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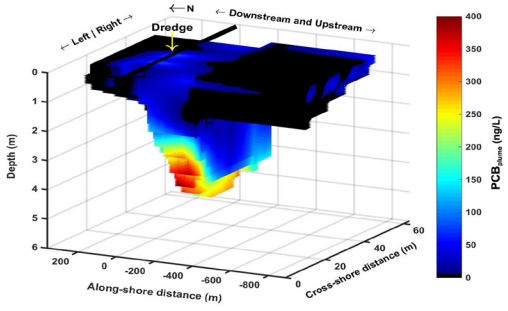
OPTICS (OPTically-based In-situ Characterization System)

The OPTICS tool (U.S. Patent No. 11079368) integrates commercial, off-the-shelf, *in situ* optical, physical, and water quality sensors, discrete surface water samples, and a multiparameter statistical model to provide high-resolution characterization of surface water chemicals of concern (COCs) (Chang et al. 2018a, b). The OPTICS methodology is effective for addressing a wide range of questions at contaminated sediment and surface water sites, including:

- What is/are the source(s) of COCs and what is its fate?
- Is erosion of the sediment bed leading to the exposure of buried contaminants?
- Are contaminants being redistributed and/or moved offsite by sediment transport and water movement?
- Will natural processes lead to the burial and isolation of contamination by relatively clean sediment?
- If a site is actively remediated, could sediment transport lead to recontamination?
- Are control measures effective at reducing contaminant transport?

The novel use of optically-based *in situ* monitoring for high-resolution, robust derivation of chemical properties allows for quantification of surface water COC concentrations over unprecedented temporal and spatial scales.



Chemical contaminant concentrations at scales that are unattainable through traditional sampling

OPTICS Technology

- Provides surface water chemical contaminant concentration at significantly higher resolution relative to traditional methods
- Integrates data from commercially available aquatic sensors with discrete water sample data using a multiparameter statistical prediction model
- Is applicable for baseline assessment, source control evaluation, remedial implementation monitoring, and remedy performance evaluation

Advantages Compared to Traditional Sampling

- Environmental monitoring costs reduced by as much as 99%
- Contaminant concentrations at resolution that supports flux and mass loading quantification
- Chemical concentrations at suitable resolution for interpretation in the context of biophysical processes

Best Suited For

- Surface water COCs
- Hydrophobic COCs at concentrations detectable using analytical laboratory procedures
- Freshwater, estuarine, or marine aquatic environments with water depths ranging from 1 meter to hundreds of meters

Pearl Harbor, Honolulu, Hawaii, Sediment Site

The Pearl Harbor Sediment Site (at Joint Base Pearl Harbor-Hickam, Hawaii) was listed by the U.S. Environmental Protection Agency as a contaminated site in 1992, primarily due to pollutants from naval and surrounding land activities. Recent investigations, facilitated by support from the Environmental Security Technology Certification Program (ESTCP), focused on Decision Unit N-2, a 10.8-hectare area along the harbor's eastern bank, where elevated PCB levels near the Oscar 1 Pier outfall suggest ongoing contamination. Using OPTICS technology, Integral completed a study from November 2022 to March 2023 to examine stormwater contributions of PCBs, employing high-resolution, *in situ* monitoring. Data from this study aids in assessing PCB dispersal patterns and informs targeted remediation efforts for long-term site recovery.

This ESTCP project demonstrated the use of OPTICS for source control evaluation and stormflow plume characterization at Oscar 1 Pier outfall, Decision Unit (DU) N-2, Pearl Harbor Sediment Site, Honolulu, Hawaii (Oahu), between November 2022 and March 2023.

- OPTICS technology was demonstrated at DU N-2, Pearl Harbor Sediment Site ("Site"), Honolulu, HI (Oahu). DU N-2 is impacted by PCBs, which were hypothesized, but had not been previously shown to be delivered during stormflow to surface water and ultimately, site sediment, via the Oscar 1 Pier outfall.
- Two stationary OPTICS systems were deployed for 4 months in winter 2022/2023 and provided near-continuous data at 20 minute intervals. A mobile OPTICS system was deployed from a vessel during baseline (November 2022 and March 2023) and stormflow conditions (February 2023) as it transited throughout DU N-2.
- OPTICS statistical prediction modeling enabled derivation of high resolution PCBs. Model results were compared to discrete water sample data and statistical metrics were compared to the same metrics calculated for water sample field duplicates.
- OPTICS provided robust PCB data at sufficient resolution to evaluate that Oscar 1 Pier outfall is a source of contamination to DU N-2, and that PCBs are discharged from the outfall, remain in suspension, and dispersed throughout the site before settling.

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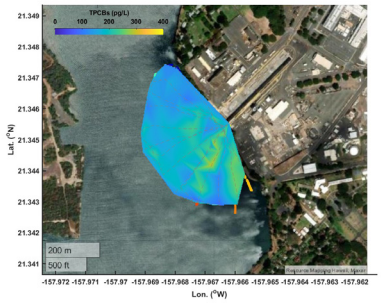
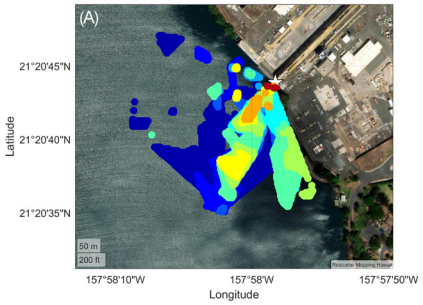
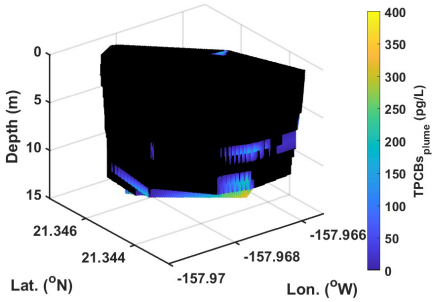
OPTICS instrumentation system deployed at the base of Oscar 1 Pier Outfall in DU N-2, Pearl Harbor.



OPTICS-derived TPCB (total PCB) concentrations at mid-water column are higher near the outfall and toward the south during ebb tide conditions.



TPCB concentrations in exceedance of baseline were observed near the water surface closest to the outfall and dispersed throughout the site at deeper depths.



3D volumetric plot of TPCB concentrations in exceedance of baseline throughout DU N-2 show that PCBs are discharged from the outfall, remain in suspension, and dispersed throughout the site before settling (the outfall is toward the back of the figure).

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View Bio

The Environmental Security Technology Certification Program (ESTCP) is the U.S. Department of Defense's environmental technology demonstration and validation program. The program's goal is to identify and assess innovative technologies that address DoD's high-priority environmental requirements efficiently and cost-effectively.