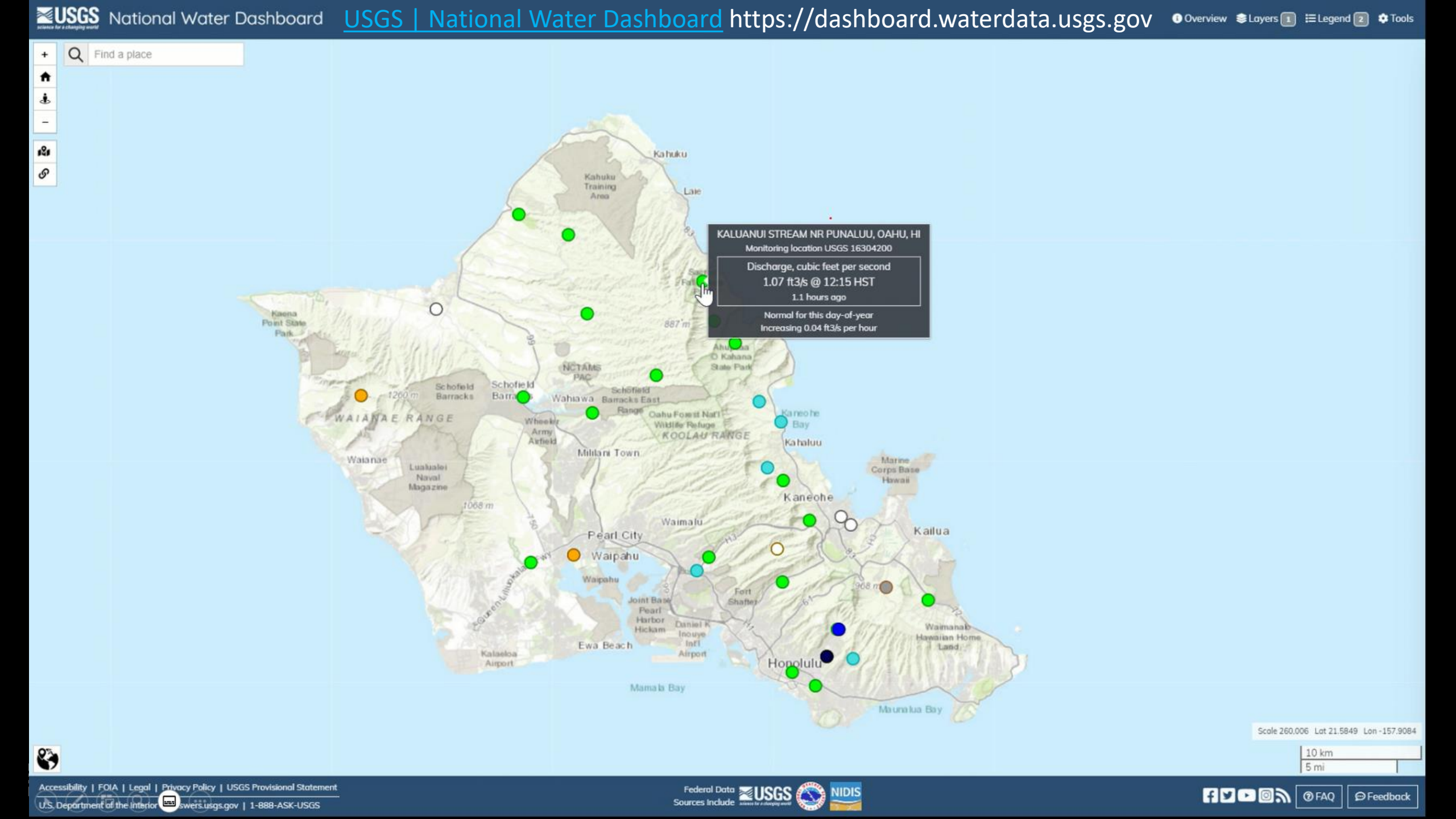

[USGS Water Data for the Nation: waterdata.usgs.gov/nwis](https://waterdata.usgs.gov/nwis)

# USGS National Water Dashboard

[USGS | National Water Dashboard](https://dashboard.waterdata.usgs.gov) https://dashboard.waterdata.usgs.gov




USGS National Water Dashboard
USGS | National Water Dashboard https://dashboard.waterdata.usgs.gov
Overview
Layers 1
Legend 2
Tools
Find a place
Layers
Close
USGS Stations 1
STREAMFLOW 8,753
SURFACE-WATER LEVELS
GROUNDWATER LEVELS
SPRING WATER LEVELS
WATER QUALITY
PRECIPITATION
ATMOSPHERIC
Weather Conditions
Hydrology
Base Map
Clear Layers
Kalaheo
Honolulu
Kahului
Kihei
3078 m
1891 m
4230 m
158 m
Kalaoa
Hilo
Kailua Kona
Holualoa
HAWAII
Hawai'i Volcanoes National Park
Scale 2,080,046 Lat 22.8033 Lon -154.1659
50 km
50 mi
Accessibility | FOIA | Legal | Privacy Policy | USGS Provisional Statement
U.S. Department of the Interior | answers.usgs.gov | 1-888-ASK-USGS
Federal Data Sources Include USGS NIDIS
FAQ
Feedback


USGS National Water Dashboard
USGS | National Water Dashboard https://dashboard.waterdata.usgs.gov
Overview
Layers 1
Legend 2
Tools
Find a place
KALUANUI STREAM NR PUNALUU, OAHU, HI
Monitoring location USGS 16304200
Discharge, cubic feet per second
1.07 ft3/s @ 12:15 HST
1.1 hours ago
Normal for this day-of-year
Increasing 0.04 ft3/s per hour
Kahuku
Kahuku Training Area
Laie
Kaena Point State Park
Schofield Barracks
Wahiawa
Schofield Barracks East Range
WAIANAE RANGE
KOOLAU RANGE
Wheeler Army Airfield
Mililani Town
Waianae
Lualualei Naval Magazine
Kaneohe Bay
Kahaluu
Marine Corps Base Hawaii
Kaneohe
Waimalu
Pearl City
Waipahu
Kailua
Fort Shafter
Joint Base Pearl Harbor Hickam
Daniel K. Inouye Intl Airport
Ewa Beach
Kalaeloa Airport
Honolulu
Waimanalo Hawaiian Home Land
Mamala Bay
Maunalua Bay
Scale 260,006 Lat 21.5849 Lon -157.9084
10 km
5 mi
Accessibility | FOIA | Legal | Privacy Policy | USGS Provisional Statement
U.S. Department of the Interior | USGS | answers.usgs.gov | 1-888-ASK-USGS
Federal Data Sources Include USGS NIDIS
FAQ
Feedback

Find a place


USGS | Monitoring Station - Work - Microsoft Edge

https://dashboard.waterdata.usgs.gov/api/gwis/2.1/service/site?agencyCode=USGS&siteNumber=16304200&open=42331

USGS science for a changing world

## Kaluanui Stream nr Punaluu, Oahu, HI

USGS 16304200 (Surface Water, Stream)

Show map | Hide plots | Site page | Data | WaterAlert | NWS forecast

Discharge, cubic feet per second

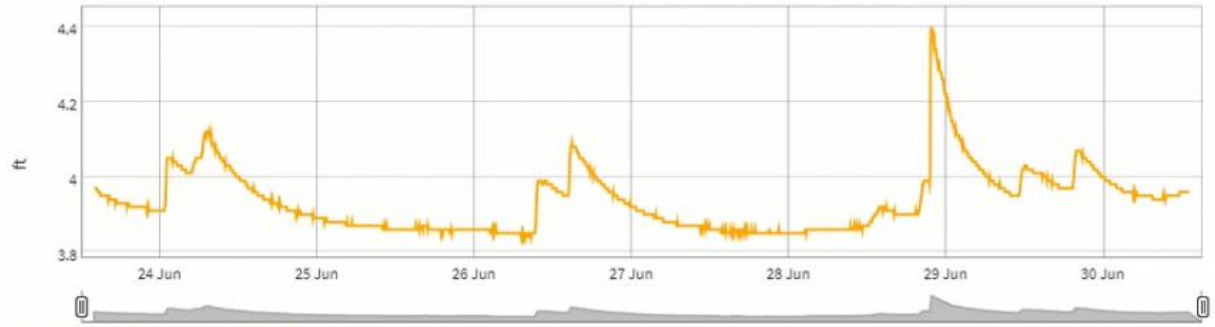
**1.07** @ 1:15 PM HST
43 minutes ago


Past 1 day | 2 days | 3 days | 1 week

Logscale

Gage height, feet

**3.96** @ 1:15 PM HST
43 minutes ago




Past 1 day | 2 days | 3 days | 1 week

Logscale

DOI Privacy Policy | Legal | Accessibility | Site Map | Contact USGS



e 231.116 Lat 21.2669 Lon -158.3042

10 km
5 mi

FAQ Feedback

# WaterAlert

USGS WaterAlert https://accounts.waterdata.usgs.gov/wateralert/

## USGS WaterAlert


### Welcome to WaterAlert

**Get notifications for changes in water conditions based on thresholds you choose.**

It's free to use!

Notifications sent to your email or phone

Simple to create, edit and remove subscriptions

Check out the User Guide

Start using WaterAlert

# Data Accuracy and Quality Assurance

Data collection and reporting follow USGS Fundamental Science Practices.
502.2 - Fundamental Science Practices: Planning and Conducting Data Collection and Research | U.S. Geological Survey (usgs.gov) The United States Geological Survey Science Data Lifecycle Model (usgs.gov)

USGS published methods for water-data collection are followed to ensure the most accurate and legally defensible data are reported. Some examples of USGS published methods are:

- Techniques and Methods 3-A7, Stage measurement at gaging stations (usgs.gov)
- Techniques and Methods 3-A8, Discharge measurements at gaging stations (usgs.gov)
- Techniques and Methods 3-A19, Levels at gaging stations (usgs.gov)

The USGS Hydrologic Instrumentation Facility performs testing, calibration and repairs of sensors and equipment used by Water Science Centers throughout the nation.
Hydrologic Instrumentation Facility (HIF) | U.S. Geological Survey (usgs.gov)

PIWSC follows a robust internal and external technical review process determined by the USGS Water Mission Area, Office for Quality Assurance.
Office of Science Quality and Integrity | U.S. Geological Survey (usgs.gov)

# MAHALO

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Pacific Islands Water Science Center
Honolulu, Hawai‘i

For questions about specific gages in our hydrologic network, please email us at: gs-w-hi_nwisweb_data_inquiries@usgs.gov

USGS