

Ridge to Reef Water Quality Monitoring Plan for the U.S. Virgin Islands



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Cover photo: Small boat marina on the north side of the St. Thomas East End Reserve, photo credit Dave Whitall (Coastal Ocean Assessments Stressors and Trends LLC).

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Executive Summary

The Ridge to Reef Water Quality Monitoring Plan for the U.S. Virgin Islands provides a comprehensive strategic framework designed to assess and track water quality with special focus on the health of coral reef ecosystems. Developed through a collaboration by experts from NOAA, the USVI Department of Planning and Natural Resources (DPNR), the U.S Environmental Protection Agency, and the University of the Virgin Islands, the Plan integrates land-based pollutant monitoring with habitat condition assessments to offer a scalable tool to inform territorial and federal resource managers.

The central goal is to identify, characterize, and prioritize the reduction of land-based sources of pollution (LBSP), to strengthen ecosystem resilience against climate-related threats like thermal bleaching, and disease outbreaks, and halt further degradation of USVI coral reefs. The Plan implements a conceptual model of impacts to link land-based stressors (e.g., sediments, nutrients, and chemical contaminants) to physical exposure (e.g., increased turbidity and sedimentation, and high nutrients) and subsequent habitat responses (e.g., decreased ecosystem health and abundance). It employs a spatiotemporally coordinated ridge-to-reef transect approach, monitoring fixed stations from the middle to upper watershed to the coral reefs, including the nearshore mangrove or seagrass beds to track LBSP exposure and habitat responses between land discharge points and the offshore reefs. Monitoring is focused on seven key watersheds: St. Thomas East End Reserve, Hull Bay, Brewers Bay, and Hendrik Bay on St. Thomas; Fish Bay and Coral Harbor on St. John; and Salt River Bay on St. Croix.

Water quality analytes are categorized into three tiers based on feasibility and risk of exposure: Tier 1 (priority) includes basic physical, chemical, and biological parameters such as temperature, pH, salinity, nutrients, total suspended sediments, chlorophyll-a, and fecal bacteria. Tier 2 includes heavy metals, contemporary and legacy herbicides and insecticides (e.g., DDT, chlordane, atrazine), and industrial chemicals (e.g., PAHs, PCBs, TCE). Tier 3 includes emerging threats like pharmaceutical products, forever chemicals, and microplastics.

A one-year proof-of-concept project is proposed for Salt River Bay and Brewers Bay or St. Thomas East End Reserve to generate a demonstration dataset. Alignment with the existing territorial Water Quality Management Program, together with the development of a formal intra-agency framework for collaboration between DPNR Divisions, are strongly recommended to successfully implement and operationalize this Ridge to Reef Water Quality Monitoring Plan.

Purpose

This document represents a collaboratively designed water quality monitoring plan to assess and track nearshore water quality, with a focus on coral reefs in the United States Virgin Islands (USVI)—henceforth USVI Ridge to Reef Water Quality Monitoring Plan. Within this Monitoring Plan, water quality is characterized and monitored to quantify the land-based pollutant levels in the watershed, the receiving coastal environment, and the associated nearshore coral reef communities. The overarching goal is to integrate watershed water quality and habitat condition of nearshore coral reefs and associated ecosystems, which are ultimately the focal point of the Territorial and Federal land-based sources of pollution (LBSP) and coral reef management priorities. This plan is scalable and can be implemented, in whole or in part, as needed by coastal managers and as funding is available.

Background

In 2024, with funding support from the National Oceanic and Atmospheric Administration (NOAA) Coral Reef Conservation Program, the NOAA National Centers for Coastal Ocean Science convened a group of local experts from USVI Department of Planning and Natural Resources (DPNR), the United States Environmental Protection Agency (EPA), and the University of the Virgin Islands, to identify and discuss data gaps, research needs, and capacity resources to effectively implement a water quality monitoring program focused on coral reef ecosystems, including inputs from land. The group held a series of virtual and in-person meetings in St. Thomas, resulting in the development of this USVI Ridge to Reef Water Quality Monitoring Plan

Coral reefs and associated marine ecosystems in the USVI play a crucial role in supporting the local economy through food provision and livelihoods (Culbertson et al. 2020). They are also integral to the local culture, reflected in historic architecture and cuisine, and the calm bays cherished by residents and tourists. Coral reefs are ecologically vital, support vast biodiversity, provide habitat and nursery grounds for countless marine species, and protect coastlines from storms and erosion. The ecosystem services provided by coral reefs in the USVI are estimated to be worth between \$ 426.3 and \$ 814.3 million USD annually (Eastern Research Group 2025). Despite their importance, these formations are in decline due to both global and localized stressors. Global threats include thermal coral bleaching and climate change which are difficult to manage locally. Local threats such as nonpoint source pollution, unsustainable land use and fishing practices, physical damage from anchors and boat groundings, and marine debris, are directly linked to human activities and can be mitigated through targeted local action (Rothenberger & Henderson 2019).

The three main islands of the U.S. Virgin Islands (St. Thomas, St. Croix and St. John) have a mountainous topography (Figure 1) with over half the islands having slopes greater than 30% (Anderson 1994). St. Thomas and St. John are primarily volcanic in origin, while St. Croix has a more complex and distinct geological history shaped by tectonic uplift (Rankin 2002). The rocky geomorphologies are overlain with shallow, well drained soils which are highly erodible due to a combination of steep topography, thin permeable profiles, and intense rainfall events (USDA 1995). Historically, significant portions of the islands were cleared for large-scale sugar cane production. Subsequent socioeconomic shifts toward urbanization and industrialization have prompted some post-agricultural forest regeneration, comprising both native



Figure 1. Hams Bluff, north shore St. Croix. Photo credit: Sabrina Picket (USVI Department of Planning and Natural Resources, Division of Coastal Zone Management).

and nonnative species (Atkinson & Marin-Spiotta 2015). However, this land-use legacy continues today with decreased agricultural productivity, contaminated aquifers, and continued pressures from climate change and biodiversity loss on lands once dominated by sugar plantations.

The climate of the USVI is classified as tropical savanna (Beck et al. 2018). Annual precipitation ranges from 90 to 115 cm yr⁻¹ and typically occurs in short, intense events with uneven spatial distribution. The dry season generally extends from January through April, followed by mid-summer weak wet period that precedes the primary rainy season beginning in September through December. Much of the annual rainfall is driven by the tropical waves and storms of the Atlantic hurricane season (Calvesbert 1970, Giannini et al., 2001).

Due to the relatively impermeable bedrock geology and terrain grade, there is little percolation of rainfall into the landscape, and the main stormwater conveyance system within the watersheds are ephemeral streams, locally referred to as "ghuts" (Figure 2). Ghuts flow only when there has been enough rain for the accumulation of water within the ghut channel, resulting in very flashy hydrographs (MacDonald et al. 1997). Even moderate rainfall events can generate substantial runoff volumes, transporting elevated loads of sediments, nutrients, and other contaminants downstream to the coastal waters (Lancellotti et al. 2024, Hensley et al. 2025). These factors, together with a large percentage of unpaved roads, active construction, and limited stormwater management infrastructure, contribute to excessive sediment loading in nearshore environments (Devine et al. 2003, Brooks et al. 2007, Ramos-Scharron et al. 2023).

Additional sources of land-based pollution include vehicles, household chemicals, human and animal waste, and construction sites. Recognition of the ecological and hydrological value of ghuts, along with concerns about their vulnerability to human impacts, led to the development of a management strategy aimed to protect ghuts (Gardner 2008). However, there is still need for a comprehensive water quality monitoring plan to better characterize the magnitude and spatiotemporal patterns of LBSP in ghuts and to assess their impacts on coastal ecosystems.



Figure 2. Dorothea Ghut with flowing water, St. Thomas. Photo credit: Sabrina Pickett (USVI Department of Planning and Natural Resources, Division of Coastal Zone Management).

Nearshore marine circulation in the U.S. Virgin Islands is primarily driven by local winds (northeast trade winds), tides, and the broader influence of the Caribbean Current. The predominantly easterly wave direction drives longshore currents from east to west along the northern and southern coasts of the islands, although these patterns are significantly influenced by local bathymetry and coastline shape. This results in highly variable, fine-scale patterns within the different bays and channels that have yet to be systematically quantified (Guannel et al. 2023, Zhang et al. 2025).

Shallow coral reef ecosystems and associated habitats comprise a total submerged area of 485 km². Of this area, coral reefs and colonized hardbottom habitats represent approximately 297.9 km², seagrasses and other submerged aquatic vegetation cover over 160 km², and unconsolidated sediments and uncolonized hard-bottom habitat comprise 23 km² (Kendall 2001b, Monaco et al. 2007). Coral reefs around St. Thomas and St. John are patchily distributed and occur primarily as fringe and patch reefs, whereas St. Croix supports a well-developed barrier reef system along its eastern and southern shores.

Coral reef ecosystems in the USVI are currently classified as being in fair condition (NOAA 2020). However, large scale disturbances from storms, thermal bleaching, and disease outbreaks, together with increased land-based sources of pollution have resulted in widespread coral and seagrass habitat loss. Consequently, many benthic communities are now dominated by turf and macroalgae (Grove et al. 2023). In addition, fishing pressure has led to severe declines in size and abundance of important fish species (Beets and Friedlander, 1999, Beets and Rogers, 2002). Furthermore, marine ecosystems of the islands support a number of endangered and threatened species (NOAA 2026a), including reef fish species, scleractinian corals, mammals, and sea turtles. For the Elkhorn and Staghorn corals (*Acropora* spp.) all waters at depths of 30 m or less around St. John, St. Thomas, and St. Croix are designated as critical habitat. This designation helps guide federal and territorial agencies in ensuring that their actions do not adversely affect these vulnerable species or their habitats (NOAA 2026b). Despite ongoing degradation, coral reefs of the USVI are among some of the most studied in the Caribbean, with long-term datasets spanning from the 1980s to the present. Key monitoring efforts include those conducted in Virgin Islands National Park (St. John), Buck Island Reef National Monument (St. Croix), the USVI Territorial Coral Reef Monitoring Program (TCRMP); and the National Coral Reef Monitoring Program (NCRMP). These programs collect a range of biological data, including benthic cover, coral health, and population demographics, but lack consistent, high-resolution water quality measurements.

The USVI DPNR Division of Environmental Protection Water Quality Management Program has been continuously collecting water quality data at more than 140 sites around the territory since 2000. This Program generates a comprehensive and representative assessment of temperature, salinity, dissolved oxygen, pH, turbidity, Secchi disk depth, total suspended solids, fecal coliforms and Enterococci, total phosphorus, and total nitrogen. However, only a limited number of the existing Water Quality Management Program sites are co-located with hard benthic reef habitat. Bioassessments have confirmed the presence of chemical contaminants, including polychlorinated biphenyls (PCBs), tributyltin, dichlorodiphenyltrichloroethane (DDT), chlordane, zinc, copper, lead, and mercury. Observed toxicity levels range from low in Coral and Fish Bays in St. John, to possible localized impacts (e.g., copper and chlordane) affecting <10% of the benthic infauna in the St. Thomas East End Reserve and Salt River Bay in St. Croix (Pait et al. 2013, Whitall et al. 2015; Pait et al. 2020, 2022, Lancellotti et al. 2023).

More recently, the EPA has supported efforts toward the development of a science-based framework and biological criteria to linking land-use, land-cover, and water quality to coral reef habitat condition in the USVI (Fore et al. 2006, Oliver et al. 2011, 2018, USEPA 2021, Bradley et al. 2022, Santavy et al. 2023). However, despite these achievements, there is an expressed need to better understand and quantify the linkages between watershed water quality and nearshore seagrass and coral reef habitat condition. The USVI Ridge to Reef Water Quality Monitoring Plan outlined herein provides the framework to develop and implement a spatially and temporally coordinated ridge-to-reef monitoring program that will allow resource managers to track water quality conditions across gradients of land-based pollution, as well as progress toward achieving the LBSP reduction management goals.

Framework for an Integrated Ridge-to-Reef Water Quality Monitoring Plan

In the USVI, stressors from land-based sources of pollution (LBSP) include sediments, nutrients, heavy metals, pesticides, herbicides, and legacy contaminants. These pollutants enter coastal waters through indirect pathways, such as runoff and erosion, as well as direct point sources, including drainage infrastructure, landfills, construction sites, vessels, and recreational boating activities (Rogers, 2013, Ramos-Scharron et al. 2023, Ferguson 2028, Whittall et al. 2015). Elevated inputs of land-based stressors increase pollutant loads in coastal waters, leading to water quality impairments such as reduced water clarity, increased turbidity, and enhanced sediment deposition from terrigenous runoff. Additional impacts include algal blooms and proliferation of nuisance macroalgae driven by excess nutrients, physiological stress and toxicity from chemical contaminants, and the introduction of pathogens and disease vectors. Exposure to pollutant levels beyond physiological thresholds can negatively affect marine organisms, resulting in measurable habitat responses (Vandiver et al. 2021, Wenger et al. 2024). For the nearshore habitats in the Virgin Islands, this includes reduced mangrove growth and recruitment, increased macroalgae and phytoplankton blooms, and overall declines in seagrass and coral reef ecosystem health and abundance. Figure 3 presents a conceptual model of LBSP Impacts illustrating the linkages between the key LBSP risk components—i.e., stressors, exposure, and habitat response. Figure 3 also highlights critical data needs across these components to establish environmental baselines and identify thresholds at which exposure to stressors translates into ecological impacts. This evidence is essential for informing management decisions, guiding progress towards LBSP reduction goals, and supporting the development of adaptive management strategies.

Management Goals, Outcomes, and Evaluation Questions

The Monitoring and Evaluation Framework in Table 1 summarizes the strategic management goals and associated actionable outcomes to reduce land-based pollutant exposure in the nearshore environment that can elicit a positive change in habitat responses in the USVI. Within this framework, the primary management goal is to identify, characterize, and prioritize reduction of land-based pollutant stressor loads from point and non-point sources contributing to nearshore water quality impairment. Improvements to coastal water quality are expected to be achieved through: 1) a thorough understanding of the range, severity, and spatiotemporal patterns of LBSP stressors in the watershed, the nearshore receiving waters, and the adjacent coral reefs and associated habitats; and 2) informing, developing, and implementing water quality criteria and management actions that are protective of coral reefs. The evaluation questions developed for each management goal are used to select the appropriate indicators

and locations that will be most sensitive to detecting change in LBSP threats over time and space, and ultimately to assess success toward achieving the established management goals. (Vandiver et al. 2021; Wenger et al. 2024).

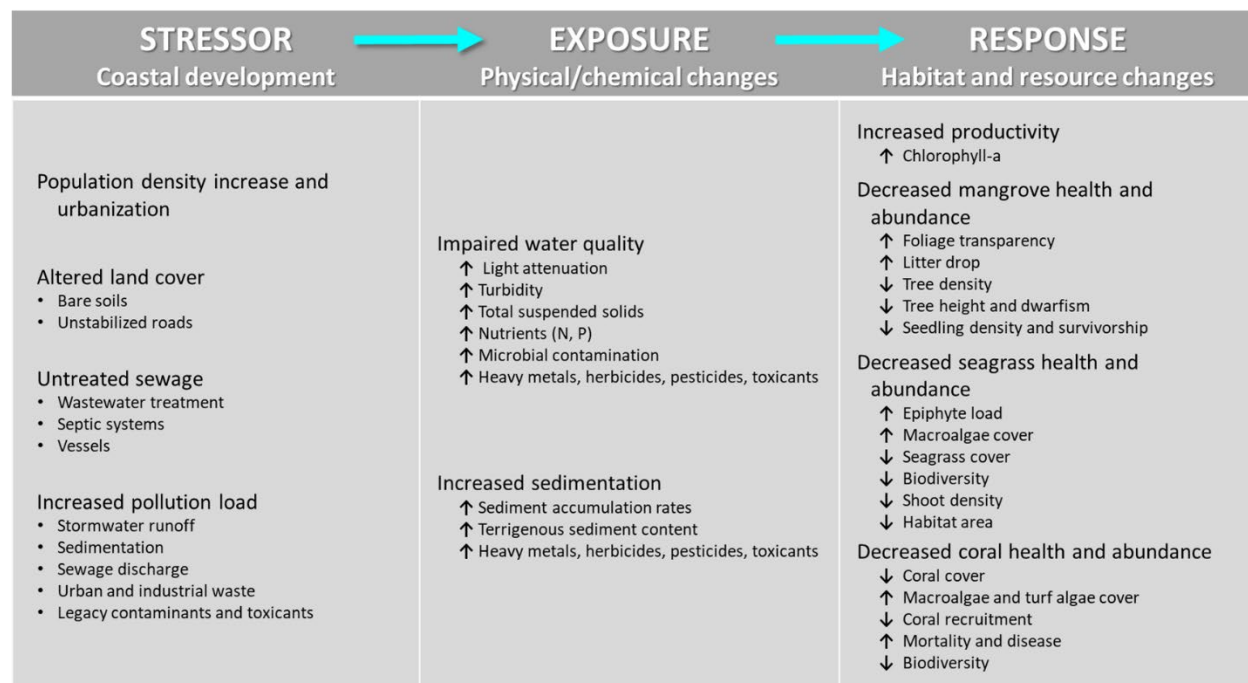


Figure 3. The Model of LBSP Impacts provides a conceptual understanding for the sources of pollutant stressors, resultant physical and chemical changes to coastal environment from pollutant exposure, and associated habitat and resource response. Modified from Vandiver et al. 2021.

The overarching management goal of USVI’s land-based pollution reduction and water quality improvement strategies is to halt further degradation of territorial coral reef ecosystems. However, due to the increasing frequency, magnitude, and severity of climate-related impacts (e.g., thermal bleaching and storms) and disease outbreaks, the ultimate actionable outcome is to minimize anthropogenic land-based stressors (Figure 4) to promote and strengthen the resilience of coastal coral reefs and associated nearshore seagrass beds and mangrove forests, thus supporting the preservation of trans-ecosystem function and services.

Priority Indicators

LBSP Stressor and Exposure Monitoring

Effective monitoring will require dedicated funding, as well as strong interagency collaboration and leveraging partnerships. These efforts are essential to address the key evaluation questions outlined in Table 1: (1) What is the magnitude and spatial extent of water quality impairment in ghuts? (2) How closely tied is the water quality in priority coral reefs to inputs from the adjacent watershed? (3) What are the source categories of this pollution? (4) Has watershed and nearshore water quality changed/improved?

Table 1. Conceptual Ridge-to-Reef water quality monitoring framework summarizing USVI water quality management goals, outcomes, and evaluation questions aligned with the LBSP threat risk components (stressor, exposure, response). Priority indicators will be used to evaluate temporal trends as well as progress toward improved water quality conditions. Collectively, this information will provide the support needed to assess change over time. Addressing additional management and research questions may be possible with data generated from this plan, or the plan may be adjusted in the future to specifically address different/new management questions and needs.

LBSP Threat	Management Goals		Actionable Outcomes	Evaluation Questions	Priority Indicators
	National Strategy	USVI Coral Priorities			
STRESSOR	- State and territorial priority watersheds have stable or improved coastal water quality. - Water quality parameters that may be negatively impacting coral reef ecosystems are identified, characterized, and prioritized.	Identify and reduce LBSP stressor loading from point and non-point sources contributing to water quality impairment, including sediments, nutrients, oil and grease, heavy metals, pesticides, microplastics, and other contaminants.	Determine the magnitude and spatiotemporal patterns of LBSP stressors in ghuts to inform watershed management for long-term implementation.	- What is the magnitude and spatial extent of LBSP in the ghuts and near coastal waters? - Has the water quality in ghuts improved?	- Tier 1 - Tier 2 and Tier 3 as needed by managers.
EXPOSURE	Ensure state and territorial water quality criteria are appropriate for healthy and resilient coral reefs and adjacent habitats and benefits coastal communities.	Long-term LBSP exposure reduction by implementing coral-specific water quality criteria and management strategies in priority watersheds.	Document the types, spatial, and temporal patterns of LBSP exposure to nearshore coral and adjacent habitats to inform coastal and watershed management for long-term implementation.	- How closely tied is water quality in priority coral reefs to inputs from the adjacent watershed? - What are the source categories of this pollution? - Has coastal and nearshore water quality improved?	- Tier 1 - Tier 2 and Tier 3 as needed by managers.
HABITAT RESPONSE	Resilient, genetically diverse, reproductively viable populations of key coral species have been restored or preserved to maintain ecosystem function in key reef sites.	Support resilient coastal and nearshore ecosystems—i.e., mangrove, seagrass, and coral reefs— so function supports USVI economy and ecosystem services are preserved.	Improvement or no further degradation of coastal and nearshore habitats.	Has the condition of coastal and nearshore coral reefs and associated habitats improved?	Health and abundance of the nearshore ecosystems.



Figure 4. Brewers Bay, St. Thomas—May 8, 2024: A terrigenous sediment plume extended from the inlet near Range Cay past Black Point and continued westward following a heavy rainfall event. Photo credit: Moriah Sevier (University of the Virgin Islands).

To support efficient and adaptive monitoring, a tiered approach to prioritizing water quality parameters is recommended. This approach allows managers to select indicators based on management needs, available resources, and funding levels. Herein tiers were assembled based on the following criteria: (1) the likelihood of occurrence within the system; (2) degree of ecological risk or threat; and (3) feasibility, including ease and cost of measurement. Under this framework, Tier 1 parameters are both easy to measure and established as critical indicators of LBSP impacts (see Holst et al. 2016). In contrast, Tier 3 parameters include those that may not even be present in the system and are expensive to quantify.

Stressor and exposure monitoring will allow managers to establish water quality baselines and track temporal changes in these indicators, helping to determine whether conditions are trending toward reference conditions at priority locations. The tiered indicator framework represents a consensus among the planning team and is intended to be adaptive. Tiers can be adjusted over time by managers based on emerging data, evolving management priorities, and improved scientific understanding (see Appendix 1 for parameter rationale).

Tier 1 Indicators: Temperature, salinity, dissolved oxygen, pH, nutrients (nitrate, nitrite, ammonium, urea, total nitrogen, orthophosphate, total phosphorus, and silica), chlorophyll-a, fecal indicator bacteria (*Enterococcus* and *E. coli*), turbidity, and total suspended solids (TSS).

Tier 2 Indicators: Sediment accumulation, sediment geochemical composition, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), herbicides and insecticides (both contemporary and legacy e.g., DDT, chlordane, atrazine, methyl bromide, glyphosate), heavy metals (Al, Fe, Mg, and Cu),

and trichloroethene (TCE). Carbaryl and nonylphenols are included in Tier 2 because they are monitored and regulated by the U.S. EPA due to their high level of toxicity to aquatic life and endocrine-disruption properties. Also, sampling the ghut sediments for metals, organic contaminants, and *Clostridium* (see Stelma 2018) is indicated to assess the contaminant flux in the absence of flowing water even after significant rain.

Tier 3 Indicators: Pharma and personal care products (PPCPs), forever chemicals (e.g., polyfluoroalkyl substances [PFAS] and Polybrominated diphenyl ethers [PBDEs]), and micro and nano-plastics (MNPs).

Indicators for source identification: Human waste pollution: dietary tracers (e.g., caffeine and sucralose), pharmaceuticals (e.g., acetaminophen as tracer for septic vs waste water treatment plant discharges), optical brighteners (household wastewater), and human-specific microbial source tracking.

It is important to consider that water quality thresholds above which sublethal impacts to corals occur remain poorly defined, particularly for nutrients and many chemical contaminants. As more research on threshold values becomes available, it will be critical that the analytical detection limits are sufficiently low to capture ecologically relevant concentrations. Future work may need to involve additional laboratories, including those outside of the territory, depending on which analytes are targeted and how many sites are being analyzed (i.e., throughput considerations). Developing additional analytical capability particularly at the University of the Virgin Islands and other institutions will be fundamental in supporting long-term water quality monitoring efforts.

Habitat Response Monitoring

This monitoring complements the LBSP stressor and exposure monitoring to evaluate and answer the question: (1) Has the condition of coastal and nearshore coral reefs and associated habitats improved or changed over time? For this type of monitoring, fixed sites are advised to help establish robust ecological baselines, assess change over time, and determine whether management goals are trending to the expected outcomes. This component of the monitoring framework is designed to leverage existing programs and partnerships to track the condition of nearshore biological communities. Due to the ephemeral nature of water quality, the complex coastal hydrodynamics, and the distance between the watershed discharge points and the outlying coral reefs, a trans-ecosystem approach is recommended. This involves supplementing the coral reef monitoring with sentinel sites located in the inshore waters, proximal to the ghuts' outflows, often characterized by mangrove forests or seagrass beds (Figure 5). The proposed habitat response indicators listed below represent core metrics of ecosystem health and abundance which can be adjusted over time based on emerging data, evolving management priorities, and improved scientific understanding (Figure 6).

Coral Reef Indicators: Benthic cover (i.e., corals, coralline algae, macroalgae, turf or epilithic algae, sponges, octocorals, and sediment), coral colony size class distribution and recruitment, biodiversity, and coral condition (bleaching and disease prevalence).

Seagrass Indicators: Benthic cover (i.e., seagrasses, corals, coralline algae, macroalgae, turf or epilithic algae, sponges, and sediment), seagrass shoot density, maximum depth of seagrass bed development, and epiphyte load.

Mangrove Indicators: Community composition and diversity, tree height, density, diameter at breast height (DBH), canopy cover, and seedling recruitment and survival.



Figure 5. Mangrove forest community fringing the Turpentine ghut outflow in the St. Thomas East End Reserve. Photo credit: NOAA Coral Reef Conservation Program.



Figure 6. The upside-down jellyfish, Cassiopea xamachana commonly found in warm, shallow nearshore seagrass and mangrove habitats across the wider Caribbean is highly tolerant to broad environmental changes but is highly sensitive to specific water pollutants—such as herbicides and heavy metals—making them effective bioindicators of water quality impairment. Photo Credit, NOAA Coral Reef Conservation Program.

Site Selection

The study design follows a ridge-to-reef transect approach, with priority indicators monitored at fixed sites. Site prioritization is also tiered, based on recommendations from local and federal experts, and is intended to be adjusted in the future to suit evolving management priorities and research needs.

For each drainage area, two water quality monitoring sites will be established in the watershed (ghut sites); i.e., one in the upper watershed and one at the lowest accessible point before the ghut discharges into the nearshore coastal waters. Correspondingly, there will be a water quality monitoring site located in the inshore receiving waters adjacent to the ghut outflow. In locations where multiple ghuts discharge directly into the system, then multiple ridge-to-reef transects will be required.

Coral reef water quality and habitat response monitoring will be conducted at fixed sites leveraging existing biological monitoring programs (e.g., the Territorial Coral Reef Monitoring Program, TCRMP; and the National Coral Reef Monitoring Program, NCRMP). Owing to the distance between the watershed discharge points and the fringing reef, a minimum of three coral reef water quality sample sites will be needed in order to capture the spatial variability. Additionally, at least one inshore LBSP habitat response monitoring site in the nearshore mangrove forest or seagrass beds, co-located with the ghut outflow water quality monitoring sites is highly recommended. Status and trends assessment of these proximal ecosystems provides critical insight and context to the quantified coral reef habitat responses, as well as to their role in chemical processing mediating or transforming contaminants before they reach the offshore coral reef ecosystem.

The group of local experts prioritized seven watersheds and identified other sites considered ecologically relevant for a territory wide water quality monitoring plan (Figure 7). In each of the seven priority watersheds, ghut, outflow, and coral reef sites were established to assess the influence of land-based pollution on downstream coral reefs. Where possible, existing monitoring locations were used to ensure compatibility with ongoing data collection efforts (Appendix 2). In areas without pre-existing monitoring, new sites were established to complete the sampling design, except for lower ghut locations where physical and legal access will need to be verified before establishing a permanent monitoring station. Sites were divided into three priority groups to guide implementation based on available resources, with priority 1 sites being the most important and priority 3 being the least essential. In total, the monitoring network comprises 68 water quality monitoring sites distributed across three priority levels (Figure 7).

The 7 priority watersheds are:

- St. Thomas East End Reserve
- St. Thomas Hull Bay
- St. Thomas Brewers Bay
- St. Thomas Hendrik Bay
- St. John Fish Bay
- St. John Coral Harbor
- St. Croix Salt River

Sample Protocols

In order ensure data gathered through this monitoring effort are scientifically robust and comparable, field and laboratory protocols should be aligned with established Standard Operating Procedures (SOPs) from the U.S. Virgin Islands, including: (1) DPNR Department of Planning and Natural Resources Water Quality Management Program; (2) the USVI Territorial Coral Reef Monitoring Program; (3) the National Park Service seagrass habitat survey; and (4) USVI Territorial Mangrove Monitoring Program. Relevant guidance and procedures can be drawn from the following documents:

1. U.S. Environmental Protection Agency (2026) Quality Assurance Project Plan for the U.S. Virgin Islands Basic Water Quality Monitoring Program. Call Order No. 68HERC23F0250. Prepared by the Center for Water Resources RTI International and the Great Lakes Environmental Center Inc.
2. DPNR (U.S. Virgin Islands Department of Planning and Natural Resources) (2022) Assessment Methodology for the U.S. Virgin Islands Integrated Water Quality Monitoring and Assessment Report. https://dpnr.vi.gov/wp-content/uploads/2022/10/2022_Assessment_Methodology_DRAFT.pdf
3. Hollander E, Krampitz NM, Ennis RS, Heiderman SL, Kadison E, Smith TB (2026) The United States Virgin Islands Territorial Coral Reef Monitoring Program. 2024 University of the Virgin Islands, United States Virgin Islands. https://static1.squarespace.com/static/63e67b7bf74b2e1206f20635/t/6a09d7ea16fbc546b475e135/1779030045649/TCRMP2024_intro_BL_methods.pdf
4. South Florida/Caribbean Network (2022) Field methods—Version 1.1. South Florida/Caribbean Network Standard Operating Procedure NPS/SFCN/SOP—SEA05. South Florida/Caribbean Network, Palmetto Bay, Florida. <https://irma.nps.gov/DataStore/DownloadFile/673632>
5. Durdall A, Grimes K, Stewart H, Blondeau J, Henderson L (2025) The United States Virgin Islands Territorial Mangrove Monitoring Program. 2025 Annual Report. University of the Virgin Islands, United States Virgin Islands.

Data Analysis and Products

The primary outcome from this effort is this monitoring plan which can be implemented as desired by the USVI and other entities. Secondly, a one-year proof of concept pilot project will be implemented in St. Croix Salt River Bay and St. Thomas Brewers Bay or St. Thomas East End Reserve to operationalize the monitoring field efforts; and thirdly, generation of a comprehensive one year-long water quality data set for the pilot project locations and demonstration of its utility.

Within each of the pilot project locations, at least six water quality monitoring sites (i.e., two watershed ghut sites, a nearshore ghut mouth site, and three coral reef sites) will be sampled, preferably monthly, for routine Tier 1 parameters. Dietary tracers of caffeine and sucralose will be included based on available funds.

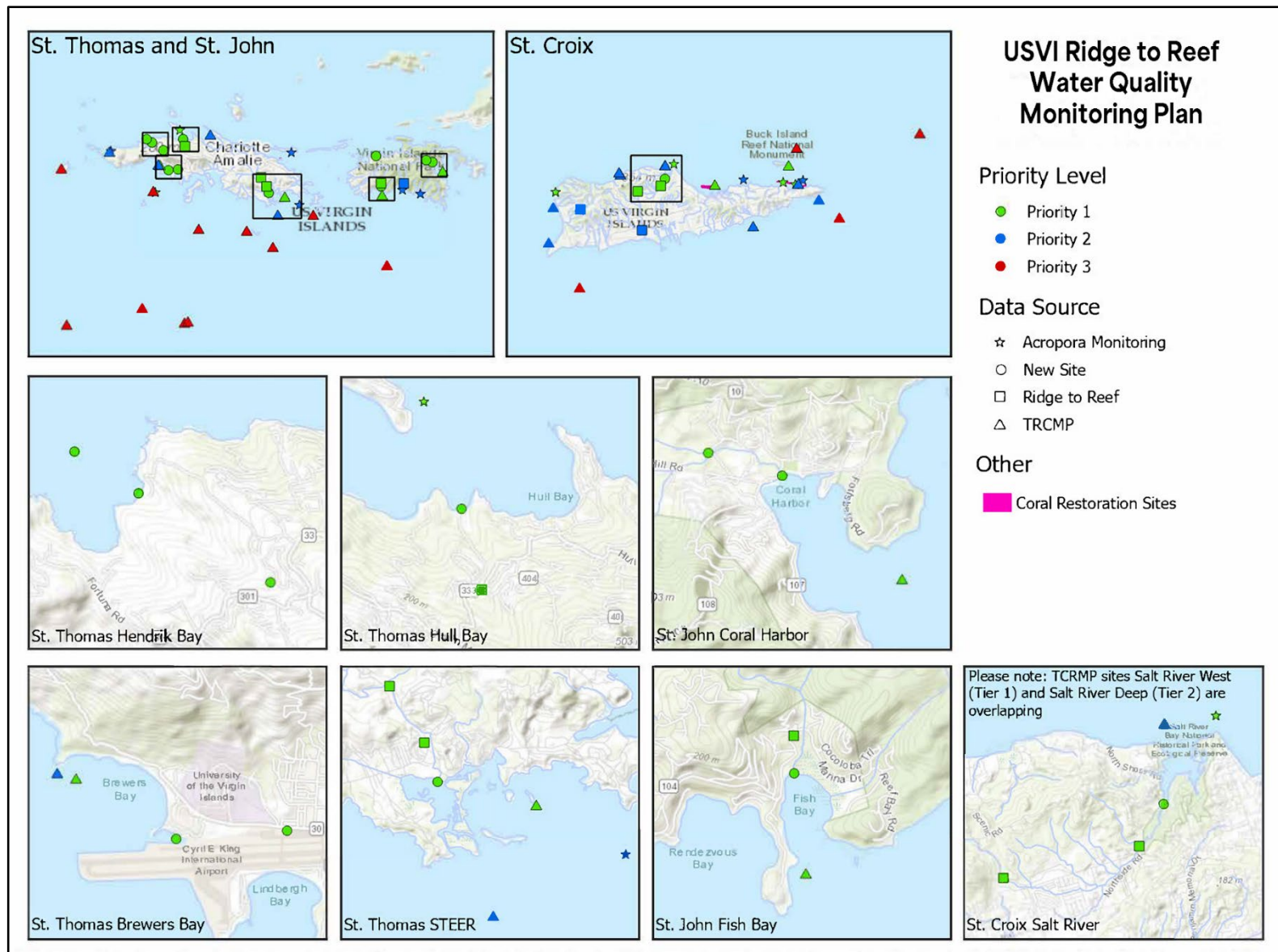


Figure 7. Location of the USVI Ridge to Reef Water Quality Monitoring Plan fixed stations; enlarged are each of the seven priority watersheds.

Throughout the implementation of the pilot project, NOAA and DPNR staff will collaborate to analyze and interpret the water quality data and develop products relevant to the management needs. Analytical approaches will include statistical summaries, hypothesis testing and comparisons, as well as geospatial techniques to evaluate geographic patterns and trends. In subsequent years, DPNR will assume primary responsibility for all data analysis. Key products generated from this effort will include written technical reports, spatial data products (e.g., maps), and publicly accessible datasets.

Data Management, Storage, and Access

Following completion of laboratory analysis, all data and documents will be stored in accordance with the Filing of Ambient Field Data Forms and Associated Paperwork SOP. The data for this monitoring program will be publicly available and will be uploaded to EPA STorage and RETrieval database and available through the National Water Quality Monitoring Council Water Quality Portal.

Recommendations

It is strongly recommended that the **USVI Department of Planning and Natural Resource develops a formal internal framework for collaboration between Divisions**, like a Memorandum of Agreement (MOA) **to successfully implement and operationalize the monitoring activities and generate standardized high-quality data to inform managers**. Intra-agency coordination roles and responsibilities should include, but not limited to: (1) Project management and oversight. (2) Procurement and allocation of funding, through federal grants (e.g., EPA, NOAA) to support implementation. (3) Sharing resources, technical expertise, and infrastructure to maximize operational efficiency. (4) Assistance in field operations, including but not limited to the provision sampling gear, instrumentation, supplies, personnel, vehicles, and vessels for marine and terrestrial monitoring logistics. (5) Data management, storage, analysis, and reporting. (6) Periodic review to ensure scientific rigor including study design, site selection, parameter prioritization, data verification, and address data and research needs.

Also, we reiterate the **importance of implementing the Monitoring and Evaluation Framework** outlined in this document to guide assessing success of LBSP management strategies in the USVI priority watersheds. This framework identifies the LBSP management goals, outcomes, and monitoring priorities at watershed and nearshore spatial scales to establish baselines and track changes to LBSP stressors, pollutant exposure, and habitat responses over time. The integrated monitoring data collected following this ridge-to-reef approach also discriminates the indicators that are the most sensitive to LBSP threats and provides managers the evidence needed to determine the progress in achieving established LBSP management goals, or whether adaptive approaches are necessary.

It is strongly recommended that the USVI Ridge to Reef Water Quality Monitoring Plan **merges and aligns efforts with the existing USVI DPNR Division of Environmental Protection Water Quality Management Program to reduce costs and ensure data compatibility, statistical comparability, and analytical integration**. The available Water Quality Management Program data provides the basis to: (1) Establish baseline environmental conditions in priority watersheds. (2) Characterize the range and severity of nearshore water quality impairment. (3) Identify reference sites representative of high and low LBSP impairment, which are essential for contextualizing change over time. Furthermore, the analysis of existing water quality data can help identify environmental drivers and covariates, which over time, can

inform targeted monitoring strategies. For example, monitoring efforts can be optimized by aligning the water quality sampling to follow the seasonal wet and dry patterns and major rainfall events.

In addition to the coral reef status and trends data obtained from the existing coral reef monitoring programs, it is strongly recommended that **habitat response monitoring sites (either seagrass bed or mangroves) be deliberately co-located with ghut outflow water quality monitoring sites. This coupled approach allows scientists to quantify direct relations between LBSP habitat responses and LBSP exposure that can be tracked down to changes in the LBSP stressor.** This strengthens the ability to detect whether nearshore habitat conditions are improving over time and inform downstream coral reef management.

An improved understanding of nearshore water circulation and residence times is also essential. These factors influence how pollutants are transported, diluted or retained, and therefore play a key role in linking water quality conditions to habitat responses at both nearshore and offshore coral reefs. Consequently, **for the pilot implementation, it is recommended that sporadic surface and bottom samples are in the nearshore and coral reef water quality monitoring stations to verify the alignment—**or lack thereof—of surface and bottom water quality conditions.

Additional Resources

1. Ridge to reef approaches to monitoring:

- Vargas-Ángel (2024) Culebra LBSP Ridge to Reef Monitoring Program: standardized work plans to monitor changes in land-based sources of pollution stressors, exposure, and habitat responses on Culebra Island, Puerto Rico. https://coast.noaa.gov/coral_storage/library/NOAA/CRCP/NMFS/OHC/Projects/30033/Culebra_LBSP_RidgeToReef_Monitoring_Program/Vargas-Angel2024_Culebra_LBSP_RidgeToReef_Monitoring_Program.pdf

2. Water quality monitoring:

- DPNR (U.S. Virgin Islands Department of Planning and Natural Resources) (2024) Amended Virgin Islands Water Quality Management Program Water Quality Standards Rules and Regulations. CVIR 12-007-000, Subchapter 186. <https://www.epa.gov/sites/default/files/2014-12/documents/viwqs.pdf>
- DPNR (U.S. Virgin Islands Department of Planning and Natural Resources) (2022) Integrated Water Quality Monitoring and Assessment Report. Division of Environmental Planning, Water Quality Management Program. <https://dpr.vi.gov/wp-content/uploads/2026/02/2022-USVI-Integrated-Report.pdf>
- Vargas-Ángel B (2024) Culebra Nearshore Water Quality Monitoring Program Work Plan: Developing a water quality monitoring program to evaluate changes in LBSP exposure in Culebra, Puerto Rico. https://coast.noaa.gov/coral_storage/library/NOAA/CRCP/NMFS/OHC/Projects/30033/Culebra_LBSP_RidgeToReef_Monitoring_Program/Vargas-Angel2024c_Nearshore_WaterQuality_Monitoring_WorkPlan.pdf

3. National Coral Reef Monitoring Program protocols
 - National Coral Reef Monitoring Program (2026) Benthic Community Assessment Survey Field Protocols for U.S. Atlantic: Florida, Flower Garden Banks, Puerto Rico, and U.S. Virgin Islands. <https://doi.org/10.25923/d5gv-s772>
3. Seagrass monitoring protocols
 - Vargas-Ángel B (2024) Culebra Seagrass Monitoring Work Plan: Developing a seagrass monitoring program to evaluate changes in LBSP responses in Culebra, Puerto Rico. https://coast.noaa.gov/coral_storage/library/NOAA/CRCP/NMFS/OHC/Projects/30033/Culebra_LBSP_RidgeToReef_Monitoring_Program/Vargas-Angel2024e_Seagrass_Monitoring_Transects_WorkPlan.pdf
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Appendix 1

Water quality monitoring metrics and water quality stressor effects on corals, seagrasses, and humans.

Tier	Indicator	Parameter	Sample type	Rationale
1	Physical	Temperature	Field probe	Indicator of heat stress and climate change. Coral bleaching and mortality is one of the most devastating ecological impacts of persistent rising ocean temperatures.
		Turbidity	Field probe	Indicator of water clarity, erosion, and runoff. Reduced light quality and quantity limit photosynthetic ability of coral symbiotic algae and seagrasses causing energy deficits and negative ecological responses.
		Total suspended solids	Grab sample	Indicator of water clarity, erosion, and runoff. Solid organic and inorganic particles (<2 mm) that remain in suspension in water after gravity settling. Reduced light quality and quantity effects.
	Chemical	Salinity	Field probe	Indicator of freshwater sources. Salinity can be a chemical stressor in the aquatic environment.
		pH	Field probe	Indicator of acidification. Fundamental to biological metabolic processes and calcium carbonate deposition. pH below 7.8 causes decreased coral and algal calcification.
		Dissolved oxygen	Field probe	Vital to aquatic life. DO levels below 5 mg/L are considered stressful for aquatic life. May be used as indicator of eutrophication.
		Nutrients		Play a critical role in the healthy functioning of aquatic ecosystems supporting growth of aquatic plants and algae that provide food and habitat for aquatic biota. Excess nutrients cause increased macroalgal growth which can overgrow and outcompete corals. Excess inorganic nitrogen and phosphorus can reduce corals photosynthesis, calcification, and fertilization success.
		Nitrite/nitrate	Grab sample	Indicator of nitrogen pollution through runoff from fields treated with nitrogen fertilizers, animal manure, septic tanks wastes, and sewage sludge. Reef corals thrive in nutrient-poor waters (< 0.003 mg/L). High concentrations can lead to eutrophication with the risk of adverse effects on corals.
		Ammonium	Grab sample	Indicator of nitrogen pollution from agricultural runoff, animal waste, or sewage effluent. Generally non-toxic acts like a nutrient promoting eutrophication and algal blooms. Direct precursor of ammonia (NH ₃) which is highly toxic to aquatic biota.
		Urea	Grab sample	Indicator of human or animal waste contamination; acts like a nutrient that promotes eutrophication and excessive algae growth. Although stable in water, rapid bacterial breakdown releases ammonia which is toxic to aquatic life.
		Total Nitrogen	Grab sample	Is the sum of all nitrogen forms: ammonia nitrogen + organic nitrogen + nitrate + nitrite.
		Orthophosphate	Grab sample	Indicator nutrient pollution from waste water discharge and agricultural runoff. The simplest form of phosphorus that is up-taken by photosynthetic organisms. Adverse effects of increased phosphate include algal blooms and nuisance algal growth, as well as decreased coral reproduction and skeletal deposition.

Tier	Indicator	Parameter	Sample type	Rationale
	Biological	Total phosphorus	Grab sample	Measurement of all dissolved and suspended inorganic and organic phosphorus species.
		Silica	Grab sample	Indicator of runoff through its concentration, which can reflect the different sources and residence times of water moving through a catchment.
		Chlorophyll-a	Field probe / grab sample	Indicator of high nutrient loads from wastewater and/or runoff. Main photosynthetic pigment in marine phytoplankton and a good proxy for phytoplankton biomass and primary productivity. Nutrient inputs affect phytoplankton concentrations and therefore elevated levels of chlorophyll can lead to high turbidity.
		Fecal coliforms	Grab sample	Indicator of human and animal waste contamination. Pathogens that affect corals can be introduced by wastewater and runoff.
2	Physical	Sediment accumulation	Traps/pods	Indicator of erosion and runoff. Causes increased turbidity and particle deposition; may smother corals and other benthic organisms.
	Chemical	Sediment geochemical composition	Traps	Increased terrigenous sedimentation is an indicator of increased erosion and terrestrial runoff. Effects on light attenuation and smothering of benthic organisms.
		Polycyclic aromatic hydrocarbons (PAHs)	Grab sample	Indicators of industrial contamination, oil spills, and incomplete fossil fuel combustion. Immunosuppressants, carcinogenic, potential endocrine disruptors.
		Polychlorinated biphenyls (PCBs)	Grab sample	Indicators of industrial contamination. Immunosuppressants, carcinogenic, endocrine disruptors, neuro-developmental disorders.
		Herbicides and insecticides	Grab sample	Indicators of agricultural runoff and urban non-point pollution. Neurotoxic, carcinogenic, endocrine disruptors, neurotoxic, developmental disorders. Highly toxic to aquatic life.
		Heavy metals	Grab sample	Al, Fe, Mn: crustal elements; indicators of runoff. Pb and Cu: indicators corrosion of old pipes. Cu causes reduced coral fertilization success and zooxanthellae growth; impairs invertebrate larval settlement.
		Trichloroethene (TCE)	Grab sample	Indicator of industrial contamination: synthetic degreasers, adhesives, paint removers, and refrigerants. Respiratory and musculoskeletal effects, increased cancer risk.
		Nonylphenol	Grab sample	Indicator of industrial contamination. Surfactant, used to produce detergents, paints, lubricants, and plastics. Endocrine disruptor; linked to oxidative stress and neurotoxicity.
3	Chemical	Pharma and personal care products (PPCPs)	Grab sample	Indicators of human waste contamination. Harmful to aquatic life, potential impact on human health.
		Polyfluoroalkyl substances (PFAS)	Grab sample	Indicators of industrial contamination. Synthetic oil, stain, grease, and water-resistant "forever chemicals" that bioaccumulate in tissues. Linked to liver damage, cancer, and thyroid disease risk.

Tier	Indicator	Parameter	Sample type	Rationale
		Polybrominated diphenyl ethers (PBDES)	Grab sample	Indicators of industrial contamination. Synthetic flame-retardant organic chemicals that bioaccumulate. Endocrine disruptors, linked to neurodevelopmental toxicity, reproductive issues, potential cancer risk.
		Micro/nano plastics (MNPs)	Grab sample	Indicator of advanced plastic pollution Absorb pollutants (e.g., PCBs, heavy metals) and enter the bloodstream; immune modulation impairment, reproductive/cardiovascular effects.
Indicators for source identification				
	Chemical	Caffeine and sucralose	Grab sample	Human dietary tracers, indicator human wastewater contamination.
		Acetaminophen	Grab sample	Indicator of raw, untreated, or poorly treated wastewater contamination. Breaks down relatively quickly in surface waters (primarily through sunlight and bacterial action), its ratio to other persistent contaminants is highly useful.
		Optical brighteners	Grab sample	Indicator of household wastewater discharge. Chemical compounds added to laundry detergents, cleaners, and toilet paper to make them appear whiter and brighter.

Appendix 2

Existing programs considered for water quality monitoring site selection.

1. Territorial Coral Reef Monitoring Program (TCRMP): TCRMP consists of annual to semi-annual assessments of coral health, benthic community structure, fish community structure, and physical dynamics at 33 sites down to 65 m (220 ft) depth. TCRMP sites within the seven priority watersheds or overlapping coral restoration sites were included in priority 1. Remaining nearshore TCRMP sites were included in Priority 2 and remaining offshore sites were included in priority 3.
2. Acropora Monitoring: In addition to the 33 coral reef sites mentioned above, TCRMP monitors 13 *Acropora* Monitoring sites (sampled in triplicate). Any *Acropora* monitoring sites that are associated with either one of the seven priority watersheds or a coral restoration site were placed in priority 1. The remainder of the *Acropora* Monitoring sites were placed in priority 2. Since these sites are sampled in triplicate, only one of the 3 triplicates was included in the USVI Ridge to Reef Water Quality Monitoring Plan site list.
3. Coral outplants and coral nursery: Coral outplants and coral nursery sites were not considered in any priority of sampling as it was decided these were not relevant for LBSP habitat response monitoring.
4. Coral Restoration Sites: There are six active coral restoration sites in the USVI. Two are located on St. Thomas (Coki and Flat Cay) and the remaining four are located on St. Croix (Butler Bay, Llews Reef, Long Reef, and Sweeper's Complex). Coral restoration sites in Flat Cay, Butler Bay and Llews Reef already have associated *Acropora* monitoring sites and Long Reef is an associated TCRMP site. However, Coki and Sweeper's Complex sites only have coral outplant sites associated with them. It was decided to prioritize the *Acropora* Monitoring and TCRMP sites already associated with the Coral Restoration sites (see numerals 1 and 2 above) and not to add new sampling sites overlapping coral restoration sites Coki and Sweeper's Complex. The reasoning is that restoration projects may be too dynamic to base permanent water quality site locations on and UVI may plan to incorporate water quality monitoring sites themselves, making it unnecessary to do so in the USVI Ridge to Reef Water Quality Monitoring Plan site list.
5. Ridge to Reef: This University of the Virgin Islands project, led by researcher Dr. David Hensley, seeks to understand how land-based inputs can affect places downstream, like coral reefs. As part of this project, many monitoring sites have been established in USVI ghuts. Since these sites already have complementary data being collected, and have been determined accessible, they were used as the upper ghut sampling locations when available for the seven Priority Watersheds. Any additional sites associated with this project were included in priority 2.
6. Water Quality Standards Rules and Regulations: [The Water Quality Standards Rules and Regulations, adopted by the U.S. VI DPNR \(DPNR 2019\)](#), include Class A marine and coastal waters which represent the outstanding national resource waters, as specified in section 186-3(b): (1) within 0.5 miles of the boundaries of Buck Island's Natural Barrier Reef, St. Croix, and (2) Trunk Bay, St. John, from the northern-most point of the west shore outcropping of Trunk Bay, linearly to the northern-most point of Trunk Cay, linearly to the northernmost point of the east shore outcropping of Trunk Bay. It was decided that it would be beneficial to include these very special waters in the long-term monitoring strategy to ensure that there is sufficient amount of data available to assess them in the future from a point of view of section 303(d) of the Clean Water Act, related to the listing impaired waters and potential development of Total Maximum Daily Loads or restoration plans for these waters. TCRMP site (Buck Island STX), surrounded by several coral outplant sites, already exists about a quarter of a mile southeast of Buck Island, which would fall within the 0.5-mile perimeter. There are no existing outplant, nursery or monitoring sites in Trunk Bay, so a new site was established to monitor that area. Both of these sites were included in priority 1 sampling.

Breakdown of the monitoring sites by priority level and location.

Priority Group	Total Number of Monitoring Sites	St. Croix	St. Thomas	St. John
Priority 1	31	10	14	7
Priority 2	22	12	7	3
Priority 3	15	4	10	1

Complete list of water quality monitoring sites.

Priority Level	Data Source	Priority Reasoning	Location	Code	Island	Latitude	Longitude
1	<i>Acropora</i> Monitoring	Coral Restoration Site - Llews Reef	Teague Bay West	TBW1	SCX	17.76483	-64.61577
1	<i>Acropora</i> Monitoring	Coral Restoration Site - Llews Reef	Teague Bay East	TBE1	SCX	17.76215	-64.60087
1	<i>Acropora</i> Monitoring	Coral Restoration Site - Butler Bay	Butler Bay	BT1	SCX	17.75282	-64.89169
1	<i>Acropora</i> Monitoring	Salt River - Reef	White Horse	WH1	SCX	17.78701	-64.74867
1	<i>Acropora</i> Monitoring	Coral Restoration Site - Flat Cay	Flat Cay	FC4	STT	18.31716	-64.98894
1	<i>Acropora</i> Monitoring	Hull Bay - Reef	Inner Brass	IB4	STT	18.37904	-64.96462
1	New Site	Salt River- Outflow	Salt River outflow		SCX	17.76861	-64.7595
1	New Site	Class A Waters - Trunk Bay	Trunk Bay reef		STJ	18.35290	-64.77016
1	New Site	Coral Harbor - Outflow	Coral Harbor outflow		STJ	18.34675	-64.71417
1	New Site	Coral Harbor - Ghut	Coral Harbor Ghut		STJ	18.34871	-64.72050
1	New Site	Fish Bay - Outflow	Fish Bay outflow		STJ	18.32269	-64.76507
1	New Site	Brewers Bay - Outflow	Brewers Bay outflow		STT	18.33889	-64.97584
1	New Site	Brewers Bay - Ghut	Brewers Bay Ghut		STT	18.33959	-64.96641
1	New Site	Hendrik Bay - Ghut	Hendrik Bay Ghut		STT	18.35862	-64.981
1	New Site	Hendrik Bay - Outflow	Hendrik Bay outflow		STT	18.36622	-64.9922
1	New Site	Hendrik Bay - Reef	Hendrik Bay reef		STT	18.36973	-64.9976
1	New Site	Hull Bay -Outflow	Hull Bay outflow		STT	18.36966	-64.9614
1	New Site	STEER -Outflow	STEER outflow		STT	18.31628	-64.8765
1	Ridge to Reef	Salt River - Ghut	Salt River 1	SR1	SCX	17.75330	-64.79260
1	Ridge to Reef	Salt River - Ghut	Salt River 2	SR2	SCX	17.75990	-64.76460
1	Ridge to Reef	Fish Bay - Ghut	Fish Bay	FB	STJ	18.32590	-64.76510
1	Ridge to Reef	Hull Bay - Ghut	Dorothea	Dorothea	STT	18.36260	-64.95960
1	Ridge to Reef	STEER - Ghut	Turpentine Run 1	TR1	STT	18.33170	-64.88420
1	Ridge to Reef	STEER - Ghut	Turpentine Run 2	TR2	STT	18.32260	-64.87860
1	TCRMP	Class A Waters - Buck Island	Buck Island STX	BIX	SCX	17.78500	-64.60917
1	TCRMP	Coral Restoration Site - Long Reef	Eagle Ray	EGR	SCX	17.76150	-64.69880
1	TCRMP	Salt River - Reef	Salt River West	SRW	SCX	17.78530	-64.75940
1	TCRMP	Coral Harbor - Reef	Coral Bay	CRB	STJ	18.33797	-64.70402
1	TCRMP	Fish Bay - Reef	Fish Bay	FSB	STJ	18.31417	-64.76408
1	TCRMP	Brewers Bay - Reef	Brewers Bay	BWR	STT	18.34403	-64.98435
1	TCRMP	STEER - Reef	Coculus Rock	CKR	STT	18.31257	-64.86058
2	<i>Acropora</i> Monitoring	Remaining <i>Acropora</i>	Channel Rock	CR1	SCX	17.76713	-64.59161
2	<i>Acropora</i> Monitoring	Remaining <i>Acropora</i>	Green Cay	GC1	SCX	17.76807	-64.66394

Priority Level	Data Source	Priority Reasoning	Location	Code	Island	Latitude	Longitude
2	<i>Acropora</i> Monitoring	Remaining <i>Acropora</i>	Reef Bay	RB4	STJ	18.31964	-64.74399
2	<i>Acropora</i> Monitoring	Remaining <i>Acropora</i>	Yawzi Point	YP4	STJ	18.31567	-64.72617
2	<i>Acropora</i> Monitoring	Remaining <i>Acropora</i>	Botany Bay	BB4	STT	18.35822	-65.03301
2	<i>Acropora</i> Monitoring	Remaining <i>Acropora</i>	Thatch Cay	TC4	STT	18.35674	-64.85407
2	<i>Acropora</i> Monitoring	Remaining <i>Acropora</i>	Cow and Calf	CC4	STT	18.30466	-64.84613
2	Ridge to Reef	Remaining Reef to Ridge	River	River	SCX	17.70580	-64.78740
2	Ridge to Reef	Remaining Reef to Ridge	Jolly Hill	Jolly Hill	SCX	17.73130	-64.86220
2	Ridge to Reef	Remaining Reef to Ridge	Reef Bay	RB	STJ	18.32560	-64.74260
2	TCRMP	Nearshore	Cane Bay	CBS	SCX	17.77388	-64.81350
2	TCRMP	Nearshore	Great Pond	GRP	SCX	17.71097	-64.65221
2	TCRMP	Nearshore	Jacks Bay	JKB	SCX	17.74337	-64.57160
2	TCRMP	Nearshore	Kings Corner	KGC	SCX	17.69116	-64.90008
2	TCRMP	Nearshore	Salt River Deep	SRD	SCX	17.78523	-64.75917
2	TCRMP	Nearshore	Sprat Hole	SPH	SCX	17.73400	-64.89540
2	TCRMP	Nearshore	Cane Bay Deep	CBD	SCX	17.77661	-64.81522
2	TCRMP	Nearshore	Castle	CST	SCX	17.76278	-64.59743
2	TCRMP	Nearshore	Black Point	BPT	STT	18.34450	-64.98595
2	TCRMP	Nearshore	Seahorse Cottage Shoal	SHR	STT	18.29467	-64.86750
2	TCRMP	Nearshore	Botany Bay	BTY	STT	18.35738	-65.03442
2	TCRMP	Nearshore	Magens Bay	MGN	STT	18.37425	-64.93438
3	TCRMP	Offshore	Buck Island STX Deep	BID	SCX	17.80659	-64.59935
3	TCRMP	Offshore	Lang Bank EEMP	LBP	SCX	17.72145	-64.54706
3	TCRMP	Offshore	Lang Bank Red Hind FSA	LBH	SCX	17.82427	-64.44963
3	TCRMP	Offshore	Mutton Snapper FSA	MTS	SCX	17.63660	-64.86240
3	TCRMP	Offshore	Meri Shoal	MSR	STJ	18.24447	-64.75862
3	TCRMP	Offshore	Buck Island STT	BIT	STT	18.27883	-64.89833
3	TCRMP	Offshore	College Shoal East	CSE	STT	18.18568	-65.07677
3	TCRMP	Offshore	Flat Cay	FLC	STT	18.31822	-64.99104
3	TCRMP	Offshore	Ginsburg Fringe	GBF	STT	18.18770	-64.95998
3	TCRMP	Offshore	Grammanik Tiger FSA	GKT	STT	18.18885	-64.95659
3	TCRMP	Offshore	Hind Bank East FSA	HBE	STT	18.20217	-65.00158
3	TCRMP	Offshore	Savana	SVN	STT	18.34064	-65.08205
3	TCRMP	Offshore	South Capella	SCP	STT	18.26267	-64.87237
3	TCRMP	Offshore	South Water	SWT	STT	18.28068	-64.94592
3	TCRMP	Offshore	St James	SSJ	STT	18.29459	-64.83238