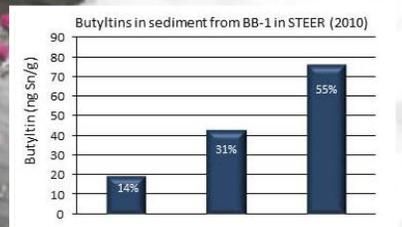
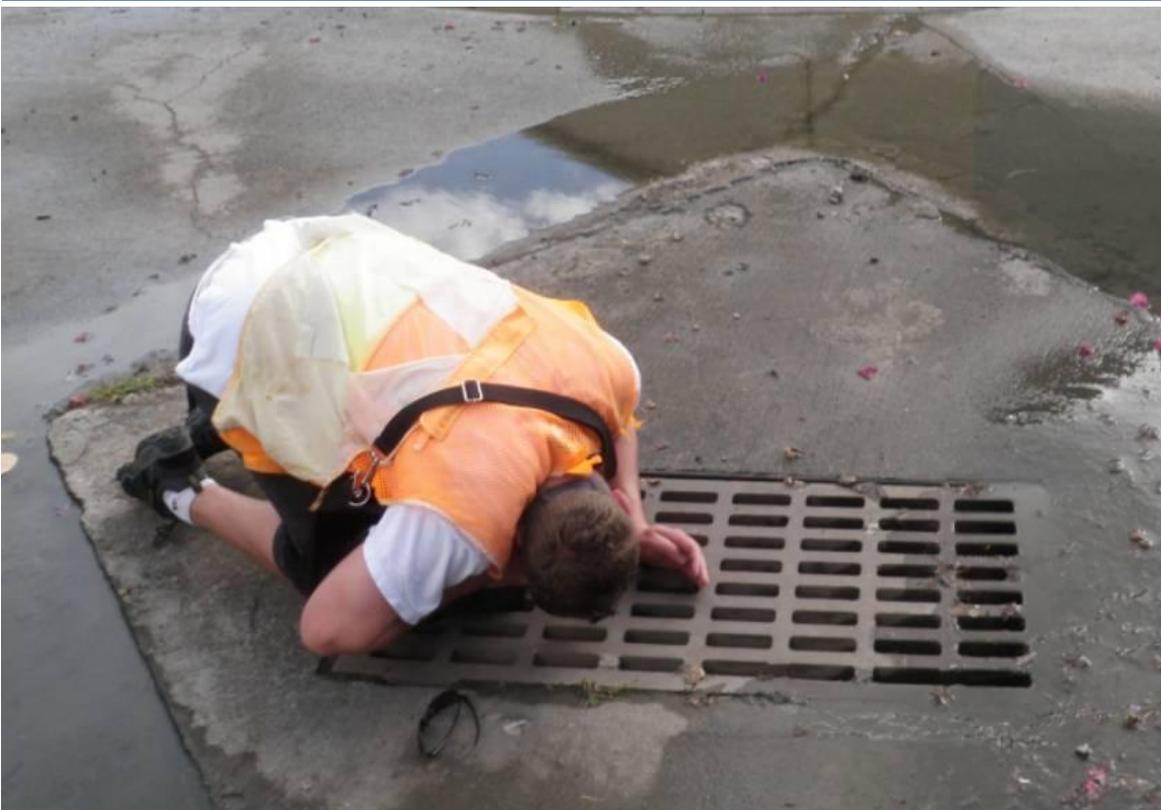


STEER Watershed Existing Conditions Report



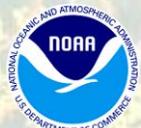
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The STEER Watersheds Assessment and Planning Project is part of a three-pronged effort sponsored by the NOAA Coral Reef Conservation Program to support protection of the St. Thomas East End Reserves (STEER) through monitoring, use studies, and watershed restoration activities. This report supplements the 2013 STEER Watershed Management Plan.

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1.0 Introduction

This report is intended to summarize information from existing reports, mapping data, stakeholder meetings, and preliminary field observations that adds to our understanding of existing watershed conditions and potential pollution sources draining to the St. Thomas East End Reserves (STEER). STEER is a 3.7 sq. mile collection of individual protected areas for significant salt pond, marine, and fisheries resources. It is currently being considered for designation as the second territorial marine protected area (STEER, 2011). As part of the initial management planning for STEER, NOAA commissioned a triad of studies including: 1) a watershed assessment; 2) sediment contaminant and supplemental biological and water quality monitoring; and 3) a marine use survey. The information presented here is intended to serve as a reference guide for baseline information on the STEER Watershed that can be used to inform the watershed planning process and supplement the 2013 STEER Watershed Management Plan.

1.1 The STEER Watershed

The STEER Watershed was delineated using DPNR watershed mapping information, and it includes all of the Jersey Bay Watershed plus the southern portion of the Redhook Bay Watershed (Figure 1). Approximately 6 sq. miles in size, the combined STEER Watershed roughly spans the highly urbanized coastal area between the Bovoni Landfill and Cabrita Pt. up to the ridge above Anna’s Retreat and Tutu Valley. The network of small cays, St. James, and Little St. James are also considered part of the STEER Watershed. The STEER Watershed was divided into 10 smaller subwatershed units shown in Figure 1 and Appendix [Map 1](#). Table 1 summarizes general subwatershed metrics.

Table 1. Summary of Key STEER Subwatershed Characteristics

USVI Watershed	STEER Subwatershed	Area (Acres)	% Impervious ¹	% A & B Soils ²	Gut ³ (miles)	% Flood (100-yr)	Road (miles)	Impaired Waters ⁴
Jersey Bay	Bovoni	531.4	15%	84%	2.4	36	10.4	Yes
	Frydenhoj/Compass Pt.	193.5	23%	4%	0.7	33	4.9	Yes
	Nadir Gut	385.2	15%	0	2.2	14	6.0	Yes
	Nazareth Bay	117.6	28%	0	0	21	2.6	Yes
	Turpentine Run	2265.8	23%	4%	10.7	23	49.8	Yes
Redhook Bay	Cowpet Bay	91.5	39%	0	0	24	3.0	Yes
	Great Bay	68.2	31%	0	0	55	1.1	Yes
Other	Cays	123.0	0	0	0	-	-	Yes/No
	Little St. James	36.4	14%	5%	0	27	-	No
	St. James	153.5	0	3%	0	19	-	Yes/No
Total		3966.0	20%		16.0	24	77.6	

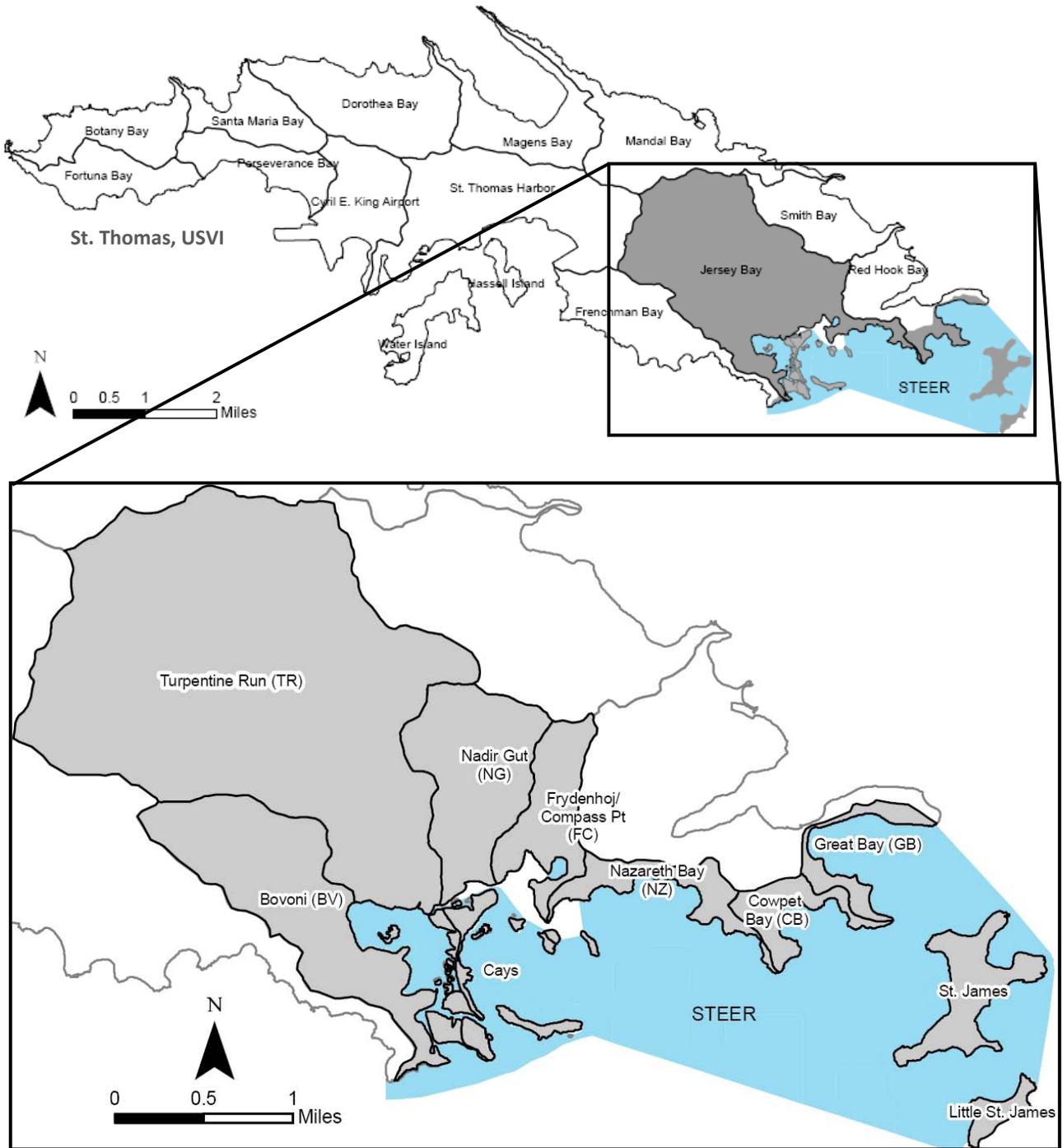
¹ Impervious cover derived from Digital Coastal Services (2007) terrestrial land cover data. Other data derived from DPNR mapping provided to HW in 2011, unless otherwise noted.

² Hydrologic Soils Group (HSG) derived from USDA SSURGO (2008); A & B soils are good for infiltration.

³ Gut length is based on existing DPNR mapping, prior to field verification.

⁴ Refers to direct drainage to DPNR 2010 Impaired Waters listing

Figure 1. The STEER Watershed and Subwatershed Delineations



Appendix **Map 2** and **Map 3** show the distribution of Hydrologic Soil Groups (HSG) throughout the watershed and wetland/floodplain boundaries as provided by DPNR, respectively. More detail on these features is provided in Sections 4.2 and 2.6 of this report, respectively.

1.2 Subwatershed Descriptions

Subwatershed boundaries were delineated to maintain consistency with former boundaries used during development of the TMDLs for Benner Bay and Mangrove Lagoon (i.e., the Benner Bay drainage includes Nadir Gut, Frydenhoj/Compass Pt., and East Cays, while the Mangrove Lagoon drainage encompasses Bovoni and Turpentine Run subwatersheds). Descriptions of each of the subwatersheds are provided below:

Bovoni Subwatershed—Contains the Bovoni Municipal Landfill and surrounding industrial/commercial areas, Mangrove Lagoon WWTP, high density residential including private and public housing, and the Bertha C. Boschulte Middle School. Most of the natural guts were re-located during the development process; and there are considerable flooding issues where the road network now serves as the main drainage path. For example, a chronic flooding issue was reported at the corner gas station near the entrance to the landfill on Bovoni Rd. A number of stormwater pollution “hotspots” were observed at commercial establishments along Bovoni Rd., including illicit discharges of septic systems and washwater. The landfill is under a consent decree from US EPA regarding dumping activity in the adjacent mangroves and for the unmanaged discharge of contaminated leachate (see Section 1.4 of this report for more details). The impact of contaminated runoff and leachate on adjacent mangroves and human health has not been quantified. The Mangrove Lagoon WWTP serves portions of the Tutu Valley, Bovoni, and Turpentine Run areas that were previously served by four smaller package plants. There are three key residential areas in Bovoni: Watergut, Bovoni Projects, Jenny’s Hope, and Thomasville Cooperative; and a strong community presence. This subwatershed drains directly to Mangrove Lagoon, which is a poorly flushing system currently listed as impaired for bacteria, temperature, and turbidity with approved TMDLs for dissolved oxygen (2003) and bacteria (2005).



One of the biggest sources of pollution from the Bovoni Subwatershed is the Bovoni Landfill.

This subwatershed offers a number of retrofit opportunities at public housing projects and at the school to address flooding and stormwater quality. The school, in particular, would be a great location for demonstration projects and a retrofit of a partially constructed detention basin that currently provides no stormwater benefits. Private property opportunities exist as well for installing stormwater management practices to help alleviate flooding. Closure plans for the landfill attempt to address many of the mitigation requirements under the consent decree, although it is unclear if key water quality and wetland restoration efforts are proposed to occur in the interim before closure. Groundwater monitoring to better understand the extent of leachate plumes into Mangrove Lagoon has been proposed by UVI. Efforts to establish Waste to Energy (WTE) partnerships have been stymied by local residents and other politics.

Cays (East & West)—Includes a string of small, undeveloped cays (e.g., Bovoni, Rotto, Cas, and Patricia Cays), separating Mangrove and Benner Lagoons. Cas and Bovoni Cays are publicly-owned. Cays include upland areas, but are mostly wetland/mangroves. The subwatershed boundaries are divided into east and west to match the existing TMDL analyses. While included in the summary tables herein, this subwatershed area is not being evaluated as part of the watershed assessment.

Cowpet Bay Subwatershed—Has the highest percentage of watershed impervious cover relative to its size (39%) of all the STEER subwatersheds. Sandwiched between the Deck Pt. and Water Pt. neighborhoods are the Elysian Beach Resort, East and West Cowpet Bay, the Anchorage, and the St. Thomas Yacht Club. Each resort has its own reverse osmosis, small wastewater treatment package plant, and parking areas. The Yacht Club shares a wastewater system with the Anchorage. Other than cisterns, no existing stormwater management facilities were observed in this watershed. Water Pt. is a private community with an active association, which geographically is split between Cowpet and Great Bays. This neighborhood maintains fairly large lots with existing vegetation; has individual septic systems (many of which don't function well due to poor soil conditions) and a community water supply; manages a salt pond and small beach area; and uses road surface sealants.



Untreated stormwater runoff from roads, parking lots, and rooftops (excluding cisterns) drains to Cowpet Bay.

Cowpet Bay is listed as impaired for dissolved oxygen (DPNR, 2010). The subwatershed is entirely within Tier I, subject to Coastal Zone development regulations. Restoration opportunities in this subwatershed are likely to focus on pollution prevention activities by homeowners and resort managers, wastewater system monitoring and inspection by resorts and DPNR, and retrofit opportunities for managing parking lot runoff. The Water Pt. community would likely be open to on-site demonstration projects (e.g., innovative septic systems, rain gardens and driveway disconnect, or other Island Green Building initiatives). The Yacht Club offers a good location for highly visible community outreach, as well as for addressing flooding issues.

Frydenhoj/Compass Pt. Subwatershed—Includes a residential area that extends from the top of the subwatershed down to Benner Bay; the main gut flows behind single family homes on the hillside, then under or on the road through the Independent Boatyard. Drainage patterns for a secondary gut have been altered by the Food Center where the small culvert and concrete channel is inadequately sized to handle the volume. The Compass Pt. Pond Marine Reserve and Wildlife Sanctuary is part of STEER, and is considered a significant wetland resource that has been studied by DFW, UVI, and others. The Compass Pt. Marina has been trying to expand the number of docking berths available; two new gravel parking lots were installed at the end of 2012 above the existing paved lot. Benner Bay and Marina Lagoon are impaired for turbidity and bacteria with established TMDLs for dissolved oxygen (2003) and bacteria (2005); note that the Marina Lagoon area is not included within the STEER boundary. This area, however, has been a key focus of recent study by NOAA's NCCOS, National Status and Trends (NS&T) Program, looking at sediment contaminants and bioeffects. In fact, the third highest TBT concentration detected in sediments analyzed by NS&T was found in 2010 near Independent Boatyard. Independent Boatyard was one of the few places where pollution prevention activities were observed (e.g., vacuums for paint chip collection, tarps for capturing hydraulic fluids, sump at ramp for surface runoff collection).



Boatyards along Benner Bay/Marina Lagoon have been linked to high TBT levels in benthic sediment samples.

Great Bay—Similar in land use to Cowpet Bay, this subwatershed includes the gated Water Pt. and Cabrita Pt. residential neighborhoods, as well as the Ritz Carlton Resort. Along the narrow isthmus leading to Cabrita Pt. is a popular local beach for Vessup Bay (outside STEER) where horses from the Clinton Phipps racetrack are often exercised. A few salt ponds remain in the watershed. The one on Ritz Carlton property is likely being used for stormwater management. The Cabrita Pt. salt pond was called out as a wetland conservation priority by the Division of Fish and Wildlife. There are a significant number of undeveloped lots on Cabrita Pt., and the lot surrounding the salt pond itself may be a high priority for conservation easement, acquisition, or application of more stringent development requirements. The subwatershed is entirely within Tier I, subject to Coastal Zone development regulations. A variety of existing stormwater BMPs are being used at the Ritz, and even though most are technically outside of the STEER watershed, they offer good examples of how to manage stormwater on resort properties. Great Bay is listed as impaired for turbidity and dissolved oxygen (DPNR, 2010).



Example of an existing stormwater management facility at the Ritz Carlton.

Nadir Gut Subwatershed—Contains the second longest gut system in the STEER watershed. Partly channelized, the gut drains the Nadir residential area and outlets at through Tropical Marine/boat repair area into the canal between Benner Bay and Mangrove Lagoon. The coastline is a highly dense chain of marinas and commercial properties that transitions to single family residential area moving uphill; however, much of the headwater area remains undeveloped. Reports of suspected illicit discharges, buffer encroachment and slope erosion, and unmanaged polluted runoff from boating-related activities may likely be the focus of restoration investigations. The owners of Tropical Marine have an existing gut restoration plan for improving the drainage on their property, and the public park offers a number of stormwater retrofit opportunities.



The Nadir gut and adjacent Nadir Community Park is visible from the residential area above.

Nazareth Bay Subwatershed—Includes the Secret Harbor Resort/Condos and the surrounding single family residential area, similar to Cowpet and Great Bays. This area is relatively steep along the coast and includes two potential residential developments in the currently remaining undeveloped areas. The subwatershed is entirely within Tier I, subject to Coastal Zone development regulations. Nazareth Bay is impaired for turbidity (DPNR, 2010). Restoration opportunities in this subwatershed are likely to focus on pollution prevention activities by homeowners and the resort manager, wastewater system monitoring and inspection by the resort/condo and DPNR, and retrofit opportunities for managing parking lot runoff.

St. James & Little St. James—Two privately-owned, off-shore cays in the southeast corner of the STEER. Some clearing and development has occurred on both, but more so on Little St. James. It is our understanding that permit enforcement actions related to development are pending (pers. comm., DPNR, 2011). From interpretation of aerial photography, it appears that there has been extensive construction activity on Little St. James. Neither of these islands will be included in watershed assessment efforts.

Turpentine Run Subwatershed—The largest of the subwatersheds, its name is derived from one of the few guts in the USVI that maintains perennial flow (this may be due, in part, to wastewater and groundwater discharges). Turpentine Run (gut) drains high-density residential and commercial areas in and is crossed by roads at multiple locations. Flooding is a particular problem where undersized and misaligned culverts are unable to accommodate increasing volumes shed from residential growth uphill. The gut drains into Benner Bay near the Clinton Phipps racetrack. There is a large reservoir and a handful of small impoundments in the northern portion of the subwatershed (e.g., Tutu Reservoir/Hartmans Pond and Hernhutt Pond)

which were identified as priority wetlands by DFW. The gut is piped throughout the retail/commercial district near Four Winds Plaza, and is channelized in concrete above the Nadir Bridge (“Bridge to Nowhere”). Dense algal mats in the channel are visible from aerial photography (Google Maps), which is an indicator of high nutrient loads.

Heavily impacted by urbanization, this subwatershed has over 500 acres of impervious cover, of which less than 20 acres drains to a stormwater management facility (not counting rooftops that drain to cisterns). Large commercial retail include the Tutu Park Mall, Four Winds Plaza, Home Depot, Price Smart, Fort Mylner Plaza, and Cost-U-Less—the Tutu Park Mall was once the location of the famous prehistoric Tutu Archeological Village Site (Righter, 2002). Tutu Park Mall, Price Smart and Cost-U-less are partially managed by existing stormwater management facilities. Heavy Materials is one of two quarries along Turpentine Run Rd. and is surrounded by a strip of salvage/repair yards, car washes, and unpermitted establishments along the banks of the gut. These areas are likely to contribute a significant amount of sediment, oils, debris, bacteria, and other chemicals to the gut. The Clinton Phipps Race Track consistently houses a dozen horses; waste management and pollution prevention at this facility should be investigated.

There are a number of private and public schools in the subwatershed including EB Oliver, Joseph Gomez and others that offer a number of stormwater retrofit and community engagement opportunities. High density, single and multifamily residential areas exist in the upper portions of the watershed, as well as along the main roadways (e.g., Anna’s Retreat, Tutu, Donoe, Hoffman, Raphune, Mariendal, and Nadir Estates). There are a number of public housing projects and community centers where watershed education for residents could be targeted. New and active construction projects were observed where no post-construction stormwater management is being provided or construction activities in the gut were observed (e.g. Grandview, Raphune Vista, and new parking lot behind Curriculum Center).

Since the removal of three small wastewater plants, approximately 30% of the subwatershed (mostly in the northern portion of the subwatershed) is now connected to public sewer system serviced by the Mangrove Lagoon WWTP. The main trunk line bisects the subwatershed, and there is potential for more businesses and residences to connect. VIWMA reports that much of the original sewer infrastructure is old and failing, that much of the upper watershed is effectively a combined stormwater/sewer system, and that sewer overflows are common (per. com. James Grum, 2012). The Tutu Wellhead Superfund site is behind the Curriculum Center near the Four Winds Plaza. Contaminated groundwater (see Section 4.4 for more detail) is pumped, filtered, and then discharged back to Turpentine Run. The USGS stream gage on Turpentine Run has been deactivated.

There are many opportunities for stormwater management to reduce flooding and improve water quality, as well as a handful of locations for gut restoration. Improvements to sewer infrastructure and pollution prevention are likely to be priority restoration activities, as well.



Turpentine Run generates a lot of polluted runoff from new construction (top); industrial uses, and unmanaged impervious cover.

1.3 Existing Studies and Regulatory Drivers

There are a number of existing recommendations, management plans, and planning initiatives that should be integrated as much as possible with the STEER watershed planning efforts. These documents and related recommendations are summarized in Table 2.

Table 2. Summary of existing management plans relevant to STEER

Report	Relevant Findings or Management Recommendations
STEER Management Plan (2011)	<ul style="list-style-type: none"> • Summarizes a number of educational activities and community groups to engage in broader STEER watershed efforts. • Identifies land-based sources (development, sedimentation) as very high to high threat to STEER salt ponds, coral, sea grasses, and fish. • Identifies trash as an issue. • Strategies for addressing watershed issues (among others) include: <ul style="list-style-type: none"> – Redesign a comprehensive USVI NP and point source pollution permitting, reg., and enforcement program – Watershed and stormwater management: public/private sector partners – Change buffer “green zone” – Improve water circulation in Mangrove lagoon – Determine lagoon contaminants – Reduce habitat loss on St. James – Restore Compass Pt. Salt Pond; include trash management – Promote blue flag/clean marina program
USVI Coral Reef Management Priorities (NOAA, 2010)	<ul style="list-style-type: none"> • Top 5 goals include supporting activities to reduce sediment and other pollutant loading to priority reefs and education and outreach. • Objectives include development of watershed and stormwater master plans and installation of island-appropriate stormwater BMPs, culverts, and catchbasins. • Supports stricter permitting conditions for new developments and activities to improve consistency and enforcement of regulatory programs.
Framework for management of wetlands in the USVI (UVI-CDC, June 2010)	<ul style="list-style-type: none"> • There is currently no wetlands program in the USVI. • DPNR is in process of developing a coherent management policy based on a Territorial wetland inventory and assessment effort started in 2004, draft conservation plan by Division of Fish and Wildlife, and other input. • Framework document includes list of agencies and regulatory programs with some wetland oversight.
2005. USVI Marine Resources and Fisheries Strategic and Comprehensive Conservation Plan	<ul style="list-style-type: none"> • Sediment and runoff control; reduce storm/sewer/ and trash/dumping impacts; surface runoff and groundwater contamination; • Improve buffers around salt ponds and mangroves; • Monitor sewage plants; • ID sources of industrial discharges; • Stop direct discharges from boats; and • Spill response
2010 USVI Integrated Water Quality Monitoring & Assessment Report	<ul style="list-style-type: none"> – Identifies 303(d) listed impaired waters including six units within STEER – Sets priorities for TMDL development – Outlines an approach for territorial wetland and gut policy

Report	Relevant Findings or Management Recommendations
Benner Bay/Mangrove Lagoon TMDLs (2003 and 2005)	<ul style="list-style-type: none"> - Retrofit existing development; - Remove failing OSDS, expand sewer service, prohibit new OSDS in unsuitable soils - Install vessel pumpout stations; and - Integrate monitoring plan with existing program.
2006 Draft Wetlands Conservation Plan (Platenberg, 2006)	<ul style="list-style-type: none"> • Priorities in Jersey Bay watershed include: mangroves in Mangrove Lagoon/Benner Bay; Turpentine Run; Compass Pt. Salt Pond; two fresh ponds at Humane Society; Tutu Reservoir; Great Bay Salt Ponds • Actions needed include: <ul style="list-style-type: none"> - Reduce NPS entering gut, salt pond and bay; as well as Turpentine Run - Restore functionality of Compass Pt. including mangrove/buffer - Enhancement of Herrnhut Pond to promote access, recreation; - Enhance vessel wastewater management in bay via pumpout facilities; - Increase sewer network and increase OSDS inspections; - Reduced lighting around Great Bay salt ponds; and - Protection of n/s saltponds on Cabrita Pt from adjacent development.
A Strategy for Management of Ghuts in the USVI (Gardner, 2008)	<ul style="list-style-type: none"> • Nadir and Turpentine guts listed as being “of interest.” • Document provides recommendations for a process for establishing a Territorial gut management strategy, including the formation of an inter-agency working group, data collection and research needs, and building local support. • Flooding near Bovoni is one example of how changes in landscape can cause flooding problems. In addition, land development and construction result in significant changes to the hydrology, which result in more frequent and higher flooding and is exasperated by the filling of guts and development encroachment into the floodplain. • Lack of information on guts as important wildlife habitat, extent of recreational use; current status of historical sites adjacent to guts, water quality, and lack of informational sharing. Need a unified gut management strategy.
Mangrove Lagoon/Benner Bay Area of Particular Concern (APC) and Area of Preservation and Restoration (APR) Studies (DPNR, 1993); Vessup Bay/East End APC Study (1993)	<ul style="list-style-type: none"> • Describes the natural, historic, and urban characteristics of the areas and presents recommended management approaches for land conservation, development, wastewater, and other LBSP. • While outdated (e.g., pending developments, regulations, and conservation planning goals have changed), some recommendations may still be valid; although no recommendations are actually included in the scanned PDF from DPNR for MLBB. • Vessup Bay/East End APC includes recommendations for solidwaste disposal, separating combined sewer, routine septic inspections, impervious cover reduction, and protection of remaining salt ponds • APCs are part of the Coastal Barrier Resources System (1990) which prohibits the use of federal monies for development projects in designated areas.
Cadmus, 2011	<ul style="list-style-type: none"> • Storm event monitoring of guts could help calibrate runoff models and better distinguish dry/wet weather loads • Protection of undeveloped areas to minimize increases in runoff and LBSP • Addressing failing OSDS
Bovoni Landfill Consent Decree (2012)	<ul style="list-style-type: none"> - Findings of violation of the federal Clean Water Act - Direct impacts on adjacent wetlands - Mitigation requirements for leachate treatment, stormwater management, groundwater monitoring, and wetland restoration

Report	Relevant Findings or Management Recommendations
Rennis et al., 2006	<ul style="list-style-type: none"> • Actions to prevent increased sediment loads to salt ponds like Compass Pt. with low depth:area ratios suggesting that these ponds are receiving or have received abnormally high sediment loads in the past should be given high priority. • Watersheds where land modification has exceeded 10% of steep slopes should be monitored for sediment flow to the lower watershed (like Compass Pt).
2013 NOAA NCCOS Contaminants Study Reports (2)	<ul style="list-style-type: none"> - Report of findings on STEER sediment sampling: <ul style="list-style-type: none"> - Benner Bay (BB) and Mangrove Lagoon (ML) had higher levels of chemical contaminants in sediments, higher toxicity, and reduced benthic infaunal communities than rest of STEER. - Zinc, copper, lead, mercury, PCBs and DDT were above a lower NOAA sediment quality guideline in at least one location in northern BB or ML. - Very high copper and tributyltin levels in sediments from northern BB suggest marina or boating-related activities. - Copper in sediments at one site in northern BB was above a sediment quality guideline indicating that impacts were likely to aquatic organisms. - Anthropogenic stressors are likely impacting fish and invertebrate communities in STEER. - Findings from STEER & Turpentine Run water sampling for wastewater indicators: <ul style="list-style-type: none"> - A number of wastewater contaminants typical to urban watersheds were detected (chlorination byproducts, personal care products, plasticizers, wood preservatives etc), the majority at low concentrations. - Higher concentrations were found in Turpentine Run than STEER. - DEHP was found at concentrations > water quality criteria in Turpentine Run.
2012 STEER Coastal Use Survey (NOAA, DPNR, STEER Advisory Group)	<p>Compendium of maps derived from local working sessions with commercial, recreational, and other users of STEER showing spatial locations of active uses including, but not limited to:</p> <ul style="list-style-type: none"> - Charter diving and snorkeling -shows the importance of watershed health to tourism industry, territory's economy; - Non-charter diving and snorkeling--(shows the importance of watershed health to residents; - Recreational boating--shows the importance of watershed health to residents and visitors who are in the water for recreation, fishing, etc. - Heat map, sum of all dominant uses--shows intensity of all uses in STEER

In addition, there are some key federal regulatory drivers that are applicable to restoration goals and objectives in STEER, including:

- Impaired Waters—Section 303(d) under the Federal Clean Water Act: Many of the marine receiving waters in STEER are currently listed as impaired (DPNR, 2010). In fact, there are two approved Total Maximum Daily Loads (TMDLs) for Benner Bay and Mangrove Lagoon established for dissolved oxygen and bacteria. Strategies to meet these TMDLs should be implemented by the Territory and USEPA Region 2. The opening of the Mangrove Lagoon WWTP and the sewerage of a portion of watershed, perhaps, has been the single implementation effort completed to date. It is unclear if this single effort, however, is sufficient to attain water quality standards. Opportunities exist to

revisit the TMDLs, incorporate implementation recommendations in the watershed plan, and focus monitoring efforts on the regulatory parameters of concern.

- Superfund Sites—Comprehensive Environmental Response, Compensation and Liability Act (CERCLA): Groundwater contamination in the upper watershed led to establishment of Tutu Wellfield Superfund Site. Long-term cleanup and monitoring program may restrict stormwater infiltration opportunities, provide valuable information on groundwater patterns, and require long-term water quality monitoring and flow gauging in Turpentine Run. In addition, measured concentrations of Tributyltin (TBT) of 248ng Sn/g in sediments were the third highest ever recorded by NOAA. The upper screening level proposed for a Superfund site for TBT is 144ng Sn/g. This offers a potential funding opportunity to delineate TBT footprint, conduct a risk assessment, remediate sediments, and regulate against new inputs.
- National Pollution Discharge Elimination System—NPDES (or the TPDES program in the USVI): Regulates discharge permits, particularly for post-construction and construction period stormwater management at industrial, active construction, and other development sites. There are a number of examples of existing and new developments that do not appear to comply with basic TPDES permit requirements. This offers an opportunity for DPNR and US EPA Region 2 to: 1) improve program enforcement efforts; 2) require industry-specific pollution prevention measures; 3) address combined sewer issues; and 4) establish clear design criteria for stormwater management facilities in the USVI.
- Clean Air Act, National Emission Standards for Hazardous Air Pollutants for Municipal Landfill Maximum Achievable Control Technology and Resource Conservation and Recovery Act (RCRA): The Bovoni landfill is approximately 34 acres on the peninsula between Mangrove Lagoon and Bovoni Bay on the southern coast of St. Thomas. The landfill has been in operation since 1979, accepting approximately 97,000 tons of municipal solid waste (residential, commercial and industrial wastes) per year for on-site disposal. A Consent Decree (CD) was issued in 2012 between the Government of the VI, the VI Waste Management Authority (VIWMA), and owners of Bovoni Tire for: 1) operating the Bovoni Landfill in a manner that may present “*imminent and substantial endangerment to health and the environment;*” 2) dumping of scrap tires into the adjacent mangrove system, the largest remaining mangrove forest in the USVI; and 3) failure to comply with 1998 and 2008 Administrative Orders regarding these regulatory violations. The CD requires control of storm water run-on and run-off, groundwater corrective action, gas collection and closure are requirements under the CD. The Virgin Islands Port Authority is also party to the CD for Clean Air Act violations at the Anguilla Landfill.

Until final closure in 2021, VIWMA has been directed to operate the Bovoni Landfill in accordance with the CD and the federal municipal solid waste landfill operating criteria, including:

- a. Implement a groundwater monitoring program;
- b. Implement and maintain a program for detecting and preventing disposal of regulated hazardous wastes;
- c. Apply adequate cover material;
- d. Control disease vectors;
- e. Control explosive gases;
- f. Ensure that no open burning of solid wastes occurs;
- g. Control access to the Landfill;
- h. Control storm water run-on and run-off;
- i. Ensure that the Landfill does not cause discharges of pollutants into waters of United States that violate CWA requirements; and
- j. Ensure that bulk or non-containerized liquid wastes are not placed in the Landfill except when allowed.

Direct language regarding the protection of and restoration measures for the adjacent marine reserve and the mangrove system is absent from the CD. VIWMA reports that the closure plan should be publically available by the end of the year. Once this is released, the engineering details for interim controls and the extent of proposed wetland mitigation/restoration measures will be clear. Based on our discussions with VIWMA, our understanding of the proposed landfill mitigation alternatives includes:

- Previous restoration of a section of white mangrove;
- Leachate collection system, which includes pretreatment and final treatment at WWTP, which would require the relocation of the service road to the east of its current location. Typically, two alternatives for implementing gas and leachate collection systems include: 1) the installation of a combination GCCS/LCCS that relies upon drilled wells for both gas and leachate extraction; or (2) separate collection systems where wells are used for gas extraction and collection and a gravity, perimeter trench system directs leachate to a treatment facility. A combination GCCS/LCCS system may be the most cost-effective alternative provided that an existing trench LCCS system isn't already in place. The direction VIWMA will take is unknown;
- Top cover and reshaping of the landfill, which will redirect drainage for a portion of the site into Bovoni/Stalley Bay;
- Installation of three detention basins to manage surface runoff. Plans for temporary detention and treatment of stormwater management are unknown. Permanent stormwater detention basins have been proposed after the landfill has been closed;
- Methane gas system and construction of a gas to energy facility (started).

Table 3. Bovoni Closure Schedule (from Appendix B of Final Consent Decree)

Line	Phase	Description	Deadline
1	--	Completion of temporary road	4/15/12
2		Submission of Closure Plan Engineering Report	5/1/12
3		Submission of Wetlands Impact Minimization Plan	5/31/12
4		Submission of 2012 Closure Plan	7/15/12
5		Submission of Wetlands Impact Compensation Plan	8/31/12
6		Completion of Subsurface Debris and Earthen Fill Removal (unless determined it can remain in place)	12/31/12
7		Completion of Land Acquisition to West (unless not to be used for waste disposal)	6/30/13
8	1	East – Completion of storm water detention pond, storm water control	5/31/14
9	1B	East – Completion of permanent roadway relocation, leachate interceptor system, sewer force main relocation,	5/31/14
10	2	North – Completion of slope stabilization and storm water detention pond, storm water control	12/31/14
11	3	West – Completion of slope stabilization, storm water detention pond, storm water control	12/31/14
12	4	Top – Completion of fill/grade and storm water control	1/1/16
13	5	South – Completion of slope stabilization and storm water control	8/31/17
14		Permanently cease accepting waste at landfill.	4/30/19
15	6	East – Completion of slope stabilization and storm water control	8 months after deadline in line 14
16	7	Final closure – Completion of well field adjustments, closure/fill/grade, impermeable cap/cover over entire filled landfill area.	18 months after deadline in line 15

1.4 Stakeholder Input

To gain a better understanding of the watershed, and to improve chances of long-term implementation success, the community must be engaged in the assessment and planning process. This is particularly challenging in the STEER Watershed given the limited amount of watershed education and outreach that has been targeted beyond the immediate coastline. Most of the population in the watershed resides up in Turpentine Run Subwatershed where it may be difficult to see the connection between STEER and what happens at Tutu Park Mall. There are, however, a network of community centers, schools, churches, and neighborhood organizations throughout the watershed that could provide a platform for launching a long-term engagement process.

A simple survey of 60 “Bridge to Nowhere” Cleanup participants was recently conducted to gauge how USVI, STEER and the Jersey Bay watershed resources were valued (STEER, 2011). Interestingly:

- Participation in a wide range of activities was reported including fishing (5.6%), diving (7.1%), kayaking (7.7%), hiking (9.2%), snorkeling (10.9%), beach use (13.3%), and swimming (14.5%);

- Over 60% of respondents thought that water quality condition in the USVI was good to excellent, and less than 2% described waters as polluted;
- No impairment in the Jersey Bay watershed (dumping, outfalls, development, sediment runoff, clearing, etc.) was observed by more than 16% of respondents;
- Approximately 17% of respondents said they would participate in outreach programs, plant trees (16%), and report commercial polluters (16%); and
- 60% of respondents thought the Jersey Bay watershed was important because it was home to a diversity of plants and rare species.

Input on existing watershed issues and potential solutions was provided by members of the STEER Committee, as well as agency staff, local residents, business owners, and other interested parties during four public and three agency/steering committee meetings held in 2011 and 2012. An additional meeting was held with representatives of the VIWMA in February 2012 to better understand the extent of the sewer system and plans for the Bovoni Landfill. Property owners/managers were also interviewed on-site during field assessments in February 2012.

Table 4 summarizes initial problem locations identified by stakeholders during these meetings to guide watershed field investigations. All of these sites (except for the ones requiring a boat for access), as well as some additional sites, were visited in February 2012. General recommendations for the draft watershed plan garnered mentioned by participants at these meetings are summarized in Table 5. **Appendix B** includes memos submitted to key agencies outlining general findings and preliminary observations from field investigations and discussions with stakeholders.

Table 4. Stakeholder List of Sites for Field Investigation*

Subwatershed	Sites	
Bovoni	<ul style="list-style-type: none"> • Bovoni Landfill • Mangrove Lagoon WWTP • Storage facility • Drainage problem at corner gas station • Public school • Parking lot at Bovoni Projects 	<ul style="list-style-type: none"> • Commercial area along Bovoni Rd. • Potential parcel for land conservation (west of racetrack) • Mangrove Lagoon/inlet clogging
Turpentine Run	<ul style="list-style-type: none"> • Alvin McBean Rec Center- • Tutu Reservoir? (ponding on road) • Schools • Cost U less & Home Depot at Market Sq. • VI Housing Authority Building • Fire Station • Texaco • Four Winds Plaza • Tutu Park Mall • Ft Mylner Plaza • Price smart/adjacent wetland complex • Tutu wellfield superfund site • Willy George Community Center 	<ul style="list-style-type: none"> • Humane society • Raphune Vista • Active construction • Quarry • Mariendal • Salvage yards along road • Park upstream of Nadir Bridge/channelized gut • Wetland downstream of Nadir Bridge • Clinton Phipps Racetrack • Kayak spot • Culverts along Turpentine Run and Smith Bay roads
Nadir Gut	<ul style="list-style-type: none"> • Tropical marine • The Patch • Nadir ballpark 	<ul style="list-style-type: none"> • Gold hill road crossing • Marina row
Frydenhoj/Compass Pt.	<ul style="list-style-type: none"> • Food Center culvert and drainage through East End Boat yard • Independent Boat Yard 	<ul style="list-style-type: none"> • Compass Pt salt pond • Compass Pt marina
Nazareth Bay	<ul style="list-style-type: none"> • Dolphin Cove Planned development • Pony Rd neighborhood 	<ul style="list-style-type: none"> • Secret harbor condos
Cowpet Bay	<ul style="list-style-type: none"> • Deck Pt. • Anchorage • Yacht club 	<ul style="list-style-type: none"> • Elysian Beach Resort • Water Point
Great Bay	<ul style="list-style-type: none"> • The Ritz Carlton 	<ul style="list-style-type: none"> • Cabrita Point salt pond

*Additional sites were also investigated as identified by field crews on-the-ground. Restoration concepts for all sites can be found in the 2013 STEER Watershed Plan.

Table 5. Consolidated Summary of Stakeholder Input

Topic	Watershed Plan Recommendations
Enforcement Policy	<ul style="list-style-type: none"> • Enforcement of existing development regulations is key; • Consistent enforcement—make or break community involvement or participation. Currently enforcement is completely erratic and not consistent, need to equally enforce the law for every violator. Nobody will obey law if not enforced. • Shut down new construction projects like Grandview (which has federal funding) that are not meeting post-construction TPDES requirements; • Ensure all new construction projects have adequate plans for erosion controls and stormwater management during construction. Inspect and enforce during construction. Plans should take into account the steep slopes and high potential for torrential tropical rains during construction phase. Google Earth 2002 and 2004 shows sediment plumes from active construction and gut erosion. • Work with marinas/boatyards to develop BMPs for boat repair/painting/scraping activities, etc.... Bring marinas/boatyards into compliance with BMPs for such activities using combination of education/awareness about environmental impacts followed by enforcement actions for non-compliance. Ensure that hazardous materials are appropriately handled both onsite and at final disposal site. • Be sure to identify which agency has regulatory responsibility (e.g. DEP, DPW, Federal Highway) and provide actionable recommendations • USEPA has been deficient in its enforcement of the Clean Water Act in the USVI • Zoning is W-1 not W-2 or much of marina area so there is not supposed to be bottom work on boats anyway; • Ticketing and enforcement should be public and there should be a GIS database of violators (sunken vessels) • Derelict vessels are an issue • Trash police and littering fines
Policy	<ul style="list-style-type: none"> • Make suggestions on changes to policies (like comprehensive land use plan) • BVI needs to ban TBT under IMO; we could work through Inter-Virgin Islands Council (every 2 years) • Reverse policy of abandoning cisterns at government projects then running out of water • CZM Tier I line is inconsistent and not well enforced • For road projects, replace plants with native species/ seed with wild mix for disturbed areas
Stormwater	<ul style="list-style-type: none"> • Incentives for Green infrastructure; • Where possible, focus on onsite retention/treatment options or other ways to reduce burden on guts and marine ecosystems. • Encourage retention of water from driveways, roads, parking lots, etc. for applications where grey water may be appropriate? • Where onsite solutions are not immediately viable due to pre-existing constraints, etc., work to develop catchment/retention projects to slow water and retain sediments/nutrients/contaminants to prevent discharge into marine ecosystems. • From lists of potential sites: ownership, feasibility, funding, greatest impact, etc • Important to ensure that these will not increase flooding or become mosquito-filled, as dengue fever is a significant public health concern, and mosquitoes do not gain public support for future projects...

Topic	Watershed Plan Recommendations
Educating/Engaging the Community	<ul style="list-style-type: none"> • A targeted education plan is necessary and likely one of early implementation items for the watershed plan. Target residents & businesses with separate messages • Need to get the young people involved; currently, the people that live here are not involved • Education materials should be multi-ethnic and tri-lingual (English, Spanish, and Patois) • There are a lot of schools in the watershed; coordinate with the Department of Education for projects on school properties, particularly for demonstration projects and getting watersheds into the curriculum. • Offer more opportunities for recycling and household hazardous waste pickup; tap into the Recycling Partnership Meetings (EPA, UVI, Syracuse); E-waste drives work • Signage for dumping and storm drain markers • How to reduce grease-trap overflows • Use the Bovoni Homeowners Association as a forum • Stormwater Tour for politicians • A public awareness campaign, asking residents to report erosion/runoff, failed silt fences, etc. to appropriate authorities • Link runoff to declines in sea grass & coral health, water quality, etc. in order to help with public support... • More interest in the types of practices that would work in the USVI
Wastewater	<ul style="list-style-type: none"> • Replace/repair failing sewer pipes in upper watershed • Conduct illicit discharge inventory and map system • Expand sewer service • Point of sale inspection of septic system; incentive program to entice retrofits or sewer connection • Increase inspections of septic systems • Make sure people know that your septic system makes a difference! • Submerged wetlands technology for septic systems? • Commercial areas don't have proper septic systems • Food center wastewater system to be inspected
Solid Waste Management	<ul style="list-style-type: none"> • Public notification of final CD may have met minimal requirements, but should have been better • Unlined landfill is a big problem • As landfill closure approaches, ensure that runoff, groundwater, and leachate concerns are adequately addressed. • Trash and dumping (cars, guts, behind homes, etc) big problem • Pretreatment program and alternatives "fee" for disposal • Restricting use and charging more is the wrong approach; an incentive for compliance is necessary • Identify business opportunities in waste management (e.g., Benji pumpout boat) • Reduce miles between dumpsters and have more oil collection sites • Work to address the trash overflow problem at dumpsters

Topic	Watershed Plan Recommendations
Monitoring	<ul style="list-style-type: none"> • Monitoring up in the watershed to include stream gages, rain gages, water quality samples from Turpentine Run; • Groundwater seepage monitoring study by UVI at Bovoni/Mangrove Lagoon • Need more equipment and to build UVI lab capability • Put weather stations at the school • Quantify how much TBT derived from scraping and repainting vs sloughing • TNC developing water quality monitoring plan • Need to show/document dump effluent, septic contamination of guts, risk and danger of current septs • Superfund site? • Develop monitoring plans to assess progress and measure success. • Install rain & stream gauges throughout watershed in order to correlate sedimentation with rainfall quantity and intensity
Making the Watershed Case	<ul style="list-style-type: none"> • People generally not aware of the problem; there are only 2 mangrove lagoons on St Thomas and majority of people don't understand the consequences • Show that it's not just the boating community contributing to the water quality problem; • Make the financial case for why watershed restoration is important • Include information on climate change • Sedimentation has ruined a lot of areas for boaters • We pipe guts and get rid of wetlands which is a problem, then we don't want to dredge the mangroves, which is also a problem • Building on steep slopes creates more runoff issues
Specific Restoration Projects/Goals	<ul style="list-style-type: none"> • Flooding at culverts along Turpentine Run, Smith Bay Rd, and in front of Food Center; • Wetland mitigation at Bovoni; • Restoration of Compass Pt Salt pond • Make suggestions on removal of contaminated sediment/dredging in Benner Bay; increased flushing in ML • Reduce sediment load by 15% • Identify sources of funding/ apply for funding should be a goal; • Businesses that do bottom work (Tropical Marine, Independent, Patch); TM and Patch permits up for renewal. Get them to address issues. Topical Marine needs a package plant and paint chip catchment system. Enhance vegetated buffer at Bovoni • Identify land conservation/easement priorities and projects on government-owned lands; Protect the Cays and Islands • For private resorts, Ritz Carlton is a blue flag beach, they may be interested in demo ops and solving wastewater overflows

2.0 Land Use and Natural Resources

2.1 Land Use

The STEER Watershed is highly urbanized. Land use breakdowns are provided in Table 6 and shown in Appendix **Map 4**. The STEER land use map was slightly modified by HW to update “undeveloped” areas where 2012 aerial photography clearly shows new development. The watershed consists primarily of dense single-family residential development with industrial and commercial complexes centered along Route 38, Route 32, Turpentine Run Rd., and Bovoni Rd. (e.g., Tutu Park Mall, Bovoni landfill, the quarry, and the Clinton Phipps Racetrack). Along the shoreline are a string of marina-related business and private resort/condominiums. While undeveloped, forested areas remain along many of the interior slopes, multiple large-scale residential construction projects are planned or currently underway along Route 38 and Donoe Rd. (e.g., Raphune Vista, Grandview, and Whispering Woods). Given the intensity of land use in this watershed, it is not surprising that:

- Groundwater in the upper watershed (i.e., Tutu Wellfield Site) and potentially surrounding the landfill is contaminated;
- Sediments in northern Benner Bay and Mangrove Lagoon are contaminated;
- Mangroves are impacted by leachate and dumping from the adjacent landfill;
- Guts and salt ponds are highly impacted by urbanization (e.g., channelized/piped, illicit discharges, buffer encroachment, sedimentation, trash and debris); and
- Many of the marine receiving waters are currently listed as impaired (DPNR, 2010), including two Total Maximum Daily Loads (TMDLs) established for dissolved oxygen and bacteria.

The STEER watershed is home to about 1/3 of the St. Thomas population. High density residential areas in the upper portion of the watershed—Anna’s Retreat and New Tutu Valley—have the highest density and smallest lot size in the watersheds. The Bovoni area also has high density single family uses. Residential areas along the immediate shoreline, such as Cabrita Pt., Water Pt., and Deck Pt. have larger lots and are less densely developed. Relative to those areas, the Frydenhoj/Compass Pt., Nadir, and Mariendal areas are medium density, with additional buildout potential. Raphune Vistas and Grandview are recent single family and multi-family developments, respectively. There are a number of multi-family complexes, including condominiums, scattered throughout the watersheds. Six condos/resorts are clustered along the eastern shoreline. **Map 4A** shows the locations of residential areas and resorts for reference.

The commercial center at the crossroads of Smith Bay and Turpentine Run Roads contains the most expansive impervious cover in the watershed. This area includes the Tutu Park Mall, Four Winds Plaza, and Fort Mylner Plaza, and to the west, the more recently constructed Home Depot, Price Smart, and Cost-U-less retailers. In addition, the Bovoni Landfill and adjacent industrial area; the Quarry and auto yards along Turpentine Run; and the strip of marinas and boat yards along the Benner Bay coastline are likely significant sources of land-based pollution.

Table 6. Land Use Statistics for the STEER Subwatersheds

Land Use*	Acres and % of Subwatershed										STEER Watershed Acres/%
	Bovoni	Cays	Frydenhoj/ Compass Pt.	Little St. James	Nadir Gut	Nazareth Bay	St. James	Turpentine Run	Cowpet Bay	Great Bay	
Agriculture								64.5			64.5
								2.8%			2%
Parks/Rec/ Open Space					4.7			24.5			29.2
					1.2%			1.1%			1%
Public Facilities	23.4		0.1			1.2		77.3			102
	4.4%		0.1%			1.1%		3.4%			3%
Industrial Manuf.	67.2							56.5			123.7
	12.6%							2.5%			3%
Retail Commercial	42.6		0.4			1.7		121.6			166.3
	8.0%		0.2%			1.4%		5.4%			4%
Residential	Low	37.4		31.8		78.8	54.6	259.4	50.2	35.2	547.4
		7.0%		16.4%		20.5%	46.5%	11.4%	54.9%	51.6%	14%
	Med	40.7		61.3		107.5	20.0	653.5			883
		7.6%		31.7%		27.9%	17.0%	28.8%			22%
High	23.8							54.3			78.1
	4.5%							2.4%			2%
Hotel/ Resort						8.6		1.4	36.7	23.3	70
						7.3%		0.1%	40.1%	34.2%	2%
Marina/ Waterfront			14.0		8.6			4.9			27.5
			7.2%		2.2%			0.2%			1%
Undeveloped/ Forest	298.4	124.4	85.5	34.9	185.6	31.2	151.8	948.5	4.0	8.6	1872.9
	56.1%	100%	44.2%	96%	48.2%	26.6%	99.0%	41.9%	4.3%	12.5%	47%
Total Acres	533.4	124.4	193.0	34.9	386.4	117.3	151.8	2266.5	90.9	67.0	3965.6

*Land Use data in the STEER watershed received from DPNR in 2010 (source UVI, 2003) was updated by HW for the purposes of this watershed planning effort where significant discrepancies were observed in the field and visible on Bing Maps (2012). Parcels classified as Undeveloped were converted to either residential or commercial use. These data are not intended to supersede official DPNR mapping, rather to provide better estimates of land use conditions.

STEER (2011) presents a list of boat-related businesses along the coast (excerpted, not verified):

- *Tropical Marine is a marina, boat yard, and terminal facility.*
- *Humphrey's Marina is a small marina, boat yard, and has extensive trash dumped along the water's edge.*
- *Saga Haven Marina is a small marina and terminal facility.*
- *Fish Hawk Marina is a small marina with a clean, graveled and level diesel fueling station.*
- *Pirate's Cove Marina is marina with terminal facility license; however, it has an unpermitted wastewater treatment facility on site.*
- *Ruan's Marina is a very small operation, but has a direct public access point directly at the terminus of a river gut and across from Food Center Market (currently in violation for illegal food waste dumping).*
- *East End Boat Yard is a marina and boat dry dock facility.*
- *Independent Boat Yard is a fairly large boat maintenance yard that also houses an unpermitted wastewater facility that formerly discharged into Compass Point Salt Pond, but is currently undergoing coming into permit compliance.*
- *Compass Point Marina is a fairly large marina with shops and a terminal facility license.*
- *The Ritz-Carlton, The Elysian, VI EcoTours, Secret Harbor, St. Thomas Yacht Club.*

Map 4B identifies the continuous string of boatyards, supply shops, and marinas along the inner Benner Bay shoreline.

2.2 Zoning

DPNR's zoning for the STEER Watershed is shown in Appendix **Map 5**. There are some notable areas where rezoning is identified. The zoning and subdivision regulations are currently undergoing a major overhaul by DPNR, Rutgers' University, and others, primarily due to widespread agency acknowledgement that the enforcement of existing zoning and subdivision law was inconsistent (CGS et al., 2009). Subdivision regulations govern the division of land and are meant to ensure that improvements and public infrastructure are built to be feasibly maintained and that proposed water supply, sewage systems, and stormwater drainage facilities are compliant with applicable health and environmental standards. The uses allowed within the zoning code are very broad and lack general design and performance standards. Today, much of the guidance on subdivision regulation in the USVI is in the *1985 Subdivider's Handbook*, a guidance document rather than enforceable code, which contains some discrepancies from the subdivision regulations. It is our understanding that this document has not been adopted as a rule or regulation.

The lack of land and water use planning can result in inappropriate development, use conflicts, contamination of surface and ground water, erosion, increased flooding, loss habitat and declines in productivity of the marine environment, among other issues. *The Comprehensive Land and Water Use Plan (CLWUP)* has proposed to incorporate territorial-wide land and water use guidelines developed by the DPNR into the Virgin Islands Code since the 1980s. The

CLWUP, along with a new *Virgin Islands Development Law* were last updated in 2003, but have not yet been adopted.

2.3 Impervious Cover

Roads, roof tops, parking lots, and compacted soils associated with urbanization result in less infiltration of stormwater into the ground and more surface runoff. Surface runoff can erode conveyances (e.g., guts, roadways), damage infrastructure, and result in increased flood peaks and frequencies. Runoff often conveys pollutants to downstream waterbodies and can cause fluctuations in salinity, pond water levels, as well as increased water temperatures. In general, impacts to water quality, aquatic biota, gut morphology, and hydrologic functions are observed in watersheds with 10% or greater impervious cover (CWP, 2003). While this 10% threshold may be more complicated in the USVI (e.g., fewer water quality studies, widespread use of cisterns, unknown runoff coefficients from previous areas), it is important to note that: (1) the STEER watershed is over 20% impervious cover; and (2) all of the subwatersheds (except for the Cays and St. James) have impervious cover percentages ranging from 14-39%. Rennis et al. (2006), described a reduced function of salt ponds, including the Compass Pt. Salt Pond, to retain sediment when the area draining to the pond exceeded 25% developed area. Appendix **Map 6** shows the extent of impervious cover.

2.4 Pervious Areas

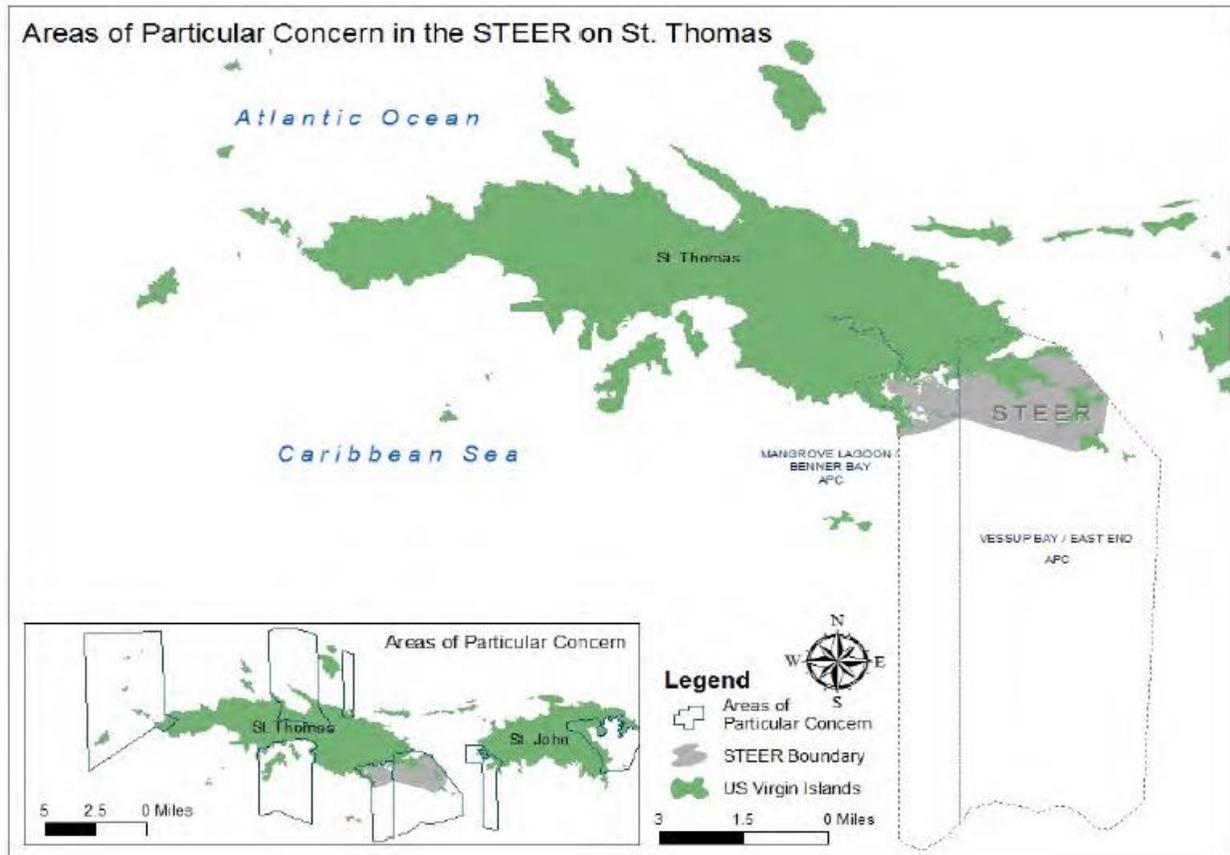
Limited information has been compiled to date (for this report) on the upland, terrestrial habitats and species present. DFW has conducted bat and frog surveys in Turpentine Run and in various locations in the East End (per com., Platenberg, 2011). The federally endangered VI tree boa only occurs in the East End, more or less within the Jersey Bay watershed. Appendix **Map 7** shows terrestrial vegetation in the STEER Watershed.

2.5 Land Development: Tier Structure and APCs

Oversight of the land development process in the USVI is divided into two coastal geographic tiers: Tier I is within the jurisdiction of the Coastal Zone Management Program (CZM); Tier II is under the jurisdiction of the Division of Environmental Protection (DEP). Tier I has Major and Minor projects types which have different requirements and permitting procedures. Minor projects include smaller developments, such as single family dwellings or small piers that are thought to have a less significant effect on the coastal environment and the community. Major projects, such as large resort hotels or multifamily dwellings, docks, and dredging, all require an extensive application form, an Environmental Assessment Report (EAR), public notices/hearings, and a decision by the appropriate committee of the CZM Commission. The Commissioner may require that a minor permit be considered as a major permit if significant adverse environmental consequences are anticipated. In the STEER Watershed, Bovoni Rd. serves as a general boundary between the two tiers (though this not always the case). Most of the STEER Watershed is in Tier II, although Nazareth, Cowpet, and Great Bays are solely within Tier I (Appendix **Map 8**). Stakeholders frequently reported that inconsistent enforcement of

development regulations between the two tiers is a significant problem. In addition, portions of the STEER watershed is also within two designated Areas of Particular Concern (Figure 2). Implementation of APC recommendations has had a mixed track record, and DPNR is in the process of evaluating existing APC plans across the Territory (pers. comm., Alex Holocek, 2011).

Figure 2. APC boundaries encompassing STEER (taken from STEER, 2011)



2.6 Wetlands

Mangroves, salt ponds, freshwater wetlands, and guts are the key wetland resources of the STEER watersheds. We refer the reader to the 2010 Wetlands Inventory of the USVI for a comprehensive discussion of these systems. In 2004, DPNR, IRF, and UVI completed a mapping inventory and limited assessment of watershed/wetland ecosystems in 18 priority watersheds throughout the territory. Mapping data can be downloaded from UVI's Conservation Data Center (www.uvi.edu/sites/uvi/Pages/ECC-Conservation_Data_Center.aspx?s=CS).

Table 7 summarizes wetland/riparian characteristics within each of the STEER subwatersheds. Refer to Appendix **Map 3** for the spatial extent of wetlands, guts, and 100-yr floodplain boundaries based by DPNR data. Floodplain boundaries shown here are for informational purposes only. The gut mapping was updated slightly by HW to better reflect aerial photos and

field observations. Primarily, updates in the Bovoni subwatershed, in the main channel along Turpentine Rd. Rd., and in the Nadir Gut subwatershed.

Table 7. Wetland Type, Riparian Communities, and 100-yr Floodplain Areas

Category		Bovoni	Cays	Frydenhoj/ Compass Pt.	Nadir Gut	Turpentine Run	Great Bay
Wetland Acres ¹	Fresh pond					0.5	0.3
	Fringing mangrove	0.4	12.8	0.4	0.2	0.5	
	Mangrove forest	2.5	35.8	0.7	0.3	0.6	
	Mangrove shrubland	2.7	9.1	1.5		0.04	
	Mixed Swamp					0.1	
	Mangrove woodland	1.2					
	Salt flat	0.6		1.5		0.0	
	Salt pond	0.7		1.5			1.1
Gut Miles		2.4		0.7	2.2	10.7	
100-yr Floodplain ²	Acres	189.5		64.7	52.5	513.4	37.6
	% Subwatershed	36%		33%	14%	23%	55%

¹ UVI Conservation Data Center, 2005

² DPNR mapping received in 2010

The Conservation Data Center (2010) included the Tutu Park Marsh and the Benner Bay/Mangrove Lagoon as two of the key wetland areas on St. Thomas. In addition to these, Platenberg (2006) identifies Compass Pt. Salt Pond, Patricia Cay, Turpentine Run, and Hernnhut Ponds, and the Great Bay and Cabrita Pt. Salt Ponds in the Wetlands Conservation Plan for St. Thomas.

The Benner Bay/Mangrove Lagoon is a complex ecosystem mixed with mangrove islands, mud flats, open water, and mixed dry forests/scrubs. Riparian vegetation here is dominated by the four common mangrove species, and the lagoon is bordered by the Bovoni Landfill, the wastewater treatment plant, the Clinton Phipps racetrack and marinas/boatyards. This wetland complex is the backbone of the STEER and is considered a major fish sanctuary. Reported (and observed) threats include solid waste, industrial effluents, sedimentation, and loss of riparian/aquatic habitats.

The Tutu Park Marsh is located northwest of the Tutu Park Mall. This freshwater wetland is filled with cattails, and surrounded by residential, commercial, and pasture lands, as well as active construction sites. Originally used as a farm pond, sedimentation and vegetative establishment over time have reportedly led to the loss of storage capacity. There is active and proposed construction in the area draining to the reservoir and it has been recently drained (reportedly). In addition to providing flood protection and groundwater recharge, an extremely rare plant species (*Cienfuegosia heterophylla*) is found here, making this site a high conservation area priority. Threats to this site are reported to include illegal dumping at the

northern end of the wetland and non-point sources pollution entering via guts (i.e., this reservoir could be serving as a defacto stormwater facility).

The Compass Pt. Salt Pond is part of the marine reserve system and has been part of a long-term biological and water quality monitoring studies. The sediment retention capacity of salt ponds is a highly variable, but important, function often based on wetland fringe, watershed modification, slope, and other factors (Rennis et al., 2006). Smaller impoundments also provide for sediment retention, which is evidenced, if not well documented, by lost storage capacity and required dredging. Rennis et al. (2006) describes the sediment retention function of salt ponds and the physical factors that influence performance. The pond is open to Benner Bay by a constricted inlet and has been dredged on the western boundary. Increased rates of sediment deposition within the pond surface layer have been contributed to development within the watershed (Brooks et al., 2004).

Compass Pt. is considered a highly disturbed system with the following characteristics listed below and in Box 1 (Rennis et al., 2006):

- A high pond surface-to-watershed area ratio: >30%
- Extensive removal of vegetation and development in floodplain area suggests that functional ability may be compromised: > 25%
- High proportion of watershed development occurring on steep slopes (8%) reduces performance: >25%
- Land modification from the natural vegetation communities in watershed:> 30%
- Low mangrove cover around fringe reducing frictional resistance and particulate settling
- The more extensive areas of SAV in the shallow areas of Compass Pt. and Flamingo Ponds contribute to increased functional performance.
- A low depth:area ratio suggests that pond receives(ed) abnormally high sediment loads, which may compromise capacity to retain sediments in the long-term.
- Ponds with restricted outlets will still retain sediment but typically will not function as effectively during the ebbing tide or storm events as ponds with no outlet.

There are additional salt ponds of interest in the watersheds: one surrounded by the Ritz Carlton, which is serving as a stormwater management facility; two on the peninsula to Cabrita Pt., which may not have been yet altered by development; and one (or more) on St. James/Little St. James Islands. Two freshwater ponds are located at Hernnhut—one adjacent to the road and another at the site of the new Humane Society building.

Box. 1. Compass Pt. Salt Pond characteristics (taken from Rennis et al., 2006)

Pond (disturbance level)	Island	Survey Date	Berm Elevation (m) ¹	Average Channel Depth (m)	Pond Area (ha) ²	Average Pond Depth (m) ³	Average Pond Depth Std Dev	SAV Category ⁴	Woody Veg intersper category	Average Wetland Fringe Width (m)	Average Wetland Fringe Range (m)	Wetland Fringe Ground Cover Percent	Wetland Fringe Ground Cover Range
Compass Pt (H)	ST	3/18/2005	Open	> 0.9	2.53	0.14 ⁶	0.0925	4	2	8.5	3-12.5	13	0-62

¹ Berm elevation at lowest point above Mean Lower Low Water

⁷ From bathymetry map provided by St. Croix Environmental Association

² From 1994 USACE digital orthophotography

⁸ from GIS

³ Taken along center line of pond

⁴ Submerged Aquatic Vegetation. Excludes diatoms and unicellular algae

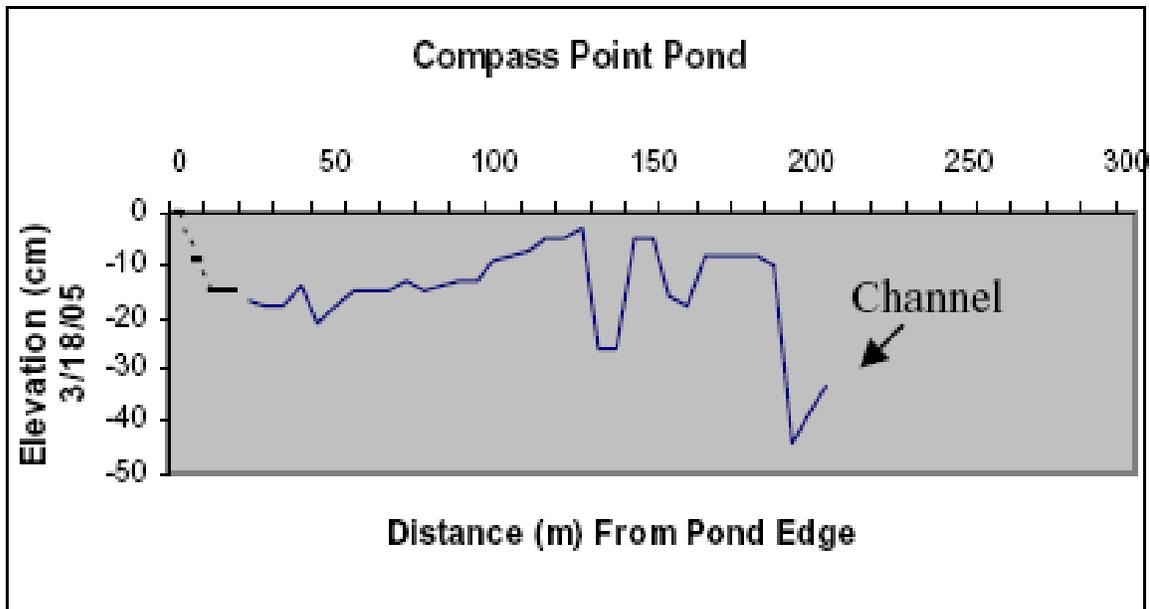
⁵ Pond has distinct channel leading from pond to berm

⁶ Pond bottom too soft or clogged with dead wood; depth estimated from edge measurements and visual observation

Pond*	Pond catchment area (exc pond) sq meters	Pond surface area sq meters	Wetland area sq meters	Wetland area % of watershed	Flood plain (exc pond) sq meters	Area of Slopes 0-3% sq meters	Area of Slopes 3.1-8% sq meters	Area of Slopes >8.1% sq meters
Compass(H)	78,931.9	25,344.7	30,243.5	29.00	4,931.1	9,718.7	5,736.6	62,987.7

Pond*	Area of development (excl roads) sq meters	Area of roads sq meters	Area of vegetation 0-3% slopes sq meters	Area of vegetation 3.1-8% slopes sq meters	Area of vegetation >8.1% slopes sq meters	Predominating soil type
Compass(H)	20,864.8	4,314.9	6,536.9	4,172.7	43,305.6	SrE

* H, Highly disturbed; M, Moderately disturbed, L, Low disturbance



2.7 Guts

Gardner et al. (2008) provides a detailed accounting of guts in the USVI. They report that guts are viewed primarily by residents as stormwater conveyances, dumping locations, and as threats to infrastructure and property in areas of active gut erosion. Little is known about the biological communities associated with these systems, though the following characterizations are made:

- Guts form the most extensive network of freshwater habitat in the USVI and are critical for several species of fish and shrimp requiring both fresh and marine water;
- Most guts only flow during and immediately after heavy rain events or during extended periods of saturation, although gut pools can persist where springs are intercepted;
- Guts provide nesting area, foraging habitat, and migration corridors for birds, bats, and other wildlife, and permanent pools are a significant habitat component; and
- Guts provide habitat for a number of known rare and endangered fauna and flora.
- Guts are threatened by changing hydrology, sedimentation, disposal of waste (construction, solid waste, sewage and septage), agricultural runoff, and removal of gut vegetation. Currently, there is a minimum protective buffer zone for guts in the USVI. The USVI *Buffer Protection Regulations* prohibits "...the cutting or injury of any tree or vegetation within 30' of the center of any natural watercourse, or within 25' of the edge of such watercourse, whichever is greater."

UVI's Rapid Ecological Assessment (2000) identified two guts of interest in the STEER watershed: Nadir Gut and Turpentine Run (Table 8). Guts of interest have been nominated as preliminary priority areas for research and more focused management by regulatory agencies. Turpentine Run is the largest perennial gut on St. Thomas with a connection to the sea; it was a historic route for Tianos to move from the coast to the Tutu Village and is now considered one of the Territory's top 5 impacted guts (Gardner et al., 2008; Platenberg, 2006). The main drainage gut, Turpentine Run, is one of the few perennial guts in the USVI. Its baseflow is reportedly supplemented by wastewater discharges and treated groundwater discharges from the Tutu Wellfield cleanup effort (Nemeth and Platenberg, 2007).

Table 8. Guts of Interests (Gardner et al., 2008)

Guts of Interest	Pools	Recreation	Community Use	Critical Habitats	Significant Species	Cultural Resources
Nadir Gut	x	x	x	x	X	
Turpentine Run	x			x	x	

Nemeth and Platenberg (2007) conducted a comparative study of freshwater shrimp and fish diversity and water quality in pools of three St. Thomas guts with various levels of upstream development. Turpentine Run was representative of the highly impacted system, showed evidence of increased channel flow and trash, and was broader, with larger pools (ranging 6-18

sq m surface area, 1.6-6 m deep) than other guts. Some portions have been channelized (near Nadir Bridge). They concluded that the most highly developed gut had higher nutrient loading (particularly downstream of residential sewage discharges), fewer fish and shrimp species, and more non-native species (Table 9). Limited water quality data was collected, but tended to show higher elevations of total phosphorous in Turpentine Run.

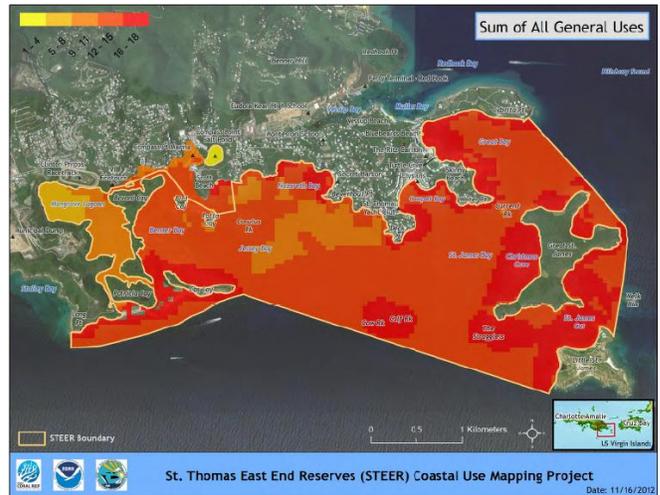
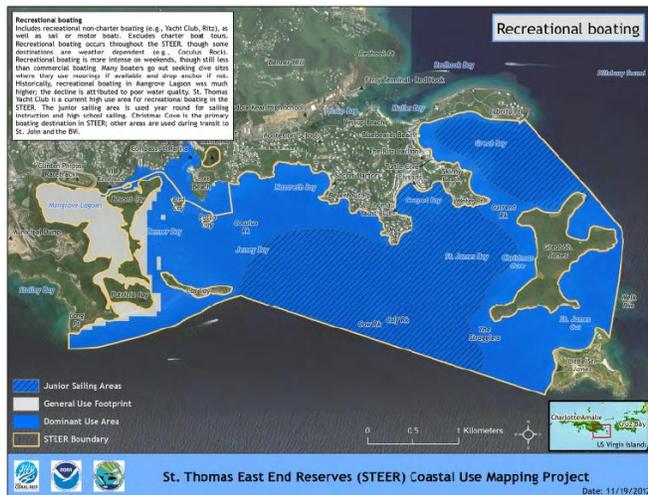
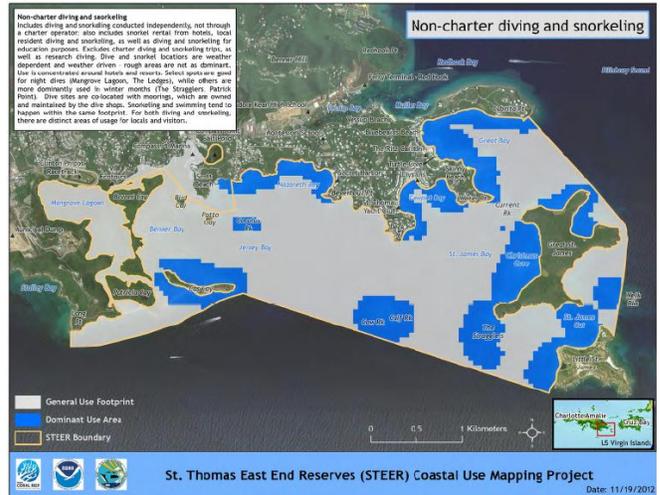
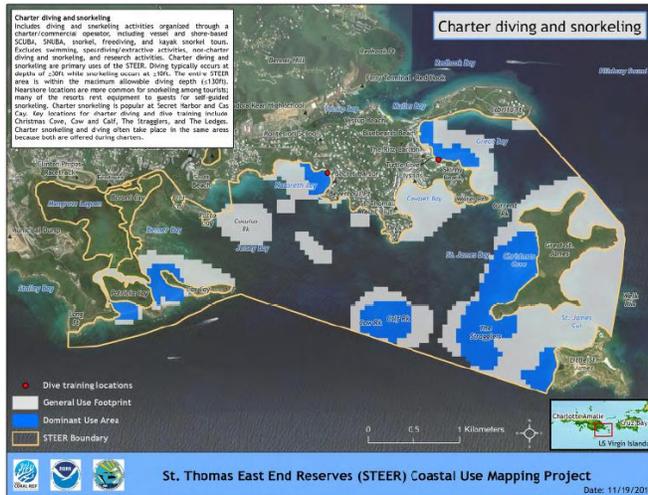
The study specifically linked algal growth and sedimentation with declining pool habitat quality in urbanized guts. While the study was limited in scope and results reportedly could have been influenced by physical and hydrologic factors downstream, these results are consistent with findings from the mainland US.

Table 9. Presence of Species Sampled in Low and Impacted Guts (from Nemeth and Platenberg, 2007)

Species present	Status	Neltjeberg (low)	Dorothea (moderate)	Turpentine Run (high)
Shrimp				
<i>Macrobrachium faustinum</i>	Native	X	X	X
<i>Macrobrachium carcinus</i>	Native	X	X	X
<i>Xiphocaris elongata</i>	Native	X	X	X
<i>Atya lanipes</i>	Native	X	X	--
<i>Atya innocous</i>	Native	X	--	--
Fish				
<i>Sicydium plumieri</i> (Goby)	Native	X	X	
<i>Agonostoma monticola</i> (Mountain Mullet)	Native	X	--	X
<i>Oreochromis</i> spp. (Tilapia)	Introduced	--	--	X
<i>Poecilia reticulata</i> (Guppy)	Introduced	--	X	X
Number of species present		7	6	6

2.8 Marine Uses

The STEER Coastal Use Mapping Project collected spatial data on human use patterns of the reserves. Outputs of the project include maps, GIS data layers, and a report, which can be downloaded here: <http://coris.noaa.gov/portals/steer/>. The maps were created using a participatory GIS mapping method that involved local users of the area, stakeholders, and resource managers to showcase the dominant and general use patterns for the marine reserves. The maps and data include information about twenty-three recreational, commercial, extractive and non-extractive uses of relevance for the STEER and current marine management. Additional mapping products include stakeholders' preferred use areas for various types of moorings. These maps contribute to our understanding of the interaction between humans and the STEER environment, important for addressing issues such as pollution, coastal development, and resource management. The maps also clearly highlight the marine areas valued by users. The mapping project was a partnership of the DPNR; NOAA's Coral Reef Conservation Program (CRCP), Office of Ocean and Coastal Resource Management (OCRM), and National Centers for Coastal Ocean Science (NCCOS); and the STEER Advisory Committee.



Example maps generated during the 2012 STEER Coastal Use Survey (NOAA) showing general (grey shading) and dominant (blue shading) areas for a variety of uses. The top two maps show charter (left) and non-charter (right) diving and snorkeling, which gives an indication of tourist vs. local resident use. The bottom left shows the recreational boating areas within STEER. The bottom right, is a general “heat map” that combines all the uses surveyed to show where the most commonly used areas are. This map shows the little use of Mangrove Lagoon, which has declined in use from historic levels, reportedly, due to water quality issues.

3.0 Hydrology

3.1 Rainfall

There are a number of rain gauge datasets maintained by the NOAA National Climatic Data Center (www.ncdc.noaa.gov/oa/ncdc) and the USGS Caribbean Water Science Center (<http://nwis.waterdata.usgs.gov>). Figure 3 shows the location of NOAA and USGS active and inactive gauges. The most frequently used gauge for studies in the East End appears to be Wintberg. Average annual precipitation is 45 inches on St. Thomas, ranging from about 40 to 60 inches (USGS, 1996). More recent NOAA (2006) estimates show mean annual precipitation for the East End study area ranging between 38-44 inches/year (Figure 4). Wet and dry seasons are not sharply defined, but May through November (particularly Sept.–Nov.) is typically the wettest period (DPNR, 2002; Nemeth and Platenberg, 2007). Gómez-Gómez and Heisel (1980) estimated annual evapotranspiration rates for the USVI to average about 39 inches/year.

Figure 3. Active and inactive rain gauge locations on St. Thomas, USVI for available datasets.



Figure 4. Annual precipitation map for St. Thomas based on >50 years of records through 2004 by the OSU Spatial Climate Analysis Service (NOAA, 2006)

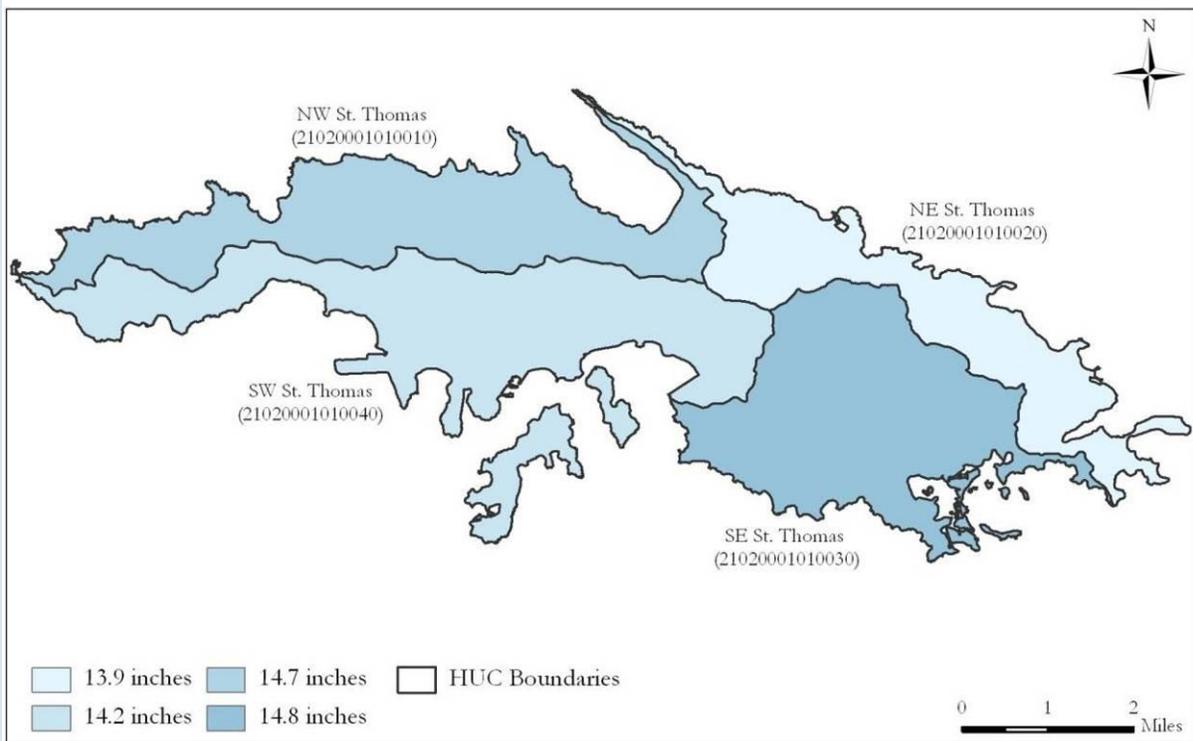


Cadmus (2011) used long-term data collected at two East End stations to calculate a variety of statistics for rainfall frequency and storm depths for the southeast watersheds (Jersey Bay and Frenchmans Bay) and northeast watersheds (Redhook, Smith, and Mandal Bays). Data taken from the 2011 report relevant to our study area are summarized in the Box 2 and 3 below.

Additional summaries of precipitation data can be found in Rennis et al. (2006). This study looked at events exceeding 1 inch and greater than 4 inches per day in Turpentine Run between January 2000-November 2005 in order to evaluate the sediment retention function of salt ponds.

Box 2. Precipitation frequency estimates for each 14-digit Hydrologic Unit Code (taken from Cadmus, 2011)

HUC	Magnitudes (inches) of 24-hour Duration Storms for Different Return Intervals						
	1 Year	2 Years	5 Years	10 Years	25 Years	50 Years	100 Years
Southeast St. Thomas (21020001010030)	3.0	4.0	6.1	7.8	10.3	12.5	14.8
Northeast St. Thomas (21020001010020)	2.9	3.9	5.8	7.5	9.8	11.8	13.9



Box 3. Storm depth analysis for two gauging stations on the East End of St. Thomas (taken from Cadmus, 2011)

Location and data record characteristics for USVI rain gage stations used for calculation of 90th percentile, 95th percentile, and mean storm depth, and large storm frequency/seasonality.

Station Name & ID	Island	Elevation (ft)	Record Start Date	Record End Date	Record Length (years)	% Missing Records
Redhook Bay (677600)	St. Thomas	2	1980	2008	29	37
Wintberg (679450)	St. Thomas	645	1972	2008	37	8

Estimated storm depth statistics for each rain gage station.

Station Name & ID	90 th Percentile Storm Depth (inches)	95 th Percentile Storm Depth (inches)	Mean Storm Depth (inches)
Redhook Bay (677600)	1.3	2.0	0.6
Wintberg (679450)	1.1	1.6	0.5

Estimated large storm (> 0.5 inches) frequency and seasonality for each rain gage station.

Station Name & ID	Number of Days per Year/Month with Storm Depth > 0.5 inches												
	Annual	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Redhook Bay (677600)	16	1	0	1	1	2	1	1	2	2	2	2	1
Wintberg (679450)	20	1	1	1	1	2	1	1	2	3	3	3	2

The current stormwater design guidance published in the 2002 USVI Environmental Protection Handbook indicates that the USVI uses a Type III rainfall distribution, and provides precipitation frequency maps for the 1-yr, 2-yr, 5-yr, 10-yr, 25-yr, and 100-yr 24-hour rainfall events, as well as intensity and duration curves (source cited from USDA-SCS, 1986).

Table 10 presents updated rainfall frequencies from NOAA (2006) for over 50 years of records through 2004. These data and graphics can be downloaded directly from http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_maps.html.

3.2 Runoff

Stormwater is typically conveyed down the mountains through natural guts, roads, and roadside ditches, carrying eroded sediment and watershed pollutants to ponds and nearshore marine waters. In the USVI, natural guts are typically steep channels, 3-12 feet wide, with a rocky substrate and little understory vegetation (Nemeth and Platenberg, 2007). Impacted guts often lack vegetated buffers, carry additional volume due to surface discharges from impervious surfaces, and are prone to active bank erosion, headcutting, and scour. With few exceptions, guts do not maintain perennial flow. Only a few have a direct connection to marine waters, as they are often separated by natural berms/bars, salt ponds, or wetland complexes.

Table 10. St. Thomas Precipitation (inches) for 24-hr Duration Recurrence Intervals

Event	2002 USVI Environmental Handbook ¹	2006 NOAA Atlas 14 ²
1-yr, 24-hr	<p>Map of St. Thomas Island showing 1-yr, 24-hr precipitation. Values: 2.7 (Dorothy), 3.4 (Birre), 3.1 (Annie), 3.1 (Annie Estate), 3.1 (Frenchmans Bay).</p>	<p>Map of St. Thomas Island showing 1-yr, 24-hr precipitation. Values: 2.7, 2.8, 2.9, 3.1, 2.6, 2.7, 2.8, 2.7.</p>
10-yr, 24-hr	<p>Map of St. Thomas Island showing 10-yr, 24-hr precipitation. Values: 5.3 (Dorothy), 6.8 (Birre), 7.0 (Annie), 7.4 (Annie Estate), 7.4 (Frenchmans Bay).</p>	<p>Map of St. Thomas Island showing 10-yr, 24-hr precipitation. Values: 6.8, 7.2, 7.4, 7.6, 7.8, 6.8, 6.4, 7, 7.2, 6.8, 7, 7.2.</p>
25-yr, 24-hr	<p>Map of St. Thomas Island showing 25-yr, 24-hr precipitation. Values: 6.2 (Dorothy), 8.1 (Birre), 8.5 (Annie), 9.0 (Annie Estate), 9.0 (Frenchmans Bay).</p>	<p>Map of St. Thomas Island showing 25-yr, 24-hr precipitation. Values: 8.5, 9.5, 9, 9.5, 10, 11, 8.5, 9, 9.5, 9, 9.5.</p>
100-yr, 24-hr	<p>Map of St. Thomas Island showing 100-yr, 24-hr precipitation. Values: 7.9 (Dorothy), 10.5 (Birre), 11.2 (Annie), 11.9 (Annie Estate), 11.9 (Frenchmans Bay).</p>	<p>Map of St. Thomas Island showing 100-yr, 24-hr precipitation. Values: 13, 13.5, 15, 14, 13, 12.5, 13, 12, 13, 14, 17, 13.5, 13, 11, 12, 11.5, 13, 15, 12.5, 12.5, 13.</p>

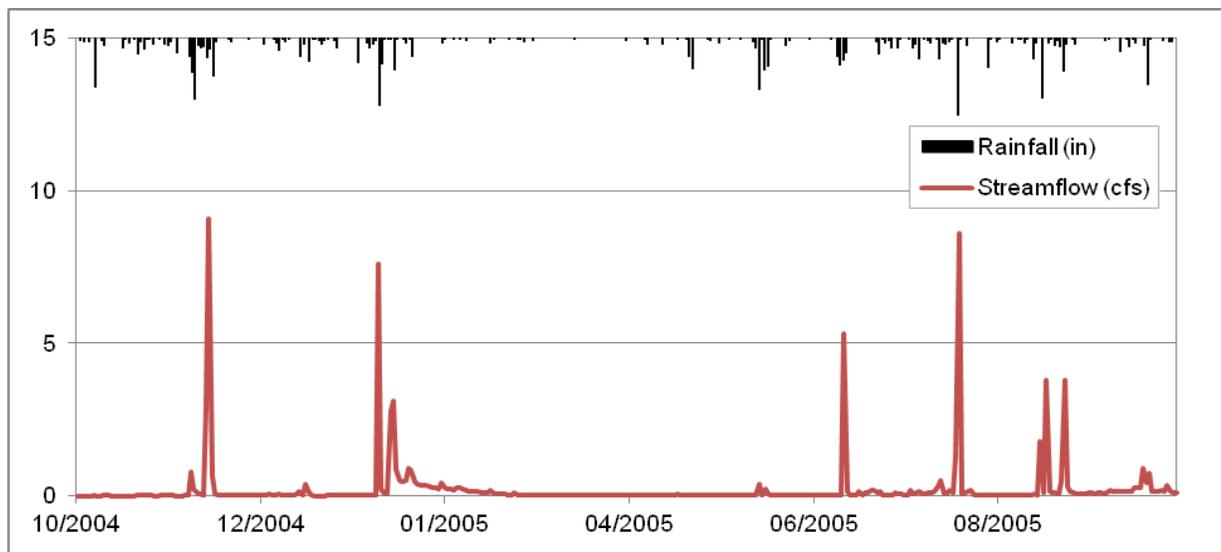
¹ USDA-SCS, 1986 with data provided by the US Weather Bureau

² NOAA US Precipitation Frequency Atlas Vol. 3: Puerto Rico and the USVI, Ver. 3 (average of 54 years of daily records through 2004)

The capacity of impacted guts to manage peak runoff while maintaining ecological functions is not well understood in the USVI. The ability of guts to provide for infiltration has anecdotally been reported as extremely high based on results from stormwater retrofit projects installed in Coral Bay, St. John (per. com., Coral Bay Community Council, 2012). Rennis et al. (2006) summarizes previous gut studies and notes that because of the predominately steep slopes, the guts can see rapid flows during storm events. They go on to say that despite this, after the most frequent storms (smaller events), most of the rainfall evaporates and/or infiltrates into the ground rather than discharging as surface flow at the bottom of the watershed. Rennis et al. (2006) cites a study on the St. Thomas East End (where average annual rainfall is approximately 40 inches) that estimated between 2-8% of the total rainfall is ultimately discharged to marine waters.

Furthermore, Cadmus (2011) states that the amount of runoff during more frequent, smaller storms shows extreme variability, due in part to the antecedent moisture conditions of soils. Surface soils generally have high permeability rates, which unless saturated, can allow for the infiltration of a high percentage of the small rainfall events. However, Cadmus (2011) also estimates that runoff response to large storm events often results in high volumes of surface runoff during and immediately after rainfall. Figure 5 shows an example of the short duration of flow typical in USVI guts. Further study is needed to compare the hydrology of natural versus guts impacted by additional stormwater loads from surrounding development.

Figure 5. Sample hydrograph of Bonne Gut on St. Thomas (from Cadmus, 2011)



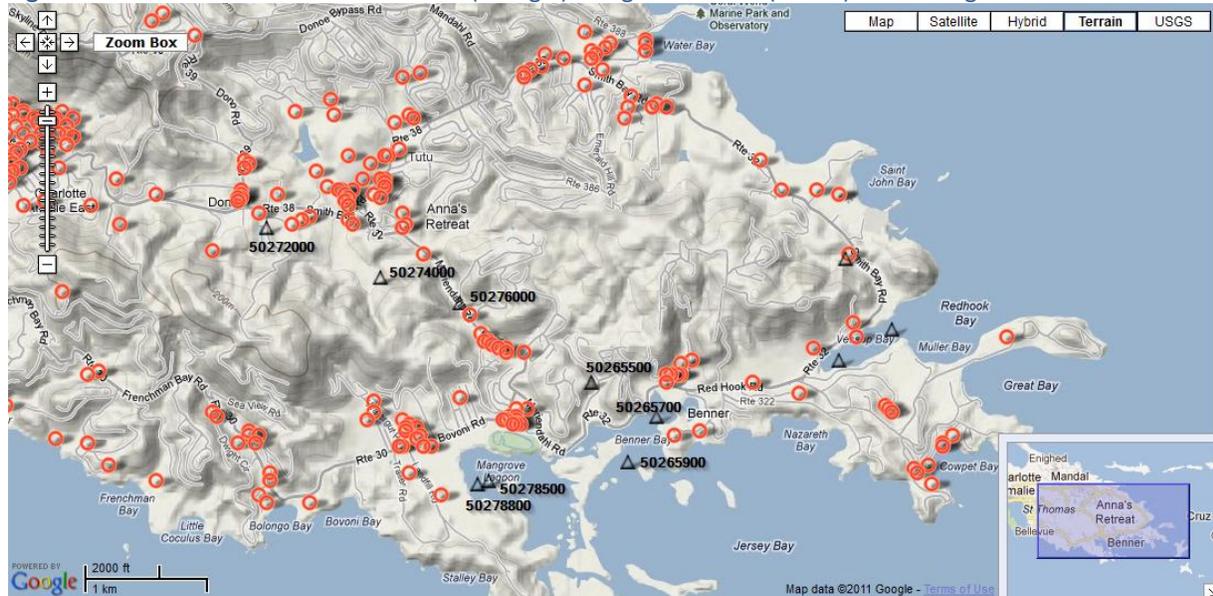
The USGS Caribbean Water Science Center <http://nwis.waterdata.usgs.gov> maintains flow records for two stream gauges on Turpentine Run. Figure 6 shows the locations of these two stations, as well as other surface and groundwater monitoring stations (active and inactive) where data records are available:

- Turpentine Run at Mt. Zion (Station #50274000)—Daily discharge data (count 5158) collected between 1992-2006. It is reported that flow at this gauge was affected by

three sewage treatment plants (Donoe, Old Tutu, and New Tutu) “that discharged to a retention pond located 0.8 mile upstream of the gauge.” See Figure 7 for an example of annual discharge data from this site.

- Turpentine Run at Mariendal (Station #50276000)—Daily discharge data (count 2604) collected between 1983-1992.

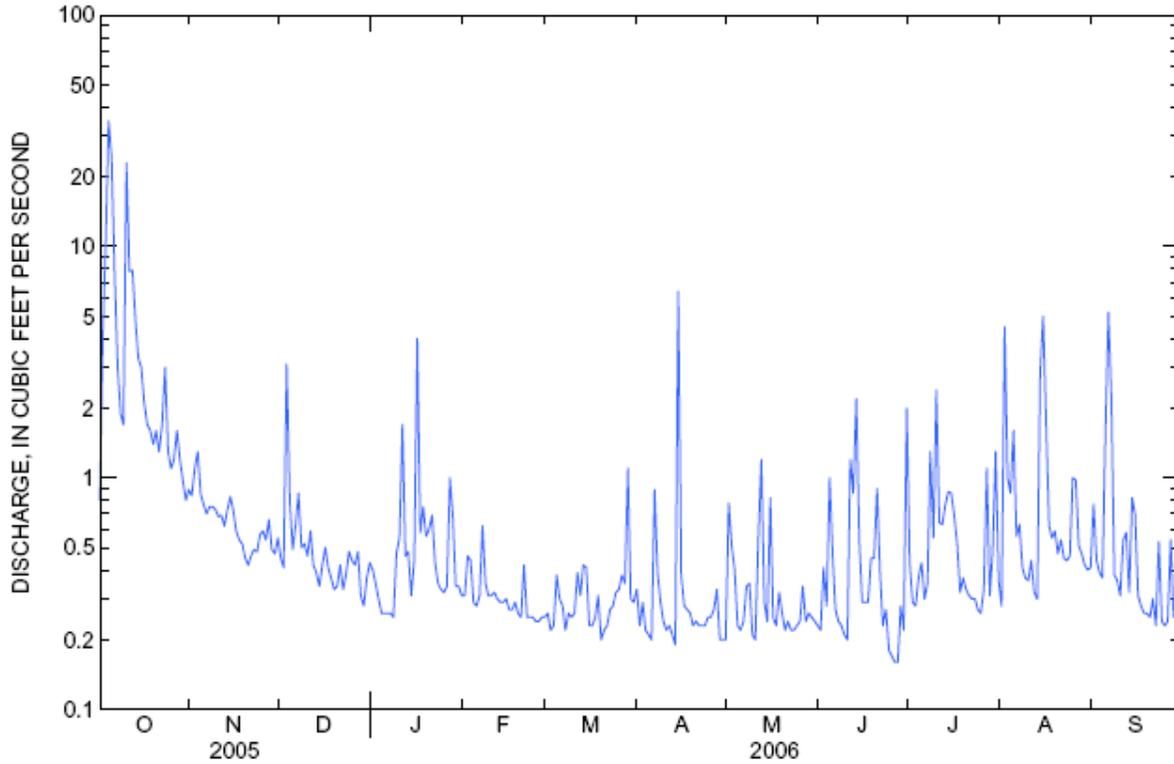
Figure 6. USGS active and inactive surface (triangle) and groundwater (circles) monitoring stations



These datasets provide valuable information used to support various watershed analyses. Henry and Nieves (in Gardner et al., 2008) performed a HEC analysis using the HEC-GeoHMS on the Benner Bay/Jersey Watershed to compare changes in stream flow before and after three large development projects: Cost-U-Less (1998): Price Smart (2001): and Home Depot (2003). Changes in land cover over this time period included a 4% increase in the developed area with a corresponding 3% and 7% decrease in herbaceous and shrubland, respectively. The HEC analysis showed significant changes in the drainage pattern around the Price Smart and an overall increase in average stream flow rate between 1994 and 2000. They also modeled around the BCB Middle School (in Bovoni) and showed similar changes in the drainage pattern.

Cadmus (2011) estimated runoff change from 2001-2007 based on precipitation, soils, and changes in land use using the Long-Term Hydrologic Impact Assessment (L-THIA) model. Results estimated a 13% and 40% increase in runoff volume for the southeast and northeast St. Thomas HUC watersheds, respectively. Cadmus also ran the SUSTAIN model to investigate runoff mechanisms and potential stormwater management options. Average stormwater runoff and pollutant yields for the Jersey Bay watershed (between Water Years 2000-2009) were modeled to be 7.5 in/yr; 116 lbs/acre/yr TSS; and 72.3 billion/ac/yr fecal coliform, respectively.

Figure 7. Hydrograph and Annual Data Summary for Turpentine Run Mt. Zion Station (50274000) Water Year 2006



Water-Data Report 2006

50274000 TURPENTINE RUN AT MOUNT ZION, ST. THOMAS, VI—Continued

SUMMARY STATISTICS

	Calendar Year 2005		Water Year 2006		Water Years 1992 - 2006	
Annual total	511.24		342.72			
Annual mean	1.40		0.94		1.43	
Highest annual mean					4.40	2004
Lowest annual mean					0.44	2001
Highest daily mean	35	Oct 4	35	Oct 4	802	Sep 16, 1995
Lowest daily mean	0.20	Jun 20	0.16	Jun 26	0.00	Mar 22, 2003
Annual seven-day minimum	0.24	Jun 3	0.21	Jun 23	0.01	Apr 3, 1995
Maximum peak flow			438	Oct 4		
Maximum peak stage			5.07	Oct 4	8.62	Sep 16, 2004
Annual runoff (ac-ft)	1,010		680		1,040	
Annual runoff (cfsm)	0.601		0.403		0.616	
Annual runoff (inches)	8.16		5.47		8.37	
10 percent exceeds	2.3		1.5		1.5	
50 percent exceeds	0.66		0.38		0.34	
90 percent exceeds	0.33		0.23		0.10	

4.0 Geomorphology

4.1 Geology

Volcanic in origin, St. Thomas topography is dominated by mountainous slopes, lacks much coastal plain, and has an extremely irregular coastline with many embayments. Rainfall tends to run off these slopes in well-defined surface channels, locally referred to as guts (i.e., guts, streams, or watercourses), rather than as subsurface flow due to thin soils and relatively impermeable underlying rock. Particularly during large storms, gut flow responds quickly to rainfall events given the small watershed ratios and steep terrain. Figure 8 is an excerpt from the USDA soil survey (2000) general geologic map.

4.2 Soils

The soil survey indicates that the general soil types for our study area are Annaberg-Cramer-Southgate in the lower half of the watershed and the Fredriksdal-Susannaberg-Dorothea association in the upper half of the watershed (Figure 9). These soils are relatively shallow and well-drained (though percolation rates are slow) and located on steep to very steep summits and side slopes of volcanic hills and mountains (USDA, 2000). Table 11 shows the Hydrologic Soil Group (HSG) classifications in the STEER Watershed (see Appendix [Map 2](#)).

Relative watershed erosion across the Caribbean was estimated by the World Resources Institute and NOAA (2005) using the N-SPECT model, which is based on the Revised Universal Soil Loss Equation (USDA, 1989). Results illustrated in Figure 10 show a relative erosion potential of St. Thomas watersheds to erosion based on slope, soil erosivity, rainfall, and land cover conditions (top); a mean relative erosion potential by subbasin (middle); and relative sediment delivery potential to embayments for each subbasin (bottom). Sediment delivery is a function of the overall watershed size and a delivery ratio accounting for number of outlet points. Appendix [Map 9](#) shows the Relative Erosion Potential in the STEER Watershed.

Table 11. STEER Watershed Soils by HSG Classification

USVI Watershed	Subwatershed	% Area per HSG*			
		A	B	C	D
Jersey Bay	Bovoni	0	84	0	10
	Cays (East & West)	0	0	0	100
	Frydenhoj/Compass Pt.	0	4	0	92
	Little St. James	5	0	0	78
	Nadir Gut	0	0	0	99
	Nazareth Bay	0	0	0	97
	St. James	2	1	0	90
	Turpentine Run	0	4	1	92
Redhook Bay	Cowpet Bay	0	0	0	90
	Great Bay	0	0	0	94

*Based on 2008 USDA SSURGO data, which may not total 100% due to incomplete spatial coverage

Figure 8. General Geology for the East End of St. Thomas (USDA, 2000)

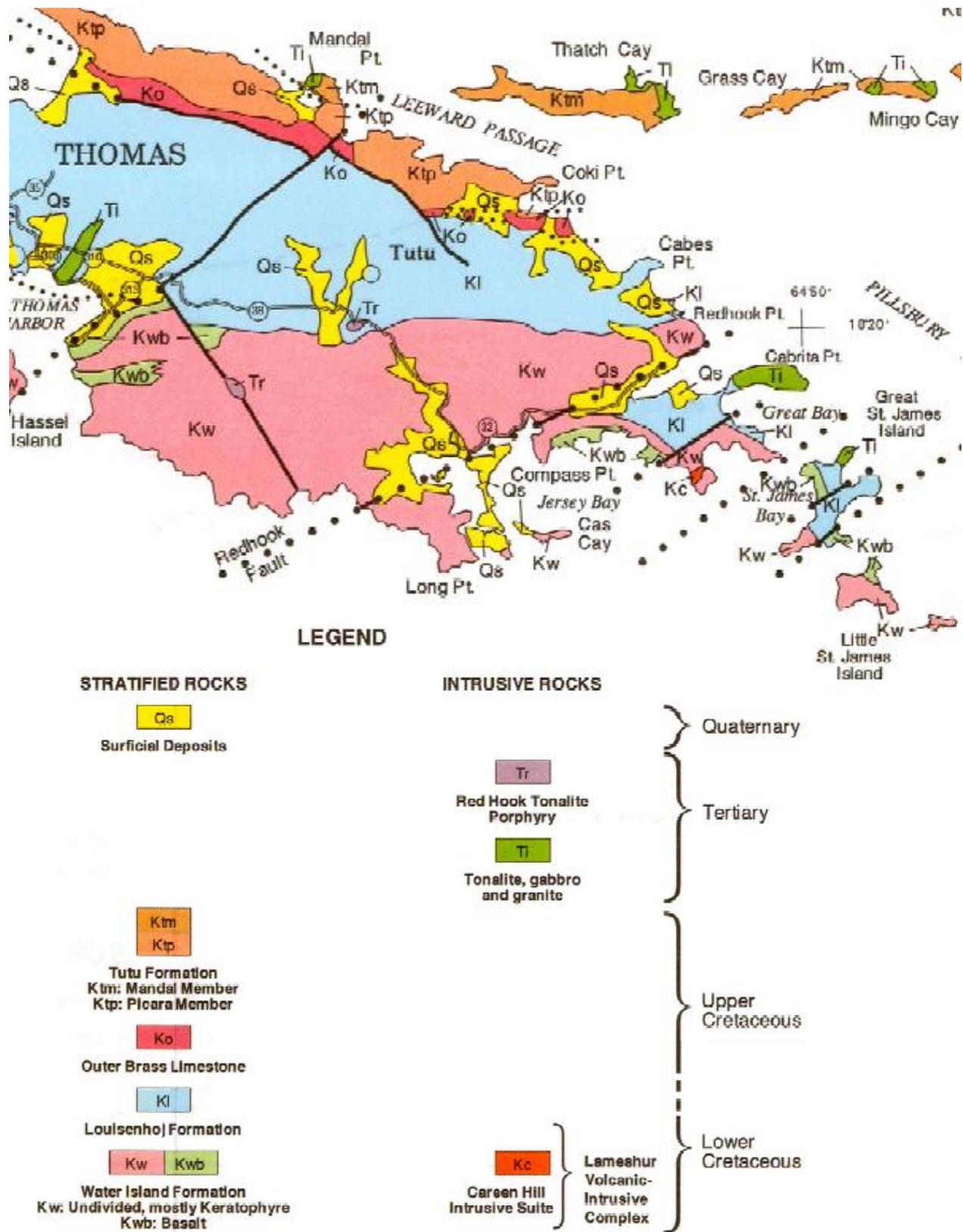
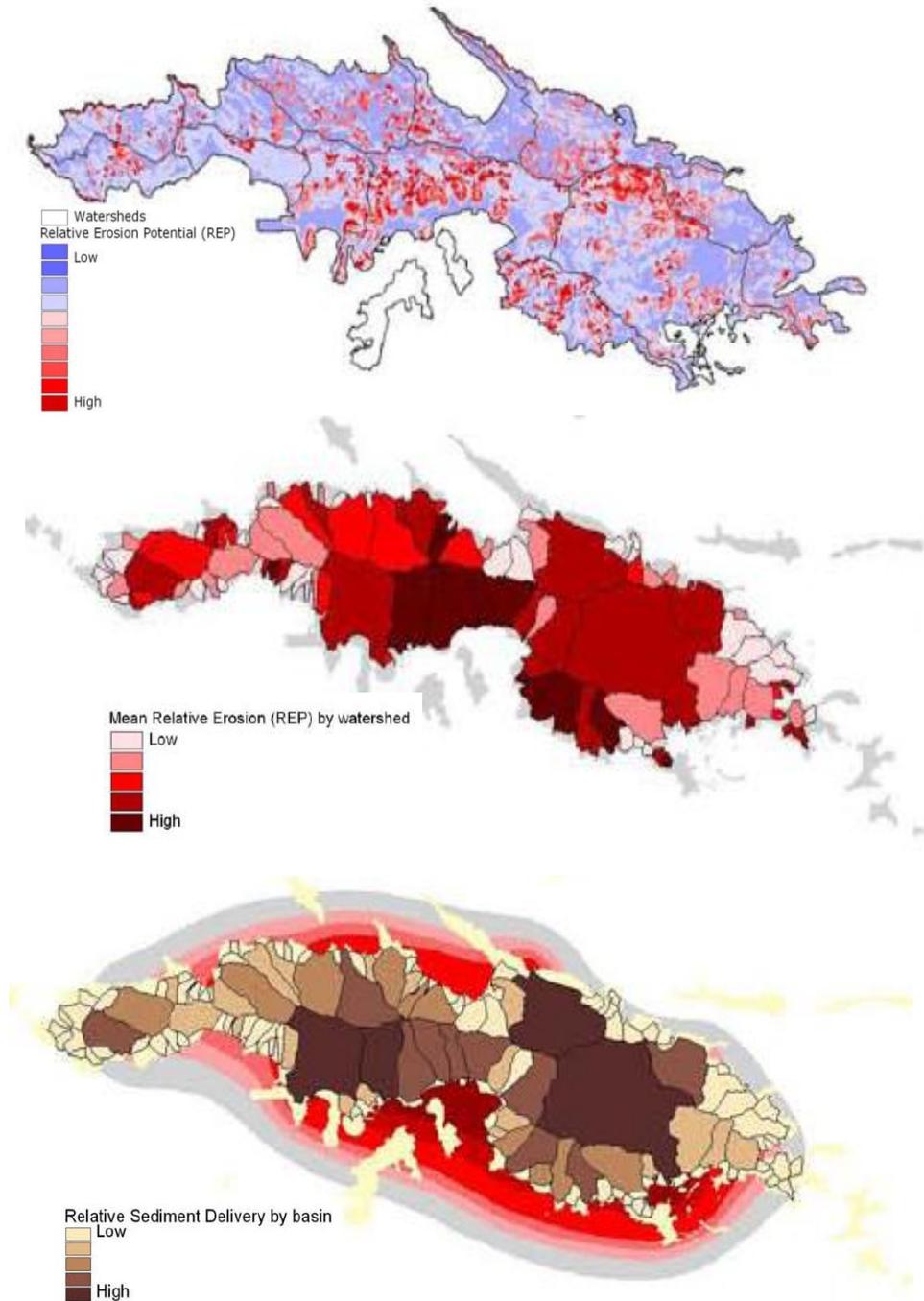


Figure 9. General Soil Map and Layer Characteristics of St. Thomas (USDA, 2000)



Soils	Surface	Subsurface	Bedrock
Annaberg	0 to 5 inches, very dark grayish brown gravelly loam	5 to 10 inches, dark brown very gravelly loam	10 to 13 inches, weathered igneous bedrock; 13 to 60 inches, unweathered igneous bedrock
Cramer	0 to 9 inches, dark reddish brown gravelly clay loam	9 to 14 inches, dark red gravelly clay; 14 to 19 inches, dark reddish brown gravelly clay	19 to 32 inches, weathered igneous bedrock; 32 to 60 inches, unweathered igneous bedrock
Southgate	0 to 5 inches, brown gravelly loam	5 to 10 inches, brown very gravelly loam	10 to 17 inches, weathered igneous bedrock; 17 to 60 inches, unweathered igneous bedrock
Fredriksdal	0 to 7 inches, dark reddish brown very gravelly clay loam	7 to 12 inches, reddish brown very gravelly clay loam	12 to 16 inches, weathered igneous bedrock; 16 to 60 inches, unweathered igneous bedrock
Susannaberg	0 to 2 inches, very dark brown clay loam	2 to 9 inches, very dark brown clay; 9 to 15 inches, dark brown gravelly clay loam	15 to 21 inches, weathered igneous bedrock; 21 to 60 inches, unweathered igneous bedrock
Dorothea	0 to 6 inches, dark brown clay loam	6 to 11 inches, brown clay loam; 11 to 19 inches, yellowish brown clay; 19 to 30 inches, strong brown clay loam	Substratum: 30 to 60 inches, strong brown saprolite

Figure 10. Erosion potential modeling for St. Thomas (WRI and NOAA, 2005)



4.3 Groundwater

USGS (1996) reported an estimated permeability of 0.63-2.00 inches/hour, as well as available water capacity of 0.15-0.20 inch/inch, for soils of thickness 0-36 inches in the study area (modified from Rivera et al., 1979). A later study by Smith and Ajayi (1983) estimated

groundwater recharge to be between 0.2 and 3.3 inches/year (Figure 11). Figure 12 shows that aquifer storage is primarily in fractured bedrock and that the extent of alluvial aquifers is small, limiting the potential for public water supply wells on the east end. The direction of groundwater flow towards Turpentine Run is shown in Figure 13. EPA (2009) mapped contaminated groundwater plumes for the Tutu Wellfield Site (Figure 14).

Figure 11. Estimated recharge to groundwater areas in St. Thomas (taken from Smith and Ajayi, 1983)

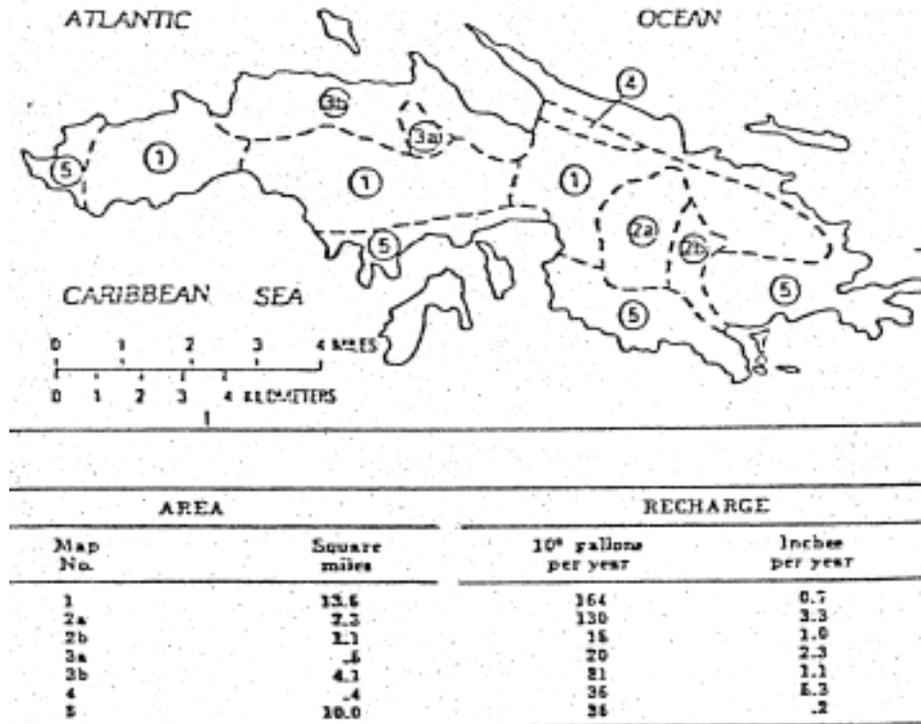


Figure 12. Principal Aquifers (taken from USGS, 1996)

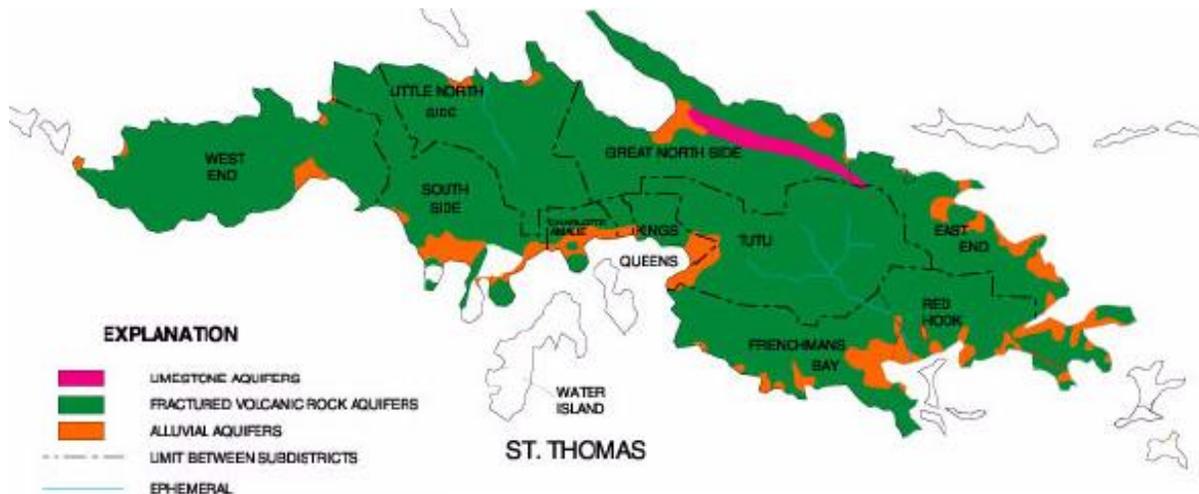


Figure 13. General direction of groundwater flow in Turpentine Run (taken from USGS, 1996)

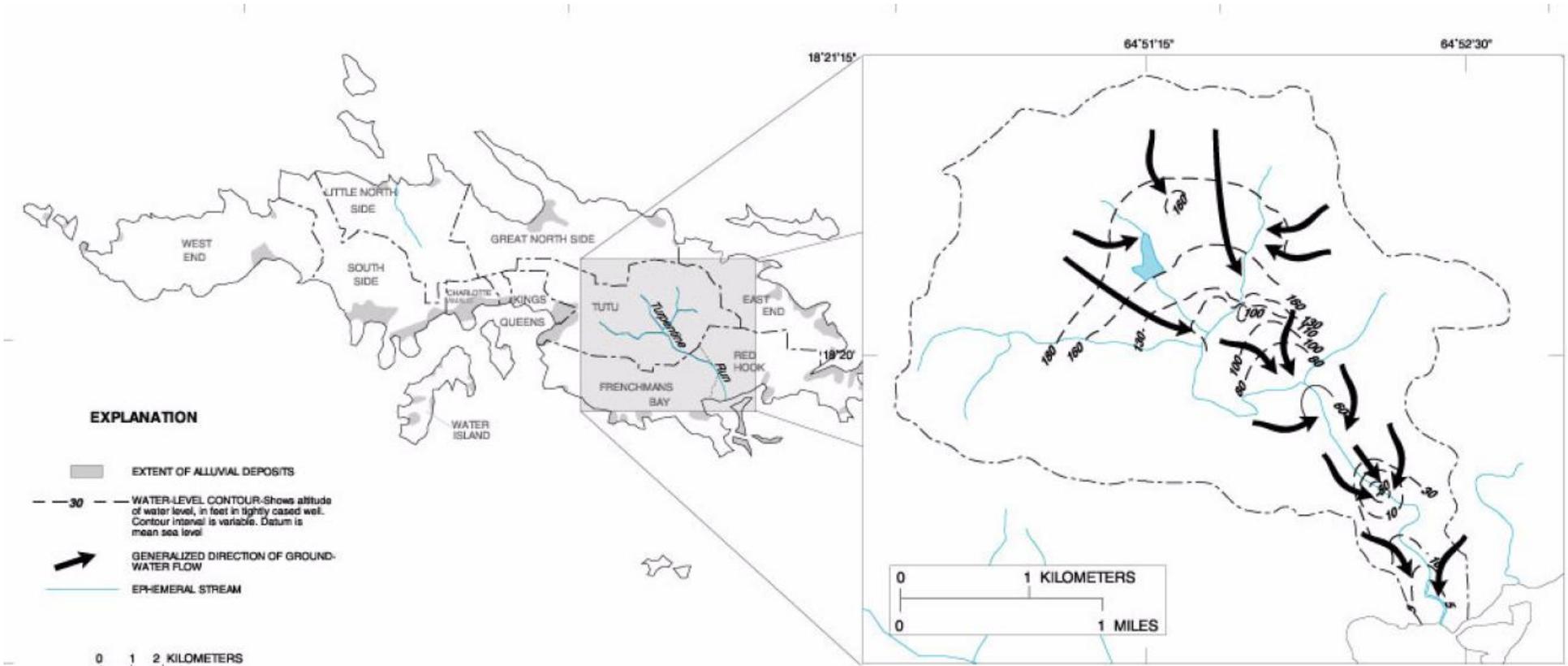
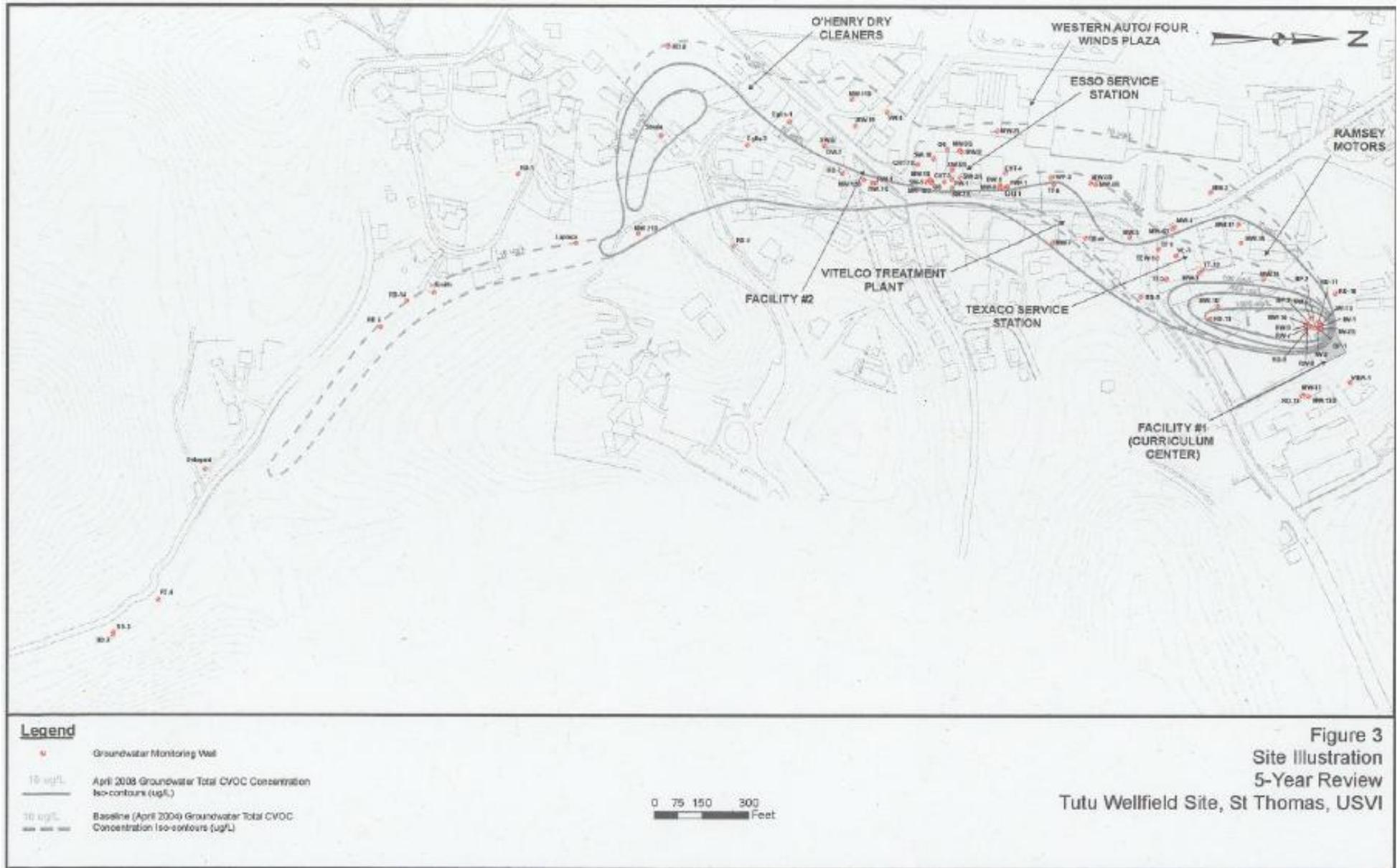


Figure 14. Contaminated groundwater plumes at Tutu Wellfield Superfund Site (from EPA, 2009)



5.0 Infrastructure

5.1 Wastewater

Wastewater management in the USVI is constrained by a number of factors--poor suitability of soils for conventional on-site disposal systems (OSDS) being one of the more significant. When the soil layer is shallow (<2 ft), effluent from septic systems or cesspools is not effectively filtered and can release bacteria, nutrients, and other contaminants to the surface or to groundwater through open joints and fractures of the bedrock.

Cadmus (2011) modeled the suitability of OSDS in the USVI and confirmed that much of the area is not suitable for conventional or even some alternative OSDS (Figure 15). Since no mapping was provided for sewer service availability on St. Thomas or St. John, the analysis was completed for the island in its entirety. They also estimated the failure potential of conventional systems based on soils, topography, and land use, which revealed high failure potential in the STEER Watershed (Appendix [Map 10](#) and Table 12).

Figure 15. Suitability of conventional (trench and bed) and alternative OSDS in USVI (taken from Cadmus, 2011)

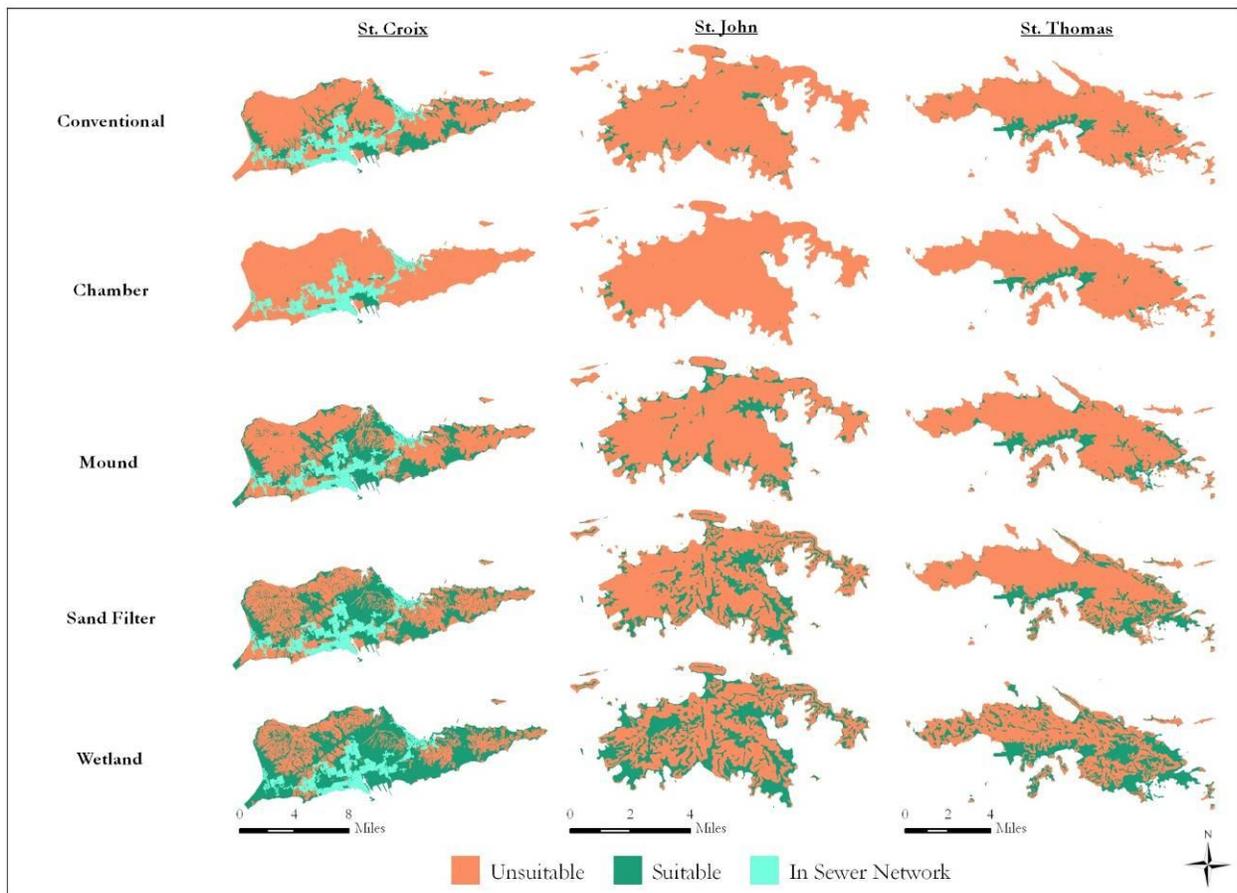


Table 12. Failure Potential for Conventional OSDS

USVI Watershed	Subwatershed	Total Acres*	% Failure Potential for Conventional OSDS*		
			Low (<5%)	Med (5-35%)	High (>35%)
Jersey Bay	Bovoni	522.1	48	34	18
	Cays	100.7	6	61	33
	Frydenhoj/Compass Pt	181.2	54	27	19
	Little St. James	36.4	100	0	0
	Nadir Ghut	372.2	14	28	58
	Nazareth Bay	105.3	13	45	43
	St. James	150.6	96	0	4
	Turpentine Run	2138.8	7	21	72
Red Hook	Cowpet Bay	82.2	10	38	52
	Great Bay	67.0	24	39	37
Total		3756.6	21	25	54

*Based on septic failure potential mapping (land use, without roads) from Cadmus (2011)

Portions of the east end of St. Thomas are on public sewer and serviced by the Mangrove Lagoon Wastewater Treatment Plant (MLWWTP) or the Vessup Bay WWTP. The MLWWTP serves portions of the STEER Watershed. Operated by the VIWMA, the MLWWTP was constructed in 2002-2003 to replace four smaller treatment systems in the watershed—Old Tutu, New Tutu, Nadir, and Donoe WWTPs. The main facility at MLWWTP is a Sequence Batch Reactor (SBR) system that applies a process of aeration, settling, decanting, and UV disinfection prior to discharge offshore to the west of Stalley Bay. The MLWWTP also accepts septic pumpout loads by private companies at a smaller, adjacent facility. The septage facility uses a belt filter press to separate the solids and create a sludge cake, which is then trucked to the landfill. The liquid is recycled back to the main system. More recently, VIWMA has also begun to accept marine vessel pumpout on a limited scale; the bacteria used in the treatment cycle do not do well with salt water and grease associated with bilge water. This consolidation and enhanced sewage treatment was a major recommendation of the Benner Bay/Mangrove Lagoon TMDL (HW, 2003), which assumed that upgrades to an advanced wastewater facility would significantly reduce water quality impairments in Benner Bay/Mangrove Lagoon. Average daily flow to the MLWWTP is 0.75 Million Gallons Per Day (MGD); the facility has a maximum 24-hour capacity of 1.2 MGD (per. com VIWMA, 2013). According to Cadmus, (2011), this facility serves a population of ~13,360, collecting approximately 0.93 MGD.

Potential expansion of the MLWWTP service area may occur along Route 38, at least to bring Cost-U-Less and Ft. Mylner Plaza on line. Installation of a pump station near Tropical Marine and line extension further east on along Bovoni Rd. could extend services to the marinas and residential areas in Frydenjoh/Compass Pt. subwatershed. This expansion would be helpful, particularly since field observations included a high number of failing OSDS and illicit discharges

of washwater in the commercial area south of Bovoni Rd. adjacent to the landfill and at businesses along marina row.

VIWMA officials report that the original sewer installation in Turpentine Run subwatershed included the installation of main trunk lines/force main and pump stations, but did not include replacement of the existing pipe network in Anna's Retreat or the New Tutu Valley. These pipes were installed in the 1960's and have far exceeded their life expectancy. There is not a lot of infrastructure in Old Tutu and portions of this area are a combined storm and sewer system. According to VIWMA, breaks in the system are frequent, manholes and joints are leaky, and there is high inflow and infiltration occurring. There is no complete mapping of the sewer system, and no illicit discharge program in place. VIWMA complains that maintenance access is difficult to obtain in much of the residential area.

A general map approximating the extent of the sewer service area was generated by HW based on sketches provided by VIWMA (Appendix [Map 11](#)). This map also includes areas served by small package systems, and developed parcels assumed to be on OSDS. Residential properties outside of the ML WWTP service area are assumed to use typical one-chambered onsite sewage disposal systems (OSDS) or cesspools/seepage pits. Map 11 shows OSDS areas divided into low, medium, and high failure potential based on Cadmus analysis.

Prior to the ML WWTP coming on-line, Horsley Witten (2003) estimated that 15% of the Mangrove Lagoon and Benner Bay/Lagoon Marina drainage areas were serviced by OSDS (Turpentine Run, Bovoni, Nadir Gut, and Frydenhoj subwatersheds). The Mangrove Lagoon and Benner Bay TMDLs both assume a 10% failure rate for septic systems in the watershed (HW, 2003 and Tetra Tech, 2005). Table 13 suggests that 40% of the entire STEER Watershed is currently serviced by OSDS and less than 20% is tied into the sewer line. The resorts and condominiums have their own onsite package plants, as do a number of commercial businesses outside of the sewer service district. The Food Center and Humane Society have a more advanced treatment systems.

OSDSs are governed by the *USVI Onsite Sewage Disposal Regulations* and *Onsite Sewage Disposal Regulations for the Coastal Zone* that specify criteria for the siting and design of conventional systems, as well as some requirements for alternative systems. The *USVI Handbook on Onsite Sewage Treatment Systems* is referenced within the regulations for requirements, such as test pit sampling procedures and sizing criteria. DPNR (2010) states that septic system regulations and regulatory authority needs to be better defined for Tier II of the coastal zone due to overlapping and conflicting jurisdictions between the VIWMA, Department of Health, and DPNR in the various statutes and regulations. There is a need to update the permitting process to include monitoring and pump out requirements. Currently, there is no inventory of septic systems or an inspection and maintenance tracking system. Properties within 60 ft of the sewer line are supposed to connect.

An estimate of number of boats using marinas at Jersey and Benner Bays together is 410, and 50 for Cowpet Bay, based on counts from aerial imagery (Google Maps 2012).

Table 13. Estimated Breakdown of Wastewater System for Parcels in STEER

Subwatershed	Total Acres	No system in use ¹	% Service				
			Sewer ²	Small Plants ³	OSDS by Failure Potential ⁴ (Acres)		
					Low	Med	High
Bovoni	522.1	59%	25%	0%	6%	6%	4%
Cays	100.7	100%	0%	0%	0%	0%	0%
Frydenhoj/Compass Pt	181.2	34%	0%	6%	35%	16%	9%
Little St. James	36.4	100%	0%	0%	0%	0%	0%
Nadir Gut	372.2	47%	0%	0%	13%	14%	26%
Nazareth Bay	105.3	24%	0%	9%	9%	29%	29%
St. James	150.6	100%	0%	0%	0%	0%	0%
Turpentine Run	2138.8	25%	29%	2%	4%	17%	22%
Cowpet Bay	82.2	0%	0%	35%	9%	30%	26%
Great Bay	67.0	1%	0%	29%	20%	31%	19%
STEER Watershed	3756.6	37%	20%	3%	7%	15%	18%

¹ Undeveloped parcels

² Based on approximated service area map (pers. comm., VIWMA 2012)

³ Field verified, based on property boundaries

⁴ Based on Cadmus (2011) analysis

5.2 Stormwater

Stormwater drainage infrastructure including catch basins, outfalls, manholes, pipes and management facilities (e.g., detention basins) are not currently mapped by DPNR. Very few structural stormwater facilities designed to provide storage, increased recharge, or water quality treatment exist in the East End. In fact, only a handful of practices were found by HW during field work (Table 14) and some of those were outside of the watershed. Appendix [Map 12](#) shows the locations of the known stormwater BMPs and delineates an approximate drainage area to them based on preliminary field observations.

The following key observations were made in the field related to stormwater management in STEER.

- There are many opportunities to retrofit existing or install new facilities on previously developed properties to improve manage stormwater. Most of the BMPs used are for detention purposes only and may not be the best option for water quality and recharge.
- There are a number of opportunities for large and small stormwater retrofit projects at the schools, public housing facilities, and community centers.
- The Grandview construction site appears to discharge unmanaged stormwater directly to the gut without treatment. In addition, there were open sewer manholes and a construction access road in the gut. Stabilization of some slopes using erosion control blankets and riprap channels was observed.

- Small sediment traps and other ESC practices were installed at Whispering Woods; No ESC practices were observed and extensive excavation/reshaping of the gut channel was occurring at a construction site behind the Curriculum Center (new parking lot).
- A number of good practices were observed at the Independent Boatyard (e.g., ground tarps, dust control, paint chip vacuum systems, and collection sump at slip).
- One of the more significant sources of TSS in the Tier II portion of the watershed is Heavy Materials (the Quarry). Preventing sediment from leaving the site is a challenge; the Quarry does have some settling basins, although muddy overflow from these ponds to Turpentine Run was observed. It is unclear if a stormwater pollution prevention plan is included with the TPDES industrial permit.
- Cisterns are a form of stormwater management. Trends away from the use of cisterns and rainwater reuse should be deterred.
- Residents from our two public meetings identified undersized culverts, particularly on Brookman Rd. where Turpentine Run crosses the road north of the Quarry, as key culprits for flooding issues in the watershed. Road repaving and maintenance was also blamed for flooding issues at the Independent Boatyard.

Table 14. Non-cistern Stormwater BMPs in the STEER Watershed

BMP Name	BMP Type	Drainage Area* (Acres)	Estimated % Impervious Cover**
Tutu Park Mall	Detention Basin (unknown)	13.5	100%
Home Depot	Detention Basin (dry)	0.2	0%
Cost-U-Less	Detention Basin (dry)	0.6	70%
Price Mart	Detention Basin (dry)	4.0	100%
Raphune Vista	Detention Basin (dry)	0	0
Ritz Carlton	Wetland	7.6	75%
Ritz (outside STEER)	Stormwater Wetland	0.7	100%
	Stormceptor	0.6	100%
	Stormceptor	0.8	100%
BCB School	Detention Basin (not completed)	21.7	60%
Quarry	Sediment Pond	11.6	100%
	Sediment Pond	0.8	100%

* Preliminary estimation of drainage area from field observations, rooftop runoff is assumed to be included

** In general, effective impervious cover draining to practices is difficult to estimate without a better understanding of cistern presence, sizing, and drawdown information. Note: Cisterns are not accounted for at this time, although rainwater harvesting is a stormwater management practice.

The 2010 Integrated Waters Report lists the following permits and enforcement activities at sites recognized as being in the STEER watersheds (no mapping available):

- TPDES discharge permits (2008-2009) for Raphune Vista, Little St. James, Texaco Tutu Station, Tutu Groundwater Remediation, Secret Harbor House III, and the Mangrove Lagoon WWTP;
- Construction permits (2008-2009) for Raphune Vista and Grandview; and
- Enforcement actions/Notice of Violations (NOVs) at Heavy Materials and Food Center.

DEP has oversight of all dischargers into the waters of the USVI through the *Virgin Islands Territorial Pollutant Discharge Elimination System (TPDES) Rules and Regulations* permit program. This program oversees stormwater management, monitors discharges, and enforces regulations controlling discharges from point sources. Mapping of TPDES permitted discharges in the STEER watershed area is not available.

Currently, there are no stormwater design or management standards required for new development or redevelopment projects in the USVI. The 2002 *Environmental Protection Handbook* provides some recommended guidance for site design and stormwater BMPs, but this manual is not mandatory and does not necessarily reflect updated rainfall frequencies, modern standards, or island-feasible approaches. Lack of stormwater requirements and clear design guidance is a critical gap in the USVI's capacity to protect natural resources from the impacts of development.

The DPW and the TPDES program have responsibility over street design and drainage. The DPW has established design standards as a matter of policy, but, there are currently no design requirements mandated by the regulations. The 2001 *Hydrologic Design of Highway Culverts* by US Department of Transportation and the Federal Highway Administration is a reference guide used by DPNR staff.

Temporary stormwater management for construction activities is managed by the Earth Change Plan and Permit Program under DPNR's Building Division. Before any land is cleared, graded, filled, or otherwise disturbed, an Earth Change Plan must be approved by DPNR. There are three different types of Earth Change Permits: I (Gut Clearing, Brush Clearing); II (Single Residential Lot); and III (Major Development). The specific application requirements are different for each of the categories; however, site plans are required for all applications that must include a sketch to identify areas to be cleared and the location of proposed erosion control practices. The 2002 *USVI Environmental Handbook* includes recommended practice standards and describes predictive models that can be used to estimate erosion and runoff.

5.3 Wellheads

The VI Water and Power Authority (WAPA) is the primary supplier of public drinking water in the USVI. Approximately 30% of supply comes from groundwater on St. Croix, but WAPA maintains no public supply wells on St. Thomas or St. John (DPNR, 2010). WAPA distributes over 2.2 MGD from desalinization on St. Thomas. Secondary suppliers (bottled water companies, schools, hotels, etc.) have over 150 permitted wells with reverse osmosis systems on St. Thomas (DPNR, 2010).

Based on DPNR wellhead GIS mapping (provided to HW in 2011), there are 110 total wells in the STEER watersheds (see Appendix [Map 12](#)). Many of these have groundwater monitoring data records maintained by USGS (see Figure 6).

In 1987, complaints from local residents in the Anna's Retreat area led to the subsequent discovery of chlorinated volatile organic compounds (benzene, toluene, ethylbenzene, and xylenes) in the groundwater above federal maximum contaminant levels (EPA, 2009). Sources were identified as the Curriculum Center, Texaco Service Station, Esso Service Station, and O'Henry Dry Cleaners, and contaminated soils were found at the Western Auto (in Four Winds Shopping Plaza) and Ramsey motors property (north of the Texaco). Remediation activities of soils and groundwater at the Tutu Wellfield Superfund Site include: groundwater extraction and cleaning; long-term monitoring; prohibition of new well installation; alternative provision of potable water to residents; in-situ soil vapor treatment and bioventing; and excavation and off-site disposal of additional soils. This could limit potential infiltration opportunities for stormwater retrofitting in the area (see Figure 14).

5.4 Solid Waste

The Bovoni landfill (~330 acres) is the major solid waste disposal site on St. Thomas; trash volume is presently measured at an average of 306 cy/day (per. com. VIWMA, 2013). It has been cited by EPA and Army Corps of Engineers for illegal wetland filling/dumping and for discharge of contaminated leachate into adjacent wetlands. A brief discussion of the Bovoni Landfill legal issues can be found in Section 1.3 of this report.

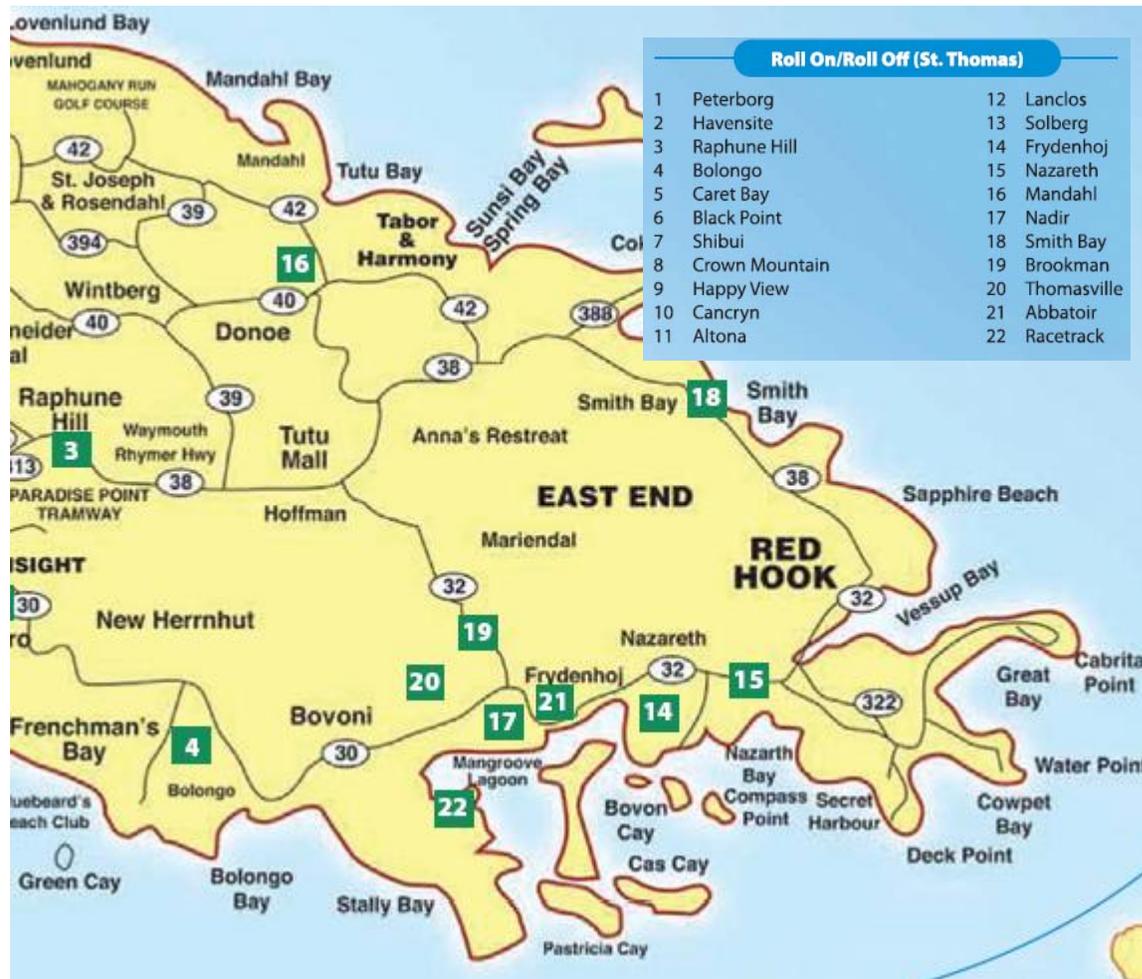
Trash in general was deemed by stakeholders as a significant problem. In addition to the overarching issue associated with the dump closure, concerns expressed by VIWMA and other stakeholders on solid waste management in STEER include:

- Failure of the Waste to Energy (WTE) plans and constraints on regulated waste that can be burned by WAPA. Much of this was backlash from Bovoni residents.
- Limited number of drop off locations that accept hazardous household waste and not enough notification indicating when drop off days are scheduled. At the entrance to the dump is a recycling drop-off center for used oil. Commercial mechanics and homeowners can bring up to five gallons/month. There is one drop off location for hazardous household waste at the Bovoni Landfill, that is open 9:00-3:00 M,W,F (per. com. VIWMA);
- Charging for trash dumping will result in more illegal dumping activities; and
- Not enough roll/on rolloff dumpsters. Figure 16 shows roll on/off dumpster station locations for the East End where residential garbage can be deposited (VIWMA, 2011). The dumpsters are uncovered and unconfined, leading to exposure to precipitation/wind and the subsequent drainage of dumpster-juice and trash into adjacent wetlands.

5.5 Underground Storage Tanks

No data was available for underground storage tanks. The 2010 Integrated Waters Report includes a lengthy list of used oil permit holders. No mapping was provided.

Figure 16. Solid waste dumpster sites on the East End of St. Thomas (VIWMA, 2011)



6.0 Water Quality and Other Monitoring

There are a number of sources of water quality information for the STEER marine area; however, limited information water quality information exists for guts and most of the USGS sampling stations shown previously in Figure 3. DPNR's Water Pollution Control Program (WPC) is responsible for implementing and enforcing Territorial water quality standards and pollution control laws under the federal Clean Water Act, although it appears that some of this responsibility will be shifting to UVI. The WPC administers two water quality monitoring programs—Ambient and Beach Monitoring—that evaluate a variety of water quality parameters. Data collected in these programs is used to protect public health and improve notification of beach closures; help determine effluent permit limits; develop various waterbody impairment listings; re-designate waterbody uses; and develop new water quality standards.

Water quality standards differ depending on the class of waters being evaluated. All waters in the STEER area are Class B waters. Standards for Class B waters are designated for the maintenance and propagation of desirable species of aquatic life and primary contact recreation, where virtually all native taxa are maintained with some changes in biomass and/or abundance, and where ecosystem functions are fully maintained within range of natural variability.

STEER includes significant coastal, marine, and fisheries resources that are well described in the STEER Management Plan (2011), USVI Comprehensive Wildlife Conservation Strategy, Wetlands of the US Virgin Islands (2010 edition), and in the Mangrove Lagoon/Benner Bay and the Vessup Bay Area of Particular Concern (APC) reports. Theoretically, these marine ecosystems are afforded some level of regulatory protection, since STEER is: (1) a collection of existing marine reserves (i.e., Inner Mangrove Lagoon, Cas Cay/Mangrove Lagoon, St. James, and the Compass Pt. Salt Pond); and (2) part of the two APC areas designated in 1979.

Appendix [Map 13](#) shows the marine habitats of STEER including sea grass beds, coral cover, and mangroves. We refer the reader to existing inventories by the DFW, STEER, the University of the Virgin Islands (UVI), TNC, Island Resources Foundation (IRF), and others for more detailed documentation on these benthic habitats, the species associated with them, as well as their economic and environmental significance.

NOAA recently completed a study quantifying and showing the distribution of recreational and commercial uses within the STEER. This information could influence Designated Uses and water quality standards.

Table 15 summarizes water quality standards; however, the Territorial water quality standards are currently being updated. It should be noted that color and turbidity standards do not apply to Benner Bay/Mangrove Lagoon (DPNR, 2010).

Table 15. 2010 Water Quality Standards

Water Quality Parameter	Standards	
	Class B	Class A
Dissolved Oxygen	≥ 5.5 mg/L	Existing natural conditions shall not be changed. The biological condition shall be similar or equivalent to reference condition for biological integrity. In no case shall Class B water quality standards be exceeded.
pH	Between 7.0 - 8.3	
Temperature	< 32°C; discharges not to be >1°C above natural	
Bacteria	≤ geometric (log) mean of 70 fecal coliforms/100 ml by MF or MPN count; ≤ 35 enterococci/ 100 ml, not to exceed a single sample max. 104/100 ml.	
Phosphorus	≤ 50 µg/l	
Chlorine	4-day average ≤ 7.5 µg/l; 1-hr. average ≤ 13 µg/l	
Suspended, colloidal, or settleable solids	None from waste water, which would cause deposition or be otherwise deleterious.	
Oil or floating substances	No residue attributable to wastewater. No visible film; no globules of grease	
Radioactivity	Gross beta: 1000 picocuries/l, in absence of Sr 90 and alpha emitters; Radium-226: 3 picocuries/l; Strontium-90: 10 picocuries/l	
Taste and odor producing substances	No interference with primary contact recreation, potability; or undesirable taste or odor for edible aquatic life	
Color and turbidity	Secchi disc depth ≥ 1 m; maximum nephelometric turbidity unit reading of 3 (Except Class B waters listed in Section 186-11(b)(1). For waters where the depth does not exceed 1 m, the bottom must be visible.	

6.1 Impairments/TMDLs

There are 12 ambient monitoring assessment units in the East End, and 2 active beach monitoring stations (Appendix [Map 14](#)). Of the assessment units, 6 are currently designated as impaired (DPNR, 2010). Table 16 summarizes impairment status, water quality parameters of concern, potential sources, and date for establishment of Total Maximum Daily Loads (TMDLs). TMDLs are a modeling/planning effort used to establish how much of a pollutant can be discharged to a waterbody on a daily basis while still meeting water quality standards. Dissolved oxygen and bacteria TMDLs have already been developed for Benner Bay and Mangrove Lagoon.

EPA approved TMDLs for dissolved oxygen (2003) and fecal coliform (2005) have been developed for Benner Bay and Mangrove Lagoon. To address dissolved oxygen, load analyses focused on biological oxygen demand (BOD), but nutrient inputs were not explicitly included in the analysis due to lack of data rather than lack of influence on the impairment condition. Discharges from three WWTPs, land use runoff, septic failures, and boat discharges were included in the analyses (HW, 2003; Tetra Tech, 2005). Summary tables showing existing loads and TMDL reduction requirements are provided in Tables 17-19.

Table 16. Summary of Impaired Assessment Units (DPNR, 2010)

Assessment Unit	Monitoring Station Name	Impairment	Source of Impairment	TMDL (Priority/Date)
VI-STT-25	Great Bay	Dissolved Oxygen, Turbidity,	Other marina/boating on vessel discharges, internal nutrient recycling	Low/2026
VI-STT-28	Cowpet Bay	Dissolved Oxygen	Package plants (small flows)	Low/2026
VI-STT-31	Nazareth Bay	Turbidity	Erosion and sedimentation	Low/2026
VI-STT-32	Jersey Bay, offshore	Fecal Coliform	Urban runoff	Low/2028
VI-STT-34	Benner Bay Lagoon Marina	Enterococci, Turbidity	Other marina/boating on vessel discharges. Discharges from Municipal Combined Storm Sewer Systems. Changes in tidal circulation/flushing highway. Road/bridge runoff (non-construction related). Sanitary Sewer Overflows (collection system failures)	Low/2028
VI-STT-35	Mangrove Lagoon	Temperature, Enterococci, Turbidity, Fecal Coliform	Changes in tidal circulation/flushing. Discharges from Municipal Combined Storm Sewer System. Highway/Road/Bridge runoff (non-construction related). Other marina/boating on-vessel discharges.	Low/2028
VI-STT-36*	Frenchman Bay Subwatershed East	Dissolved Oxygen, Turbidity,	Erosion and sedimentation	Med/2013

* Not within the STEER watershed.

Assessment Units within STEER not listed as impaired in 2010: VI-STT-29/ St. James Bay; VI-STT-27/ St. James Islands, offshore; VI-STT-41/ Frenchman Bay subwatershed, East; VI-STT-42/ SE St. Thomas HUC14, offshore; and VI-STT- 30b / NE St. Thomas HUC14, offshore South

Removal of the Nadir, Old Tutu, and New Tutu WWTPs in 2003 was a significant step in meeting load reduction requirements. The extent of progress in reducing the contributions of septics, marinas, and non-point sources (land use runoff) has not been quantified, nor has an effort to account for new loading from development activities since the TMDL was established. In addition, the TMDL did not consider that a portion of watershed was a combined storm and sewer system. The TMDL implementation strategies included the following measures for these other sources:

- Retrofitting of existing development with no stormwater management;
- Implementation of vessel waste control plans (Wernicke and Towle, 1983 and Hinkey, 1993), particularly vessel pump out stations;
- Prohibition of new OSDS in the watershed, particularly where soils are not suitable expanding the service area of ML WWTP and removal of failing OSDS; and
- Integrate proposed monitoring plans with future sampling efforts.

Table 17. Summary of Mangrove Lagoon Dissolved Oxygen TMDL Requirements (from HW, 2003)

Condition	Load (Land Use Runoff and Septic Failures) (kg/day)	Load from Ocean (implicit in WASP model) (kg/day)	Waste Load (WWTPs*) (kg/day)	Margin of Safety (kg/day)	Total (kg/day)
Existing Load (1998-2000)	120.33	37.25	417.20	0	574.78
TMDL Allocations	109.16	37.25	0	25.84**	172.25
Total Load Reduction Required***	11.17 (2.24 from septic failures) (8.93 from land use runoff)	0	417.20 (diversion of 3 WWTPs)	-	402.53

*The only permitted BOD loads discharging to Mangrove Lagoon are Nadir, New Tutu and Old Tutu WWTPs. Nadir WWTP is already off-line and New Tutu and Old Tutu WWTPs are planned to be taken off-line by summer 2003 (Personal Communication Tseng, 2003).

**The Margin of Safety is calculated as 15% of the TMDL. The reduction to account for the margin of safety is taken from the loads from land use runoff and septic failures, as opposed to the load from ocean water, because these are the loads that can reasonably and measurably be reduced through best management practices within the Mangrove Lagoon watershed.

***Total Load Reduction = (-1) x (TMDL Allocation – Existing Load)

Table 18. Summary of Benner Bay/Lagoon Marina Dissolved Oxygen TMDL Requirements (from HW, 2003)

Condition	Load (Land Use Runoff, Marina Discharge and Septic Failures) (kg/day)	Load from Mangrove Lagoon and Ocean (implicit in WASP model) (kg/day)	Waste Load (WWTPs*) (kg/day)	Margin of Safety (kg/day)	Total (kg/day)
Existing Load (1998-2000)	21.15	152.10 (114.85 from Mangrove Lagoon) (37.25 from open ocean)	0	0	173.25
TMDL Allocations	21.15	209.50 (172.25 from Mangrove Lagoon) (37.25 from open ocean)	0	223.95**	454.60
Total Load Reduction Required***	0	-	0	-	-

*The TMDL Load/ Waste Load Allocations and Margin of Safety is calculated assuming that the TMDL for Mangrove Lagoon is met.

** The margin of safety was calculated to prevent any increase in the current non-point source loads from the Benner Bay/Lagoon Marina's watershed (see Margin of Safety section).

***Total Load Reduction = (-1) x (TMDL allocation – Existing Load)

Table 19. Summary of ML/BB Fecal Coliform TMDL Load Reduction Requirements (from Tetra Tech, 2005)

Condition			Units	AU-STT-35 _a	AU-STT-34 _b
<i>Existing (1998-2002)</i>	Nonpoint sources	Land Surface Washoff Contributions	(#/day Fecal Coliform Bacteria) ¹	1.07E+12	5.39E+10
		Failing Septic Contributions	(#/day Fecal Coliform Bacteria) ²	6.98E+08	4.31E+07
		Marina Contributions	(#/day Fecal Coliform Bacteria) ³	0.00E+00	4.48E+08
	Permitted Point Source Contributions	N/A	(#/day Fecal Coliform Bacteria) ⁴	0.00E+00	-
Total existing loads			(#/day)	1.07E+12	5.44E+10
TMDL	LA	Land Surface Washoff Contributions	(#/day Fecal Coliform Bacteria) ⁵	8.03E+11	5.39E+10
		Failing Septic Contributions	(#/day Fecal Coliform Bacteria) ⁶	5.24E+08	4.31E+07
		Marina Contributions	(#/day Fecal Coliform Bacteria) ⁷	0.00E+00	0.00E+00
	WLA	N/A	(#/day Fecal Coliform Bacteria) ⁴	0.00E+00	-
	MOS	Margin of Safety	(#/day) ⁸	-	-
	TMDL	Total Maximum Daily Load	(#/day)	8.04E+11	5.40E+10

Note:

Mangrove Lagoon (STT-35) subwatershed.

Benner Bay (STT-34) subwatershed.

¹ Land Surface contributions calculated based on information shown in Table 4-1.

² Failing Septic contributions calculated based on information shown in Table 4-2.

³ Illicit marina contributions calculated based on information shown in Table 4-3.

⁴ Permitted point source contributions calculated based on information shown in Table 2-2.

⁵ Based on a 25% reduction in bacteria loading from land surface contributions.

⁶ Based on a 25% reduction in bacteria loading from failing septic systems.

⁷ In anticipation of future "no-discharge" legislation for MLBB.

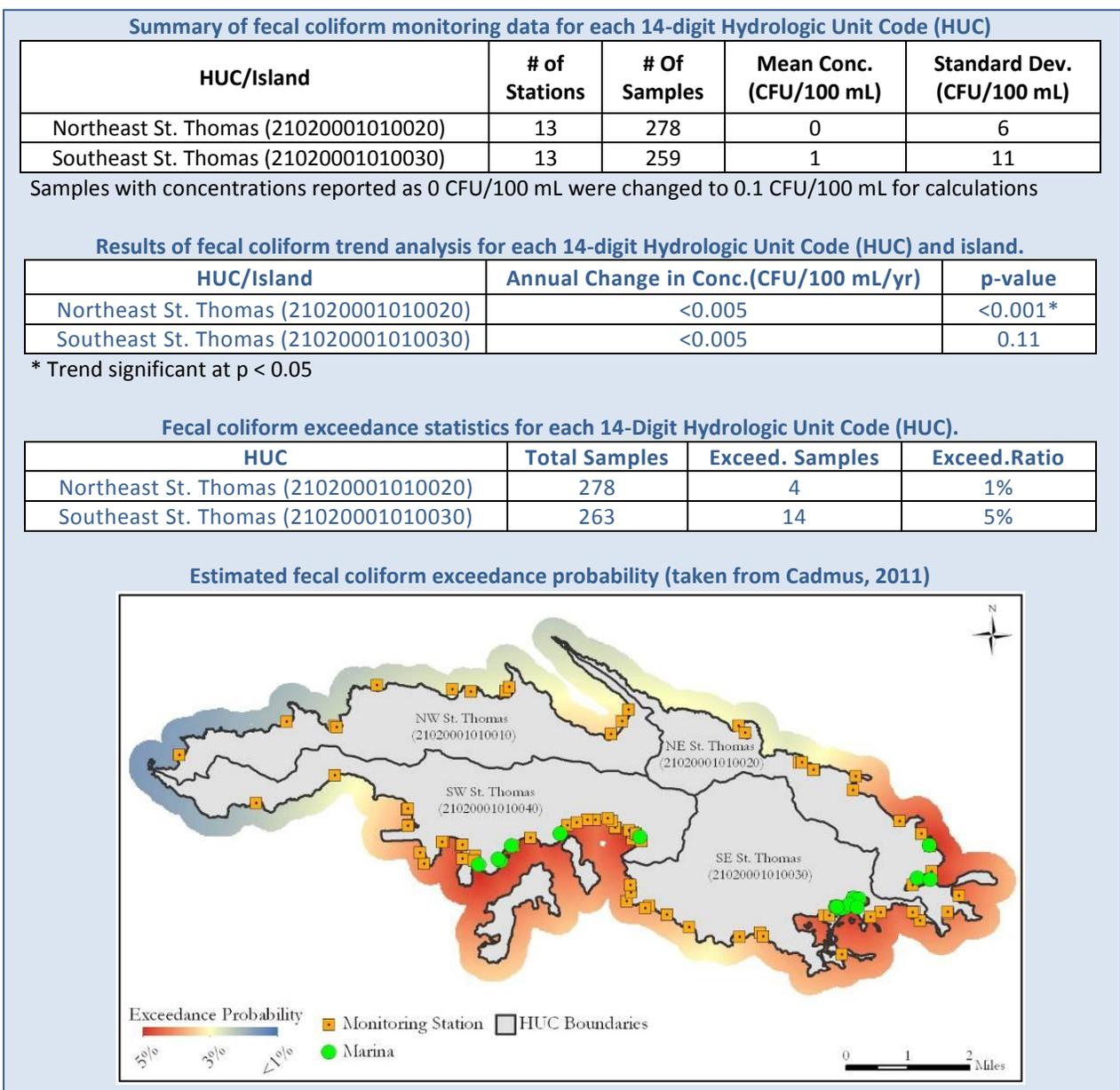
⁸ The Margin of Safety (MOS) was not applied as a loading rate in this TMDL. Instead, a higher fecal coliform

More recently, Cadmus (2011) analyzed coastal pathogen data collected at 157 sites across the USVI for the period of 2000-2009 as obtained from US EPA STORET database. Despite irregular collection frequencies and large gaps in the dataset, fecal coliform trends and

exceedance probability analyses using L-THIA were conducted at the HUC scale (Box 4). Results for the northeast and southeast HUC watersheds on St. Thomas broadly indicate that:

- Fecal coliform levels have increased on St. Thomas from 2000-2008. The model estimated a 17% and 98% increase in the southeast and northeast HUCs, respectively, though results are not statistically significant for the southeast HUC. Changes in land use and increased runoff volumes were “not likely sufficient” enough to cause increased fecal coliform loading.
- Marinas and non-point source are the most likely contributors. Distance to the nearest marinas was statistically the most highly significant comparative parameter; however, failing OSDS were not included in the modeling.

Box 4. *Fecal Coliform* estimates for two watersheds on the East End of St. Thomas (taken from Cadmus, 2011)



6.2 Characterization of Land-Based Sources of Pollution and Bioeffects in STEER

In 2011/2012, chemical contaminant and biological samples were collected at randomly-selected locations throughout the STEER. This work was part of a two year project involving NOAA, DPNR, the University of the Virgin Islands, and The Nature Conservancy to develop the first integrated ecological assessment for the STEER. Specifically, the sampling effort included:

- Collection of sediments for chemical contaminant analysis;
- Analysis of sediment samples for toxicity;
- A biological survey of benthic infaunal (organisms living within the sediments) analysis, including chemical contaminants in biota;
- Passive water samplers; and
- Monthly nutrient, total suspended solids (TSS) and sediment trap monitoring.

Figures 17-19 show the location of sediment sampling sites, locations for passive water quality collection, and sites for ongoing nutrient and sedimentation monitoring, respectively.

Figure 17. Strata and Sediment Sampling Sites in STEER (Pait et al., 2013a)

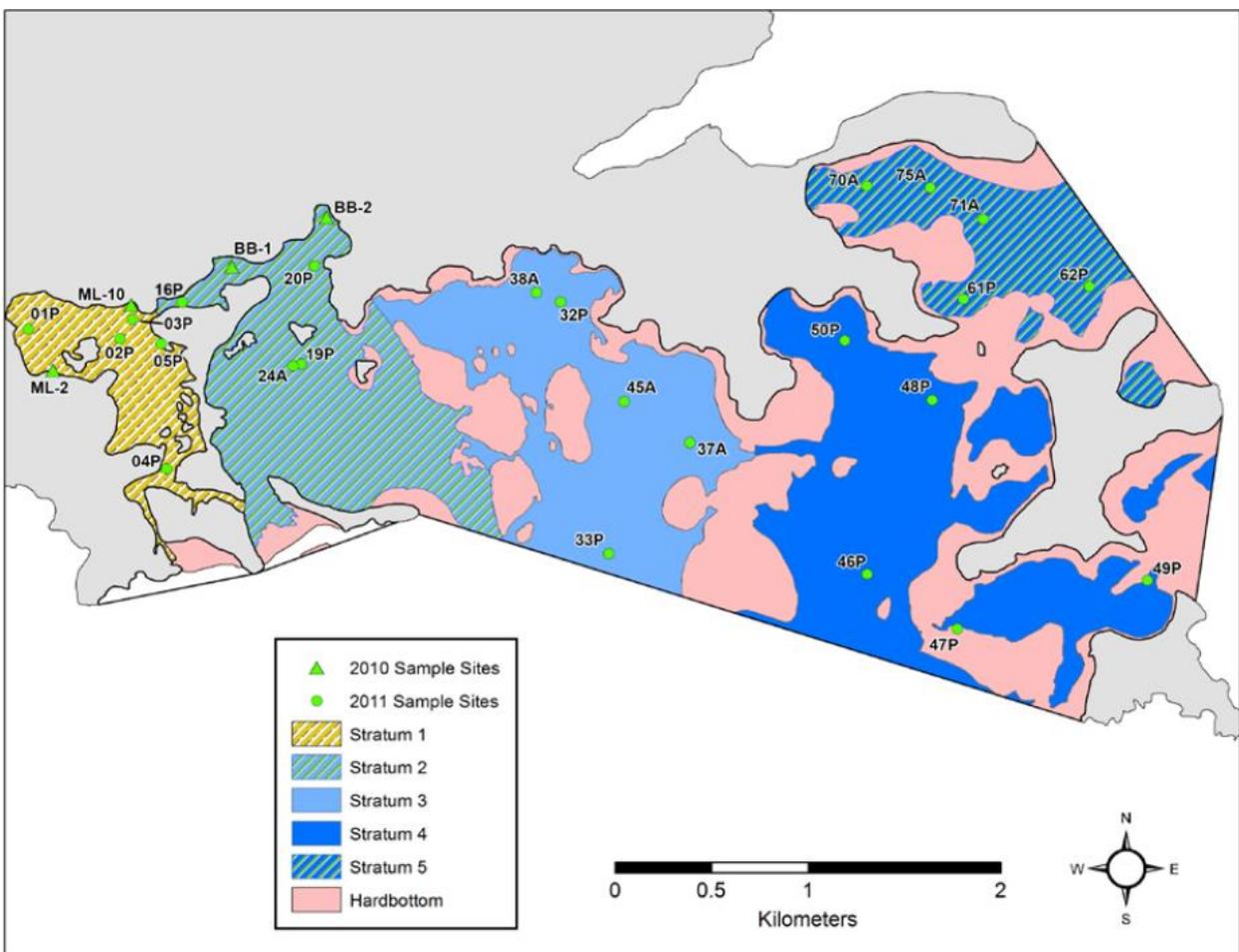


Figure 18. Locations of Passive Water Samplers in STEER (Pait et al., 2013b)

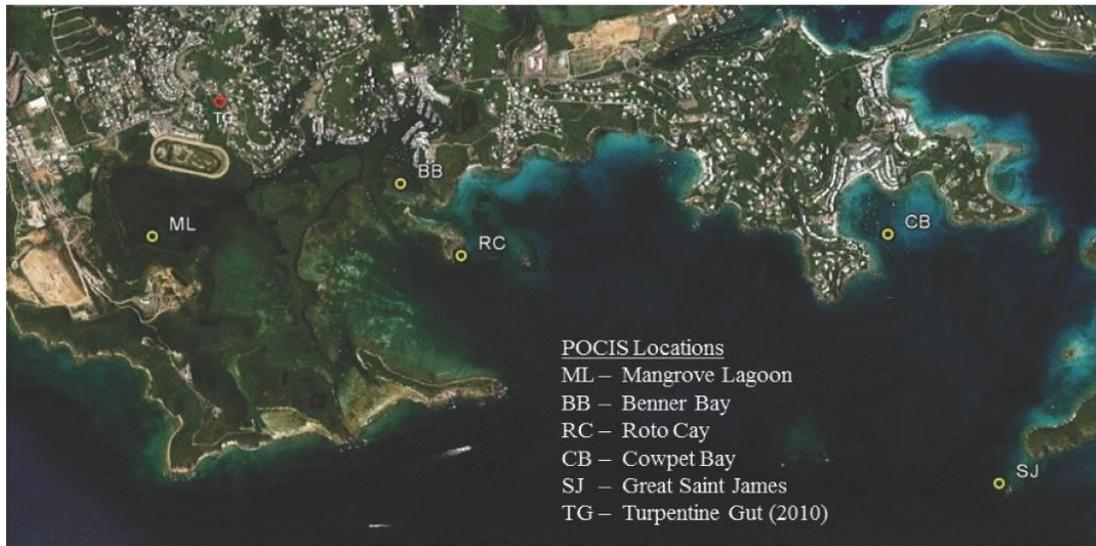
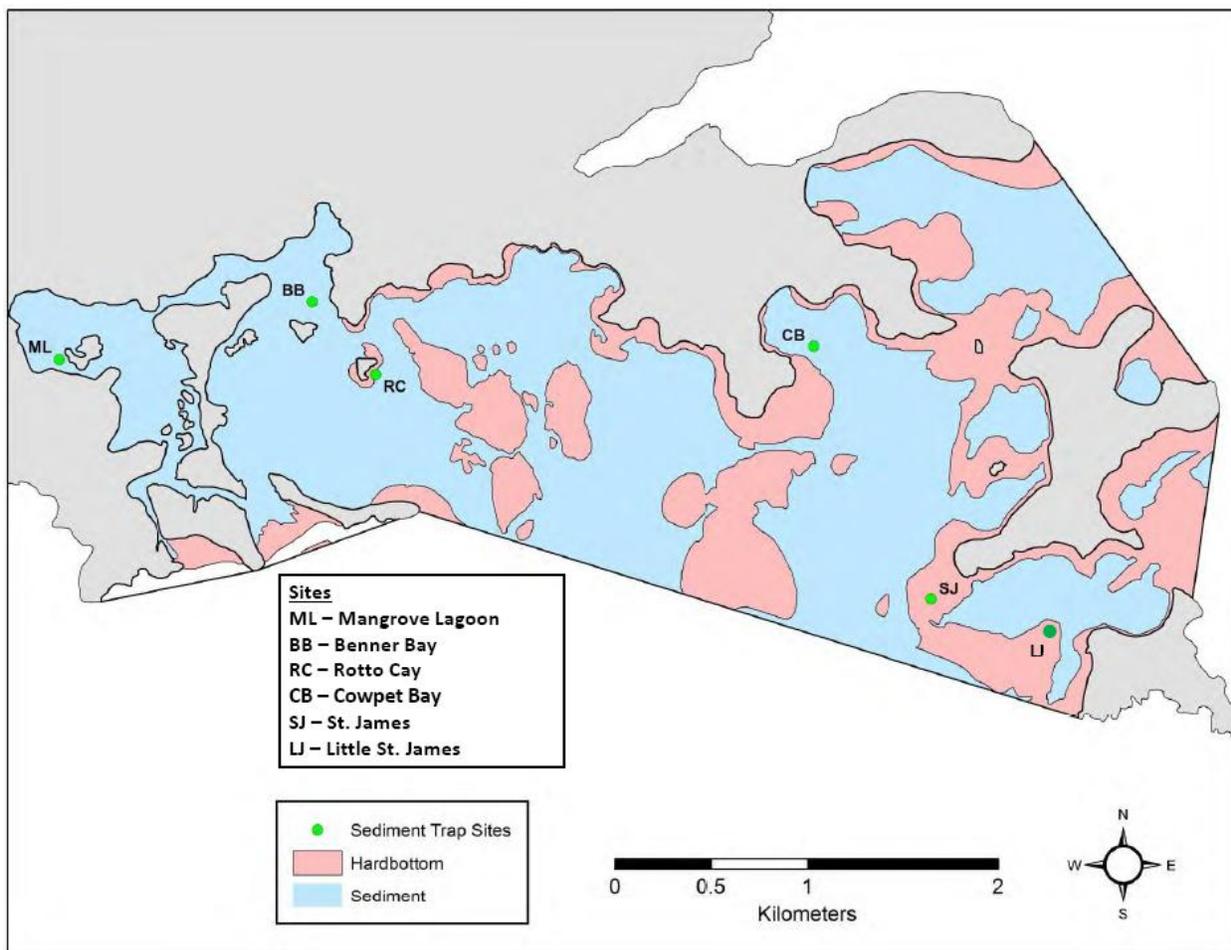


Figure 19. Monthly Monitoring Sites in STEER (Frank Galdo presentation, Dec. 2012)



Findings from the chemical contaminants and passive water samplers are described in detail in two technical publications (Pait et al., 2013a and 2013b). The monthly sedimentation monitoring remains on going (data not yet published). However, a summary of basic findings includes the following:

- Contaminants and biological monitoring:
 - The western portion of the STEER had higher levels of chemical contaminants in sediments, higher toxicity, and reduced diversity of benthic infaunal communities.
 - In particular, northern Benner Bay and Mangrove Lagoon had higher levels of chemical contaminants and toxicity in the sediments;
 - Concentrations of zinc, copper, lead, mercury, PCBs and DDT were above a lower NOAA sediment quality guideline in at least one location in either northern Benner Bay or Mangrove Lagoon (Figure 20);
 - Very high copper and tributyltin (TBT) levels in sediments from northern Benner Bay suggest marina or boating-related activities (see Figure 21);
 - Areas to the east of Mangrove Lagoon and Benner Bay tended to have lower levels of chemical sediments contaminants, below NOAA sediment quality guidelines;
 - *Clostridium perfringens* (sewage marker) samples were also high (Figure 22); and
 - Benthic organisms were collected with lower diversity and species richness at sites in Mangrove Lagoon/Benner Bay (Figure 23). The contamination of the area appears to negatively affect the health of some species.
- Passive water samplers:
 - A number of wastewater contaminants typical to urban watersheds were detected (chlorination byproducts, personal care products, plasticizers, wood preservatives etc), the majority at low concentrations;
 - Pesticides used in agricultural practices were not present;
 - The highest concentrations were found in Turpentine Run gut; and
 - DEHP was found at concentrations > water quality criteria in Turpentine Run.
- Monthly sedimentation and nutrient studies are ongoing, but preliminary results indicate terrestrial-derived sedimentation rates are highest around Rotto Cay, Benner Bay, and Mangrove Lagoon (Figure 24).

Figure 20 shows PCBs, DDT, TBT, copper, zinc, and lead. Each of these chemical constituents was found in concentrations that exceed the lower Effects Range (ERL) threshold. Northern Benner Bay and Mangrove Lagoon have the highest concentrations throughout STEER, which is not surprising given: (1) the marina industry in Benner Bay, which is tied to the use of TBT and copper-based bottom paints; and (2) Turpentine Run and Nadir guts discharge here, draining a highly urban watershed. Pait et al., (2013a) explains that the presence of TBT in Benner Bay sediments (at the third highest concentration detected in sediments by NOAA's NS&T Program), may be indicative of more recent accumulation, as butyltins degrade over time. Figure 21 compares the concentration of butyltin species (TBT, dibutyltin and monobutyltin) found in Vieques, Puerto Rico versus what was found at site BB-1 in Benner Bay.

Figure 20. Chemical Concentrations in STEER Sediments (Pait et al., 2013a)

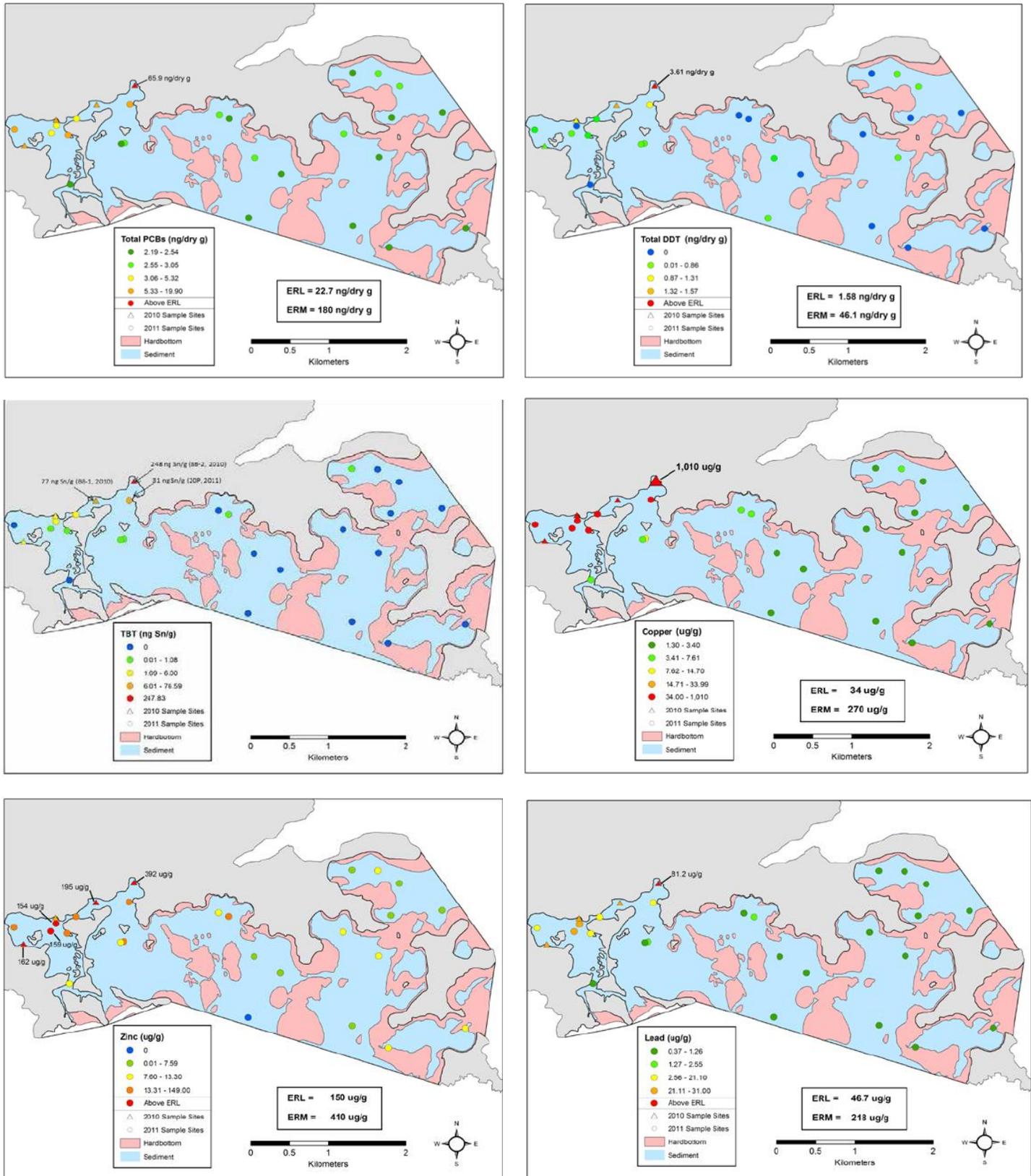


Figure 21. Comparison of Butyltins Found in Puerto Rico and Benner Bay

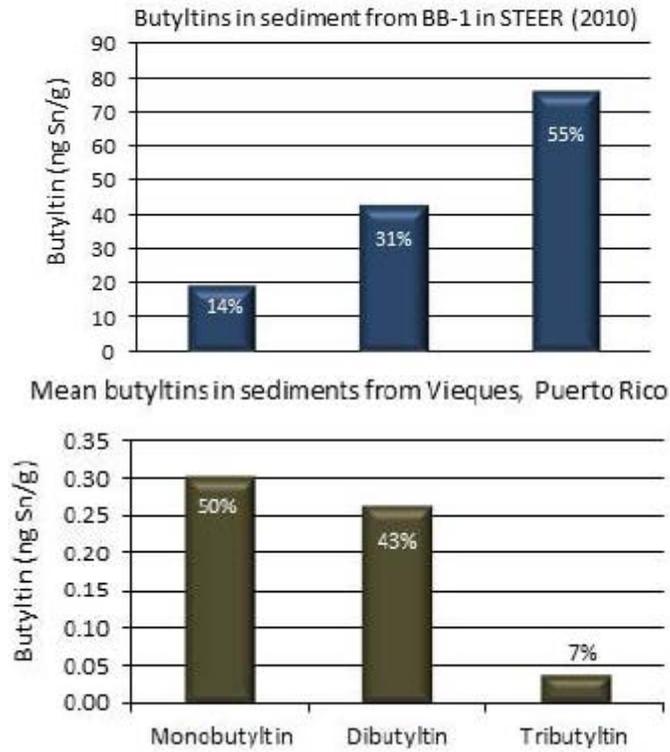


Figure 22. Elevated *Clostridium perfringens* at mouth of Turpentine Gut.

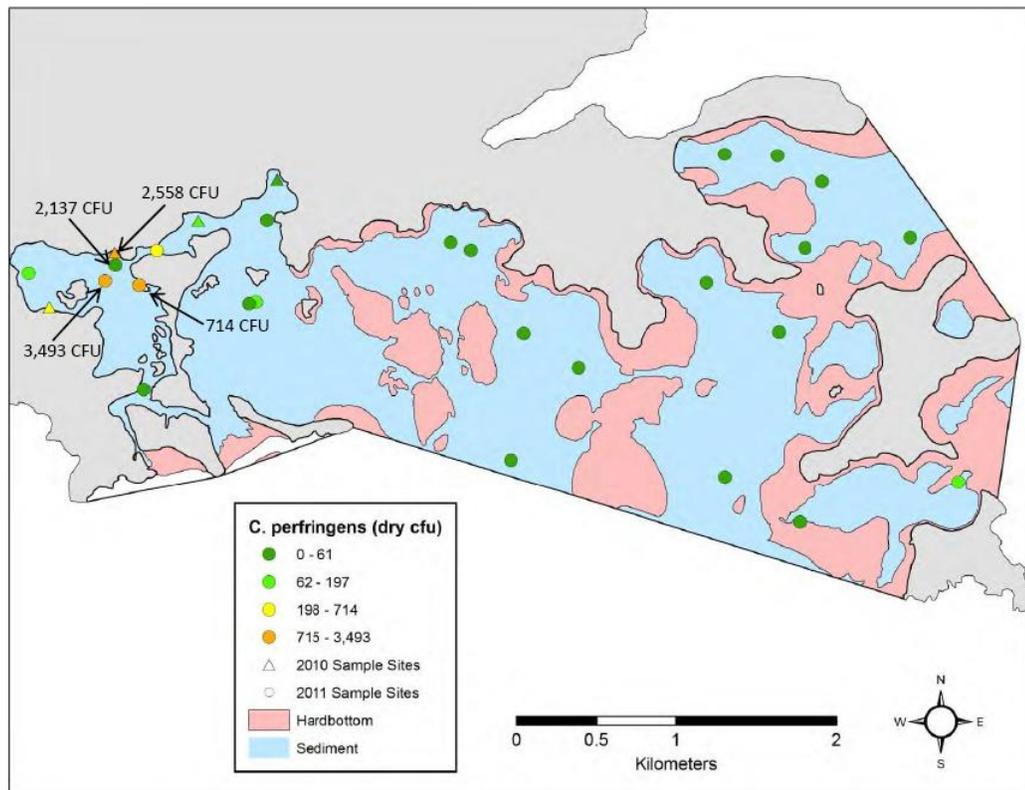


Figure 23. Diversity of Benthic Organisms collected in STEER (from Pait et al., 2013a)

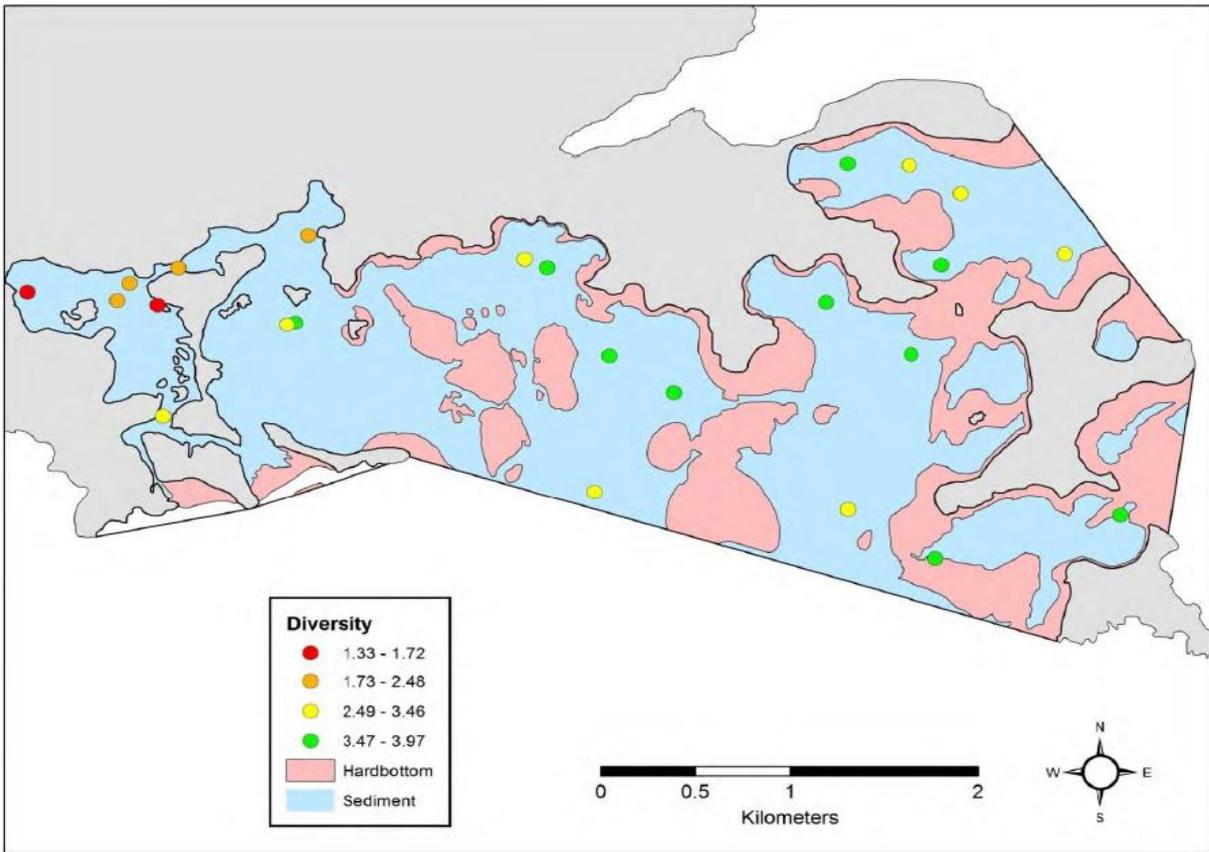
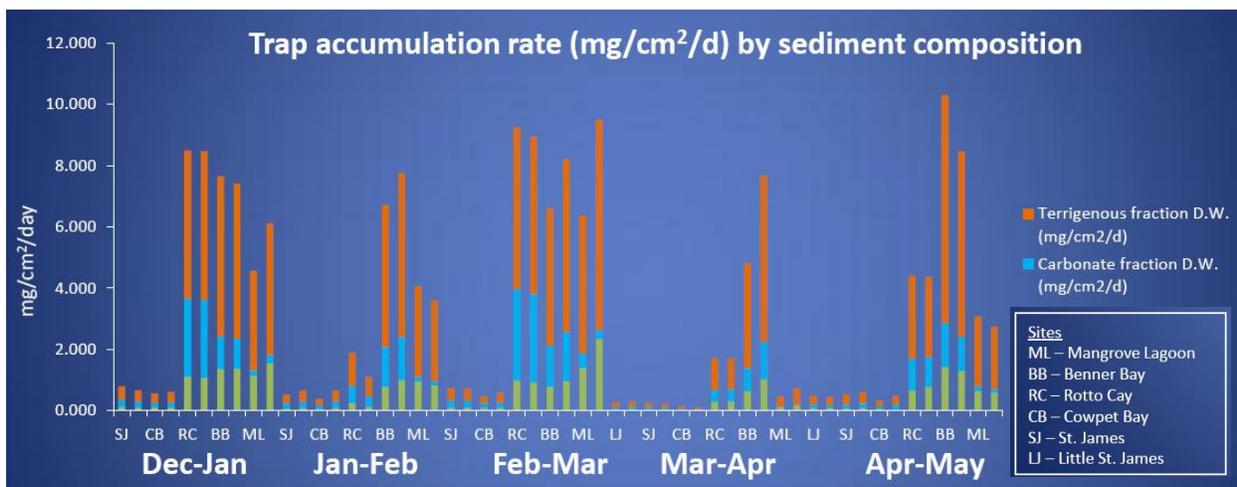


Figure 24. Preliminary Sedimentation Rate Results (from F. Galdo presentation, Dec 2012)



6.3 Additional Monitoring Efforts

In addition, STEER (2011) reports that results from long-term coral monitoring at a site near Cocus Rock has shown that this site is in the top third of 17 sites across the USVI for silt depositional rates and that Mangrove Lagoon has the highest water concentrations in the US Caribbean of Irggarol, an anti-fouling chemical (Carbery et al., 2006).

A University of the Virgin Islands researcher has begun soliciting funding to conduct groundwater monitoring at the Bovoni Landfill. Not only would this effort assist VIWMA in meeting conditions of the Consent Decree, it would answer questions on the extent of contaminated seepage and groundwater transport from the landfill out into Mangrove Lagoon.

Given the diversity of monitoring efforts in the STEER, either from a regulatory or an academic perspective, it makes sense to develop an overarching monitoring plan that coordinates parameters monitored, location of stations, and analytical resources.

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St. Thomas East End Reserves Watershed Existing Conditions Report

Appendix A

STEER Watershed Maps

Map 1: Subwatersheds

Map 2: Hydrologic Soil Group Classifications

Map 3: Wetlands

Map 4: Land Use

Map 4A: Residential and Resort Areas

Map 4B: Marinas and Boat Yards

Map 5: Zoning

Map 6: Impervious Cover

Map 7: Terrestrial Vegetation

Map 8: Regulatory Tier I & II

Map 9: Erosion Potential

Map 10: Septic Failure

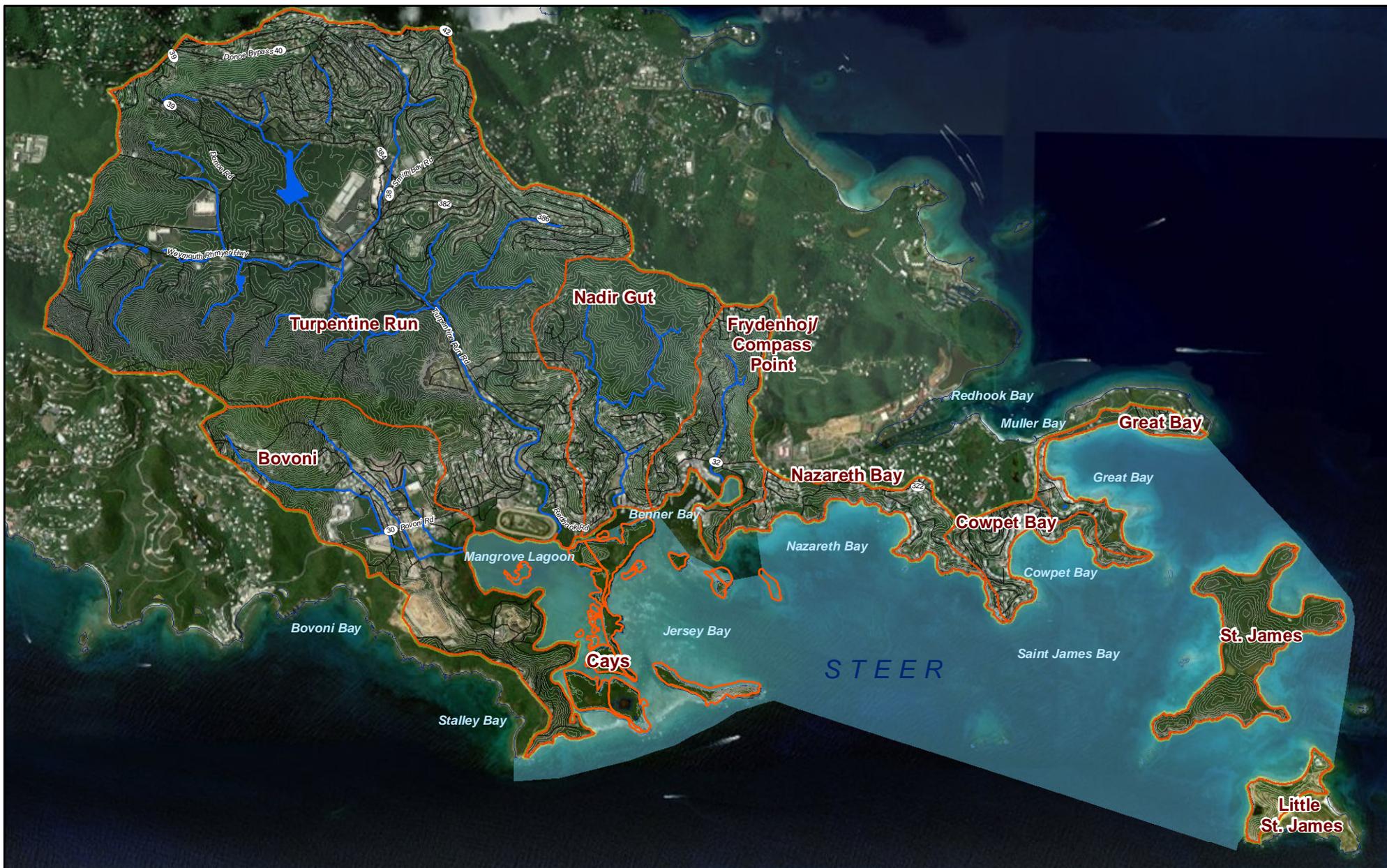
Map 11: Wastewater System

Map 12: Stormwater BMPs and Wellheads

Map 13: Marine Habitat

Map 14: Impaired Waters and DPNR Monitoring Sites

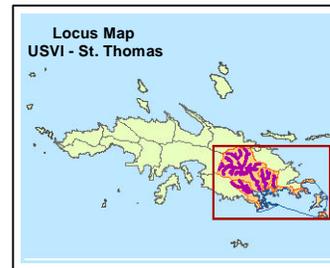




Legend

-  Watershed Boundary (HW, 2011)
-  Guts (HW revised from UVI 2007 wetlands inventory)
-  STEER Boundary
-  Contours - 20 ft (Corps of Engineers, 2008)
-  Freshwater Ponds (UVI-ECC, 2000)
-  Roads

All data provided by DPNR, 2011 unless otherwise noted



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**Map 1: Subwatersheds
STEER Watershed**

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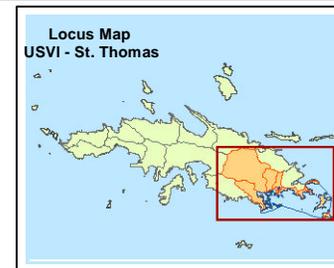
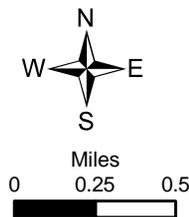
Legend

- Watershed Boundary (HW, 2011)
- STEER Boundary
- Parcels
- Freshwater Ponds (UVI-ECC, 2000)
- Guts (HW revised from UVI 2007 wetlands inventory)

HSG Soils (NRCS, 2008)

- No Data
- A
- B
- C
- D

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**Map 2. Hydrologic Soil Group (HSG)
STEER Watersheds**

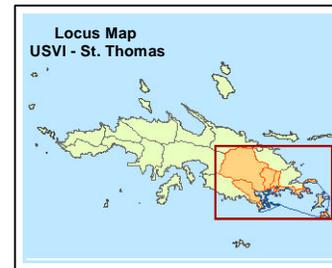
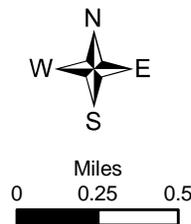
Date: 3/31/2013 - eym



Legend

- | | | |
|---|--------------------------|-------------------|
| Watershed Boundary (HW, 2011) | Wetlands (UVI-ECC, 2000) | Mangrove woodland |
| STEER Boundary | Fresh pond | Mixed swamp |
| 100-year Flood Zone | Fringing mangrove | Salt flat |
| Guts HW revised from UVI 2007 wetlands inventory) | Mangrove forest | Salt pond |
| Parcels | Mangrove shrubland | |

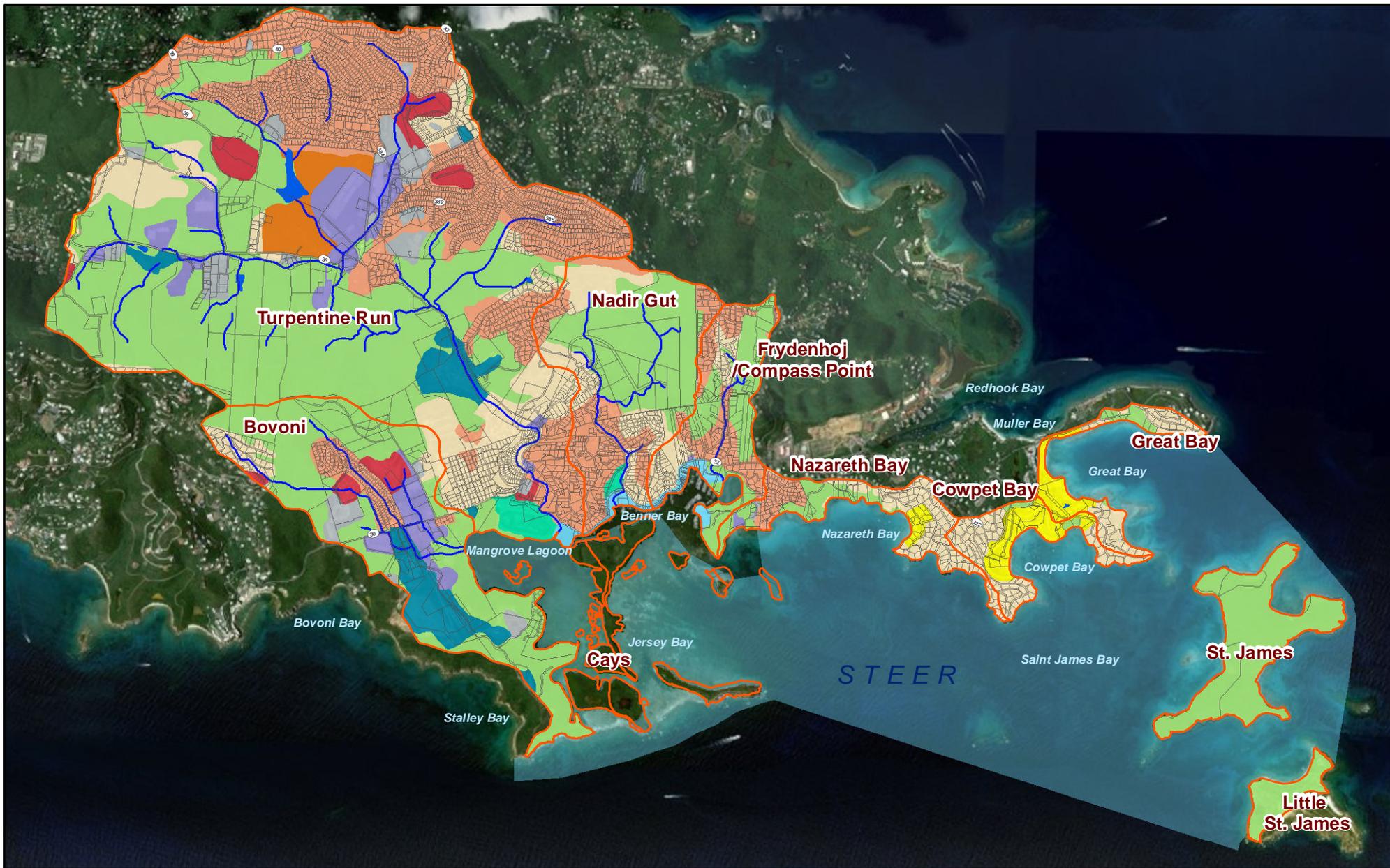
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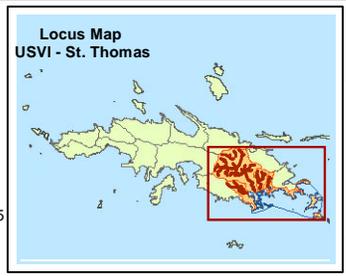
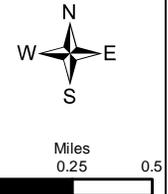
**Map 3: Wetlands
STEER Watershed**

Date: 3/31/2013 - eym



Legend

- | | | |
|---|---|------------------------------|
| Watershed Boundary (HW, 2011) | Land Use (HW revised from IRF, 1989) | Residential (High Density) |
| Parcels | Agriculture | Residential (Medium Density) |
| Freshwater Ponds (UVI-ECC, 2000) | Hotel/Resort | Residential (Low Density) |
| Gulches (HW revised from UVI 2007 wetlands inventory) | Industrial Manufacturing | Retail Commercial |
| | Parks/Recreation/Open Space | Undeveloped |
| | Public Facilities | Waterfront/Marine |



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**Map 4: Land Use
STEER Watersheds**

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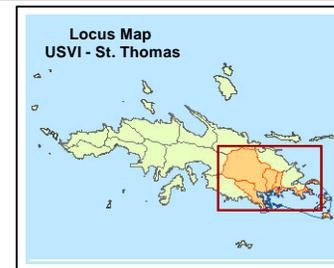
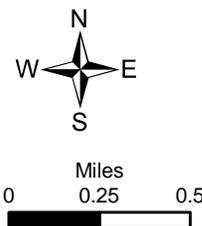
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Legend

-  Watershed Boundary (HW, 2011)
-  STEER Boundary
-  Freshwater Ponds (UVI-ECC, 2000)
-  Guts (HW revised from UVI 2007 wetlands inventory)
-  Neighborhoods (HW 2012)
-  Resorts/Condos (HW 2012)

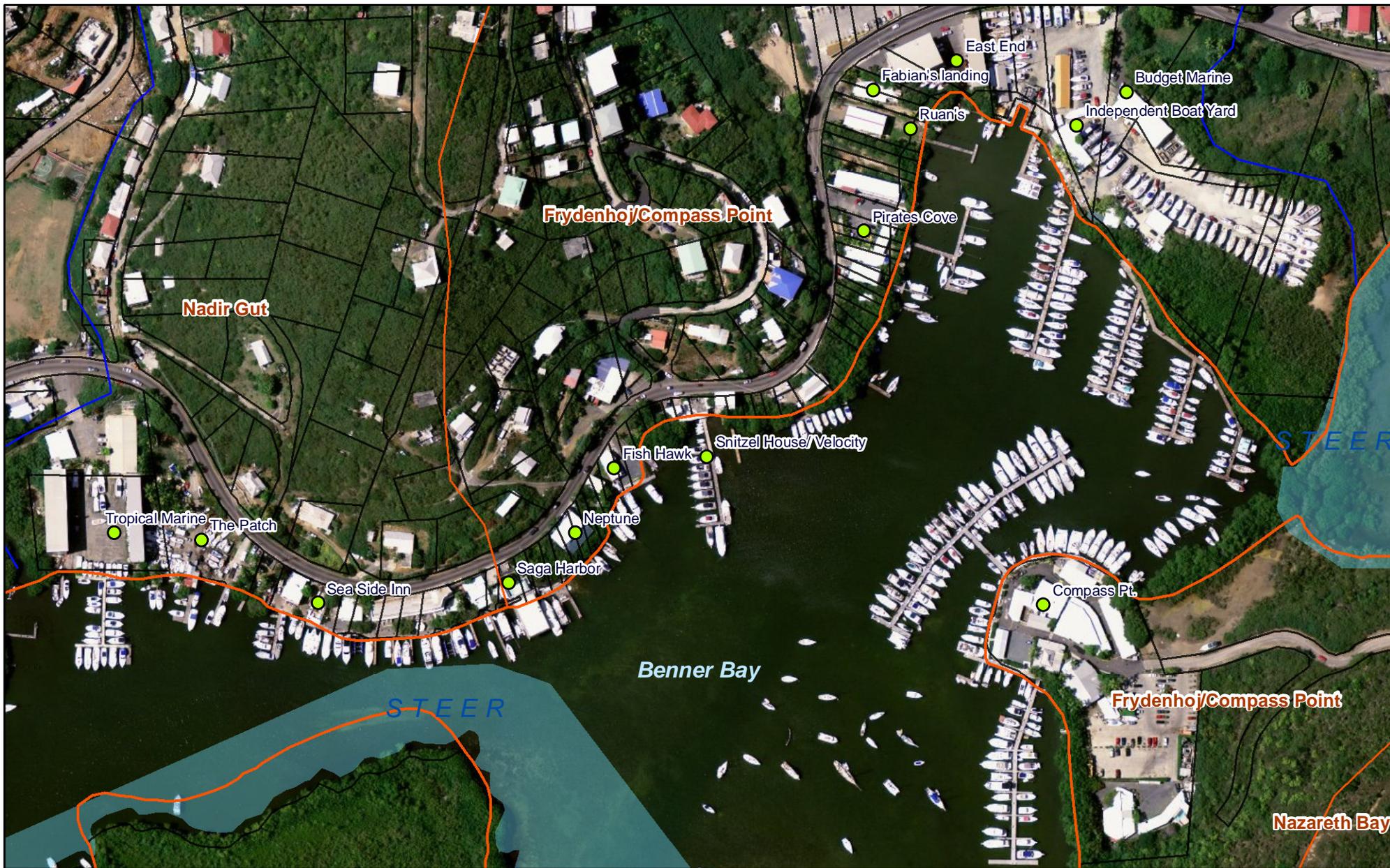
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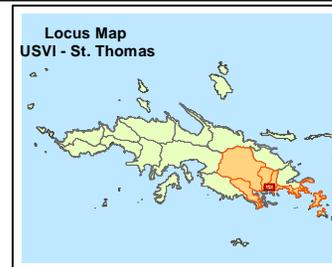
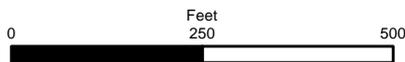
**Map 4A: Residential & Resort Areas
STEER Watershed**

Date: 3/31/2013 - eym



Legend

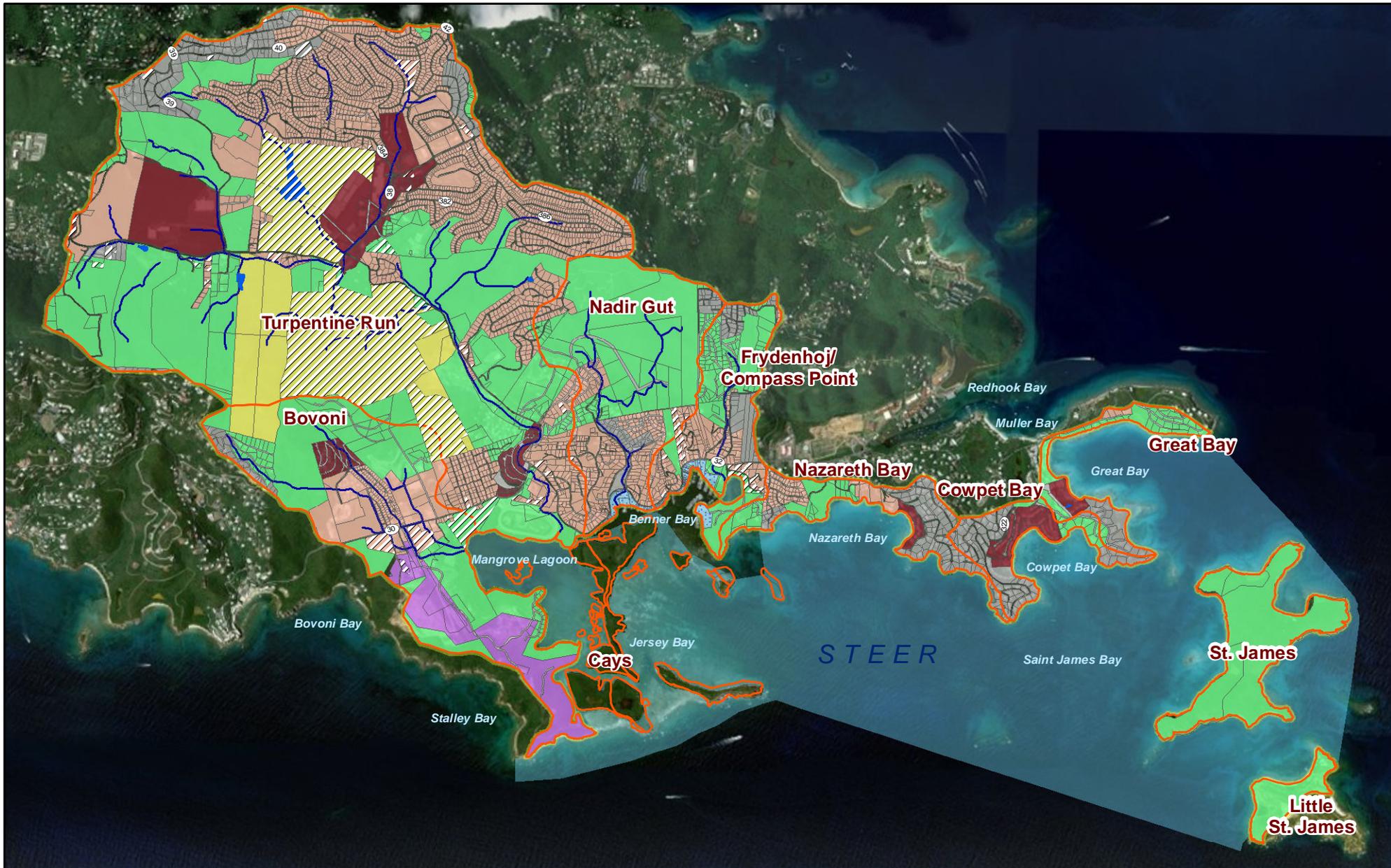
-  Watershed Boundary (HW, 2011)
-  STEER Subwatersheds (HW 2011)
-  Guts (HW revised from UVI 2007)
-  Freshwater Ponds (UVI-ECC, 2000)
-  Parcels (DPR 2011)
-  Marinas and Boatyards (HW 2012)



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**Map 4B: Marinas & Boatyards
STEER Watershed**

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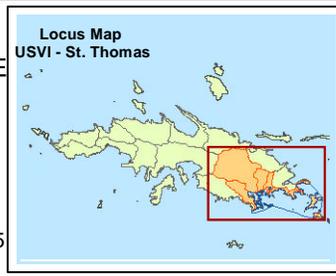
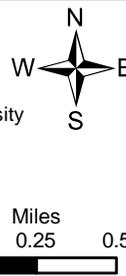


Legend

- Watershed Boundary (HW, 2011)
- Parcels
- STEER Boundary
- Freshwater Ponds (UVI-ECC, 2000)
- Guts (HW revised from UVI 2007 wetlands inventory)

Zoning

- 3W Waterfront - Moderate Density
- 4W Waterfront - High Density
- District A - Agriculture
- District 1 - Conservation
- Re-zoning
- District 2 - Low Density
- District 3 - Moderate Density
- District 4 - High Density
- District 6 - Industrial
- Road



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**Map 5: Zoning
STEER Watershed**

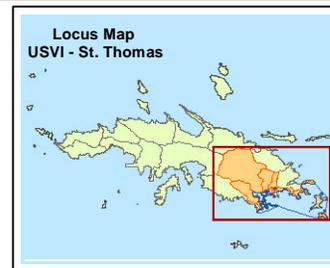
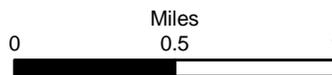
Date: 3/31/2013 - eym

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Legend

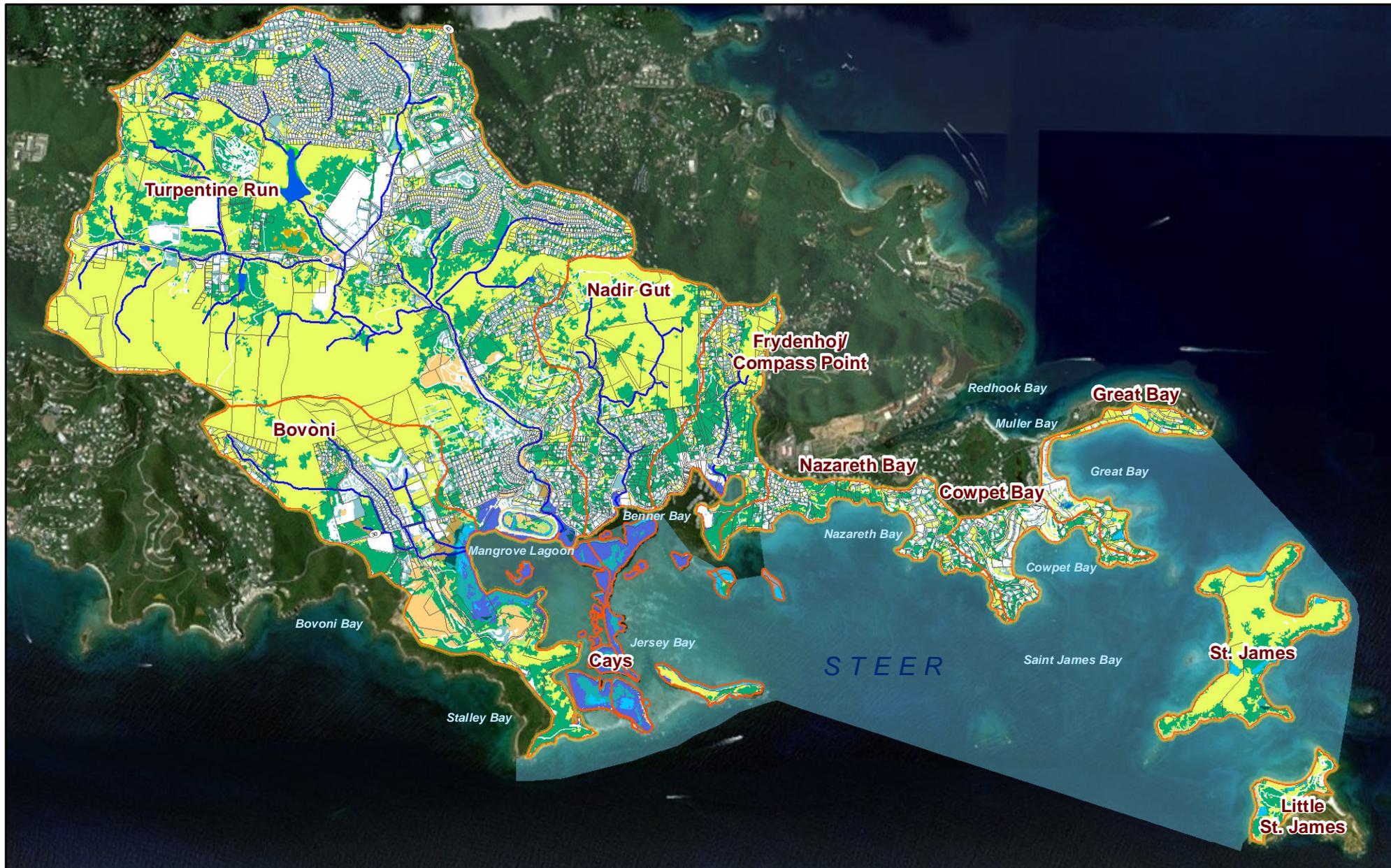
-  Watershed Boundary (HW, 2011)
-  Impervious Cover (Digital Coastal Service, 2007)
-  Freshwater Ponds (UVI-ECC, 2000)
-  Guts (HW revised from UVI 2007 wetlands inventory)



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**Map 6: Impervious Cover
STEER Watershed**

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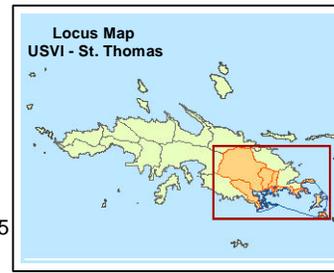


Legend

-  Watershed Boundary (HW, 2011)
-  STEER Boundary
-  Parcels
-  Freshwater Ponds (UVI-ECC, 2000)
-  Guts (HW revised from UVI 2007 wetlands inventory)

LandCover (Digital Coast Data, 2007)

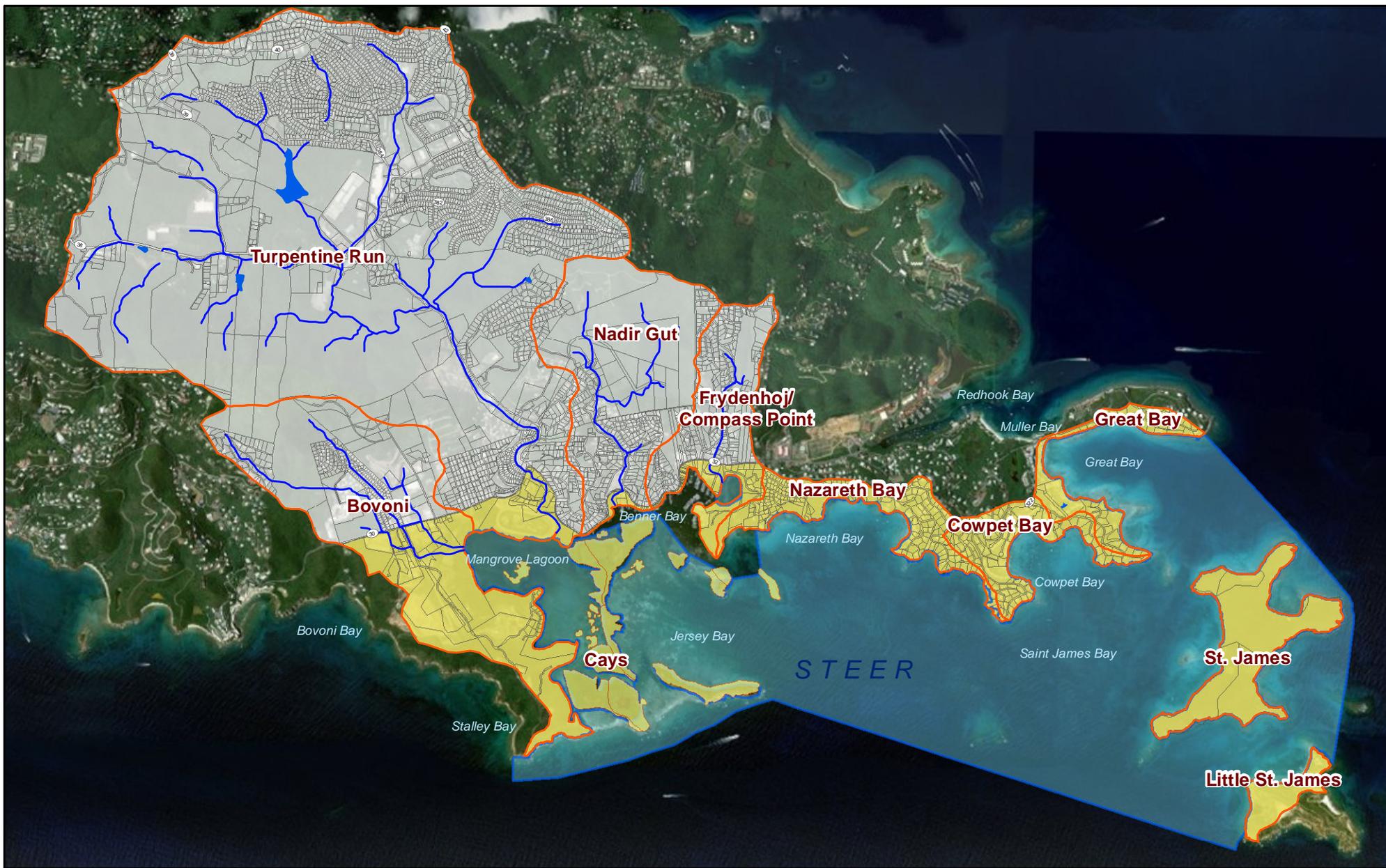
- | | |
|--|--|
|  Estuarine Emergent Wetland |  Grassland |
|  Estuarine Forested Wetland |  Bare Land |
|  Estuarine Scrub Shrub Wetland |  Pasture/Hay |
|  Palustrine Emergent Wetland |  Unconsolidated Shore |
|  Palustrine Forested Wetland |  Open Space Developed |
|  Palustrine Scrub Shrub Wetland |  Impervious Surface |
|  Deciduous Forest |  Open Water |
|  Scrub Shrub |  Unclassified |



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**Map 7: Terrestrial Vegetation
STEER Watershed**

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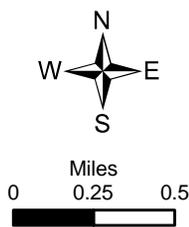


Legend

-  Watershed Boundary (HW, 2011)
-  STEER Boundary
-  Parcels
-  Freshwater Ponds (UVI-ECC, 2000)
-  Guts (HW revised from UVI 2007 wetlands inventory)

-  TIER I (DPNR-CZM, 2007)
-  TIER II (DPNR-CZM, 2007)

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Map 8: Regulatory Tier I & II STEER Watershed

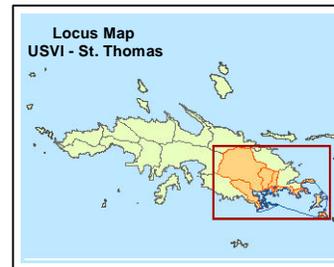
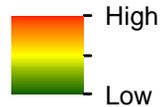
Date: 3/31/2013 - eym



Legend

-  STEER Subwatersheds
-  Guts (HW revised 2012)
-  Parcels

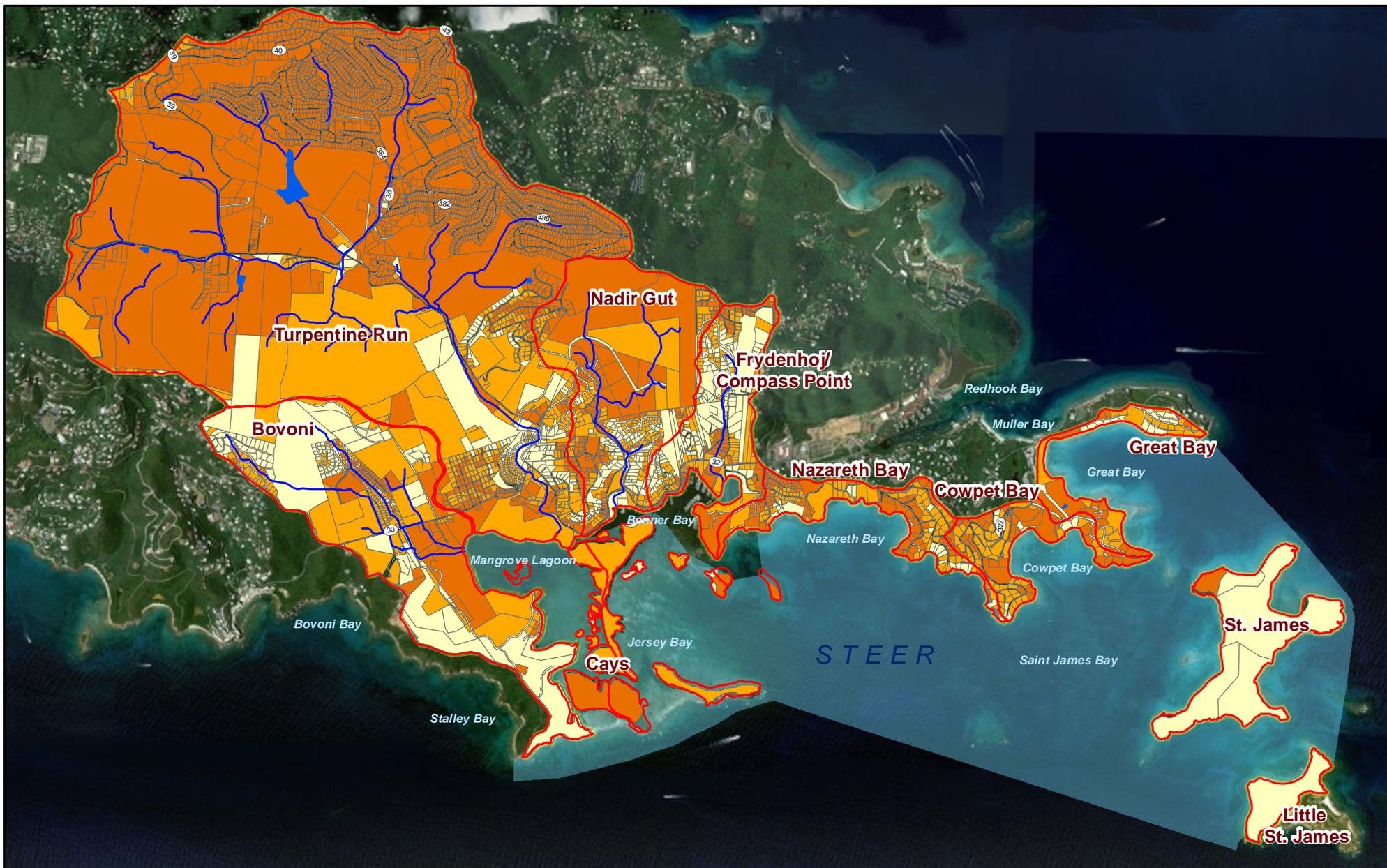
Relative Erosion Potential (WR/NOAA 2005)



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Map 9: Relative Erosion Potential STEER Watershed

Date: 3/31/2013 - eym

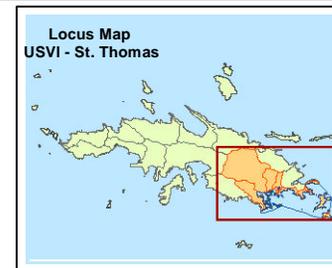
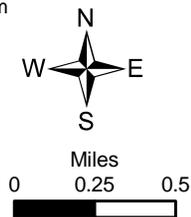


Legend

-  Watershed Boundary (HW, 2011)
-  STEER Boundary
-  Parcels
-  Freshwater Ponds (UVI-ECC, 2000)
-  Guts (HW revised from UVI 2007 wetlands inventory)

Conventional On-Site Septic System Failure Potential (Cadmus, 2011)

-  High (>35%)
-  Medium (5-35%)
-  Low (<5%)



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Map 10: Septic System Failure Potential STEER Watershed

Date: 3/31/2013 - ack

All data provided by DPNR, 2011 unless otherwise noted

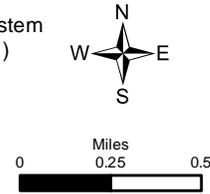


Legend

-  Watershed Boundary (HW, 2011)
-  Package System Area (approx.)
-  Sewer Service Area (approx.)
-  Priority Service Extension
-  Sewer trunk lines (approx.)
-  Future Sewer Lines (approx.)

-  Small Package Plants
-  WWTP
-  Pump Stations

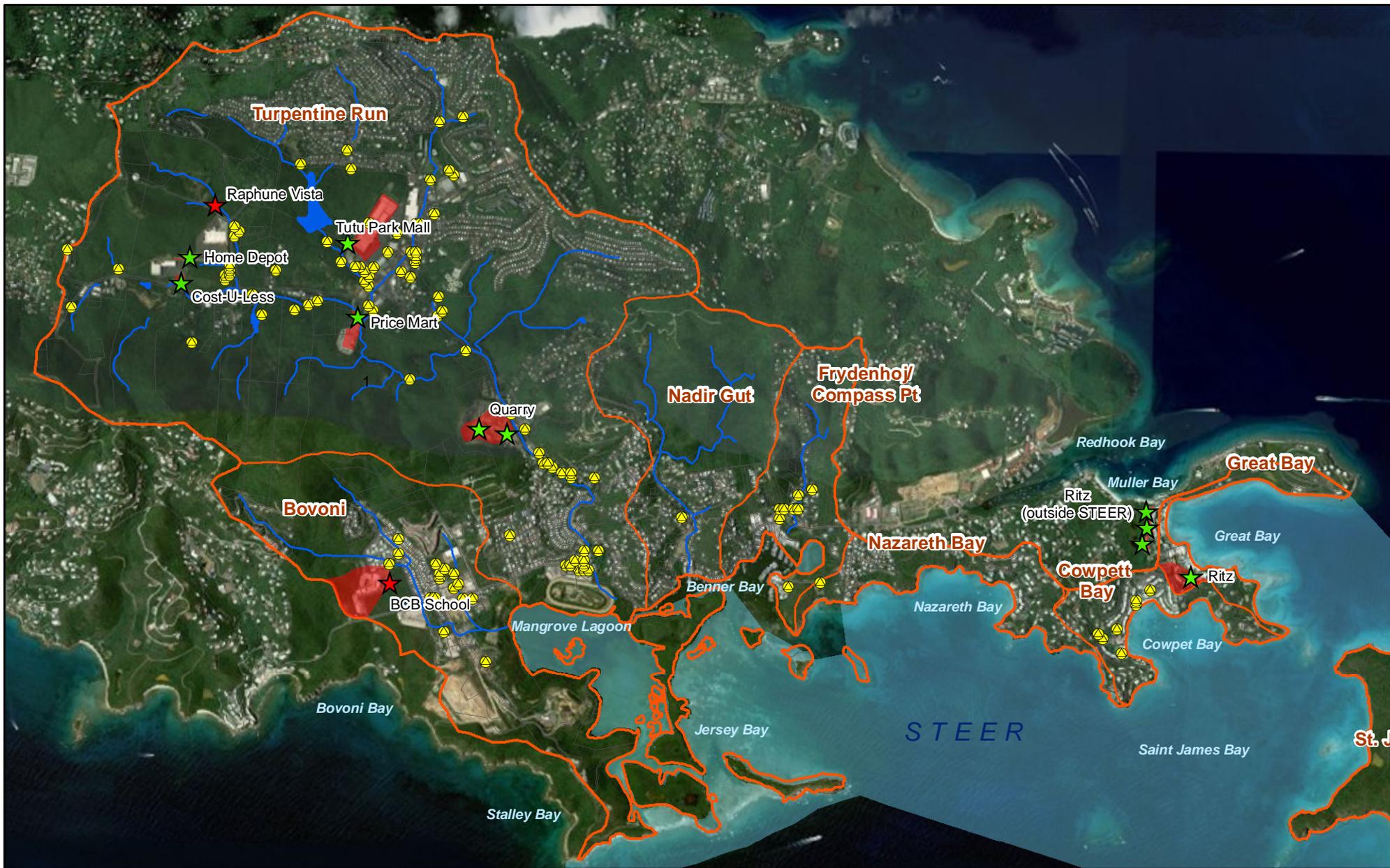
- Conventional On-Site Septic System Failure Potential (Cadmus, 2011)
-  High
 -  Medium
 -  Low



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Map 11: Wastewater System STEER Watershed

Date: 3/31/2013 - eym



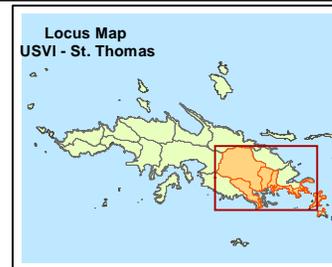
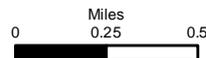
Legend

- Watershed Boundary (HW, 2011)
- STEER Subwatersheds
- Guts (interpreted from UVI 2007)
- Freshwater Ponds (UVI-ECC, 2000)
- Wellheads

Existing BMPs

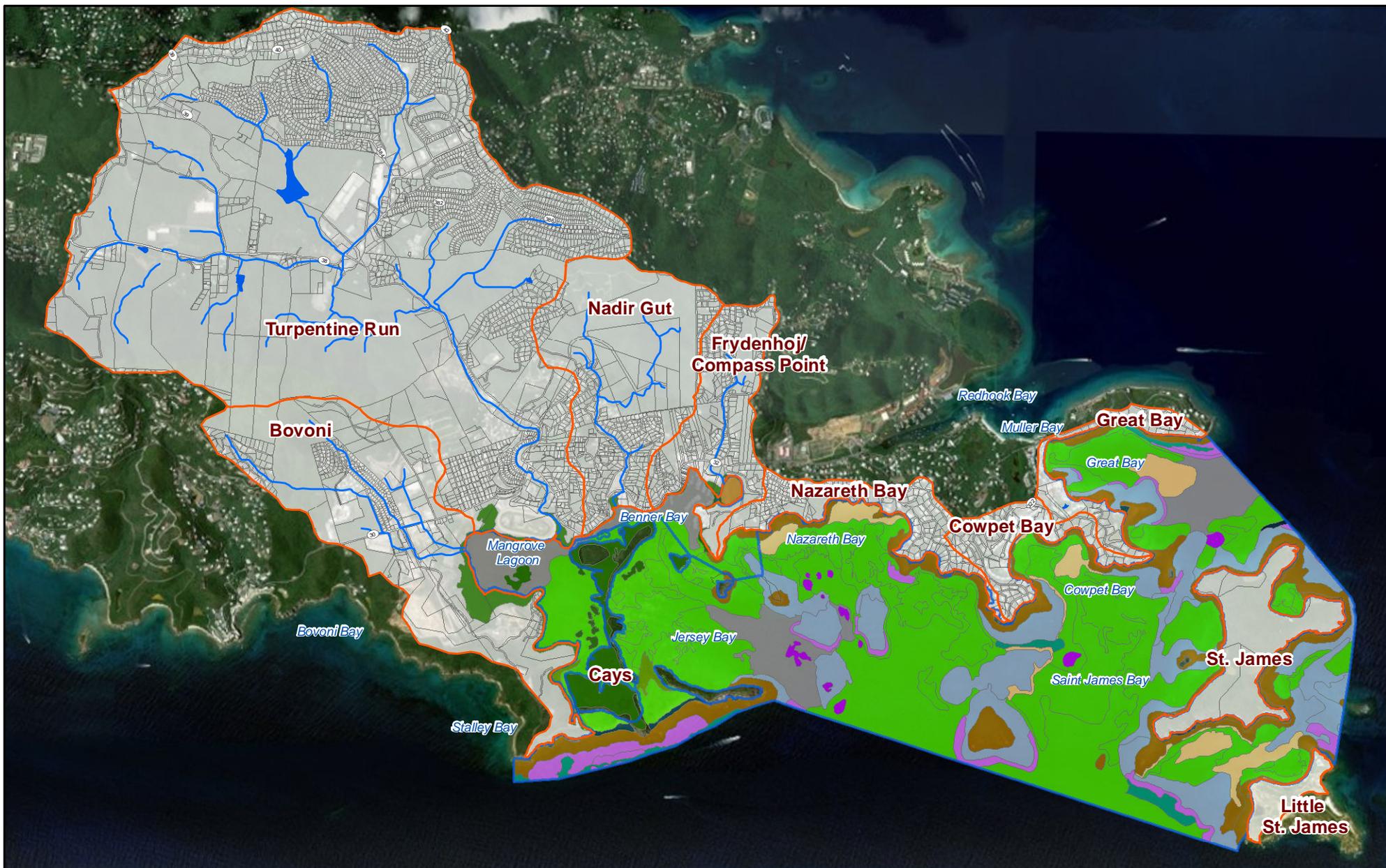
- Unfinished
- Completed
- Approx. Drainage Areas to BMPs

All data provided by DPNR, 2011 unless otherwise noted



Map 12: Stormwater BMPs & Wellheads STEER Watershed

Date: 3/31/2013 - eym

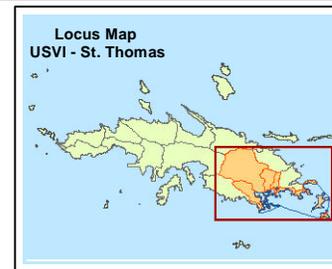
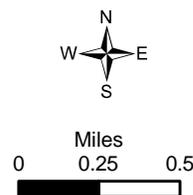


Legend

- Watershed Boundary (HW, 2011)
- STEER Boundary
- Parcels
- Freshwater Ponds (UVI-ECC, 2000)
- Guts HW revised from UVI 2007 wetlands inventory)

Benthic Habitats

- | | |
|-------------------------|------------|
| Algal plain | Mud |
| Beachrock | Patch reef |
| Bedrock Col/uncol | Rubble |
| Coral reef | Sand |
| Hard pavement Col/uncol | Seagrass |
| Mangrove | Unknown |

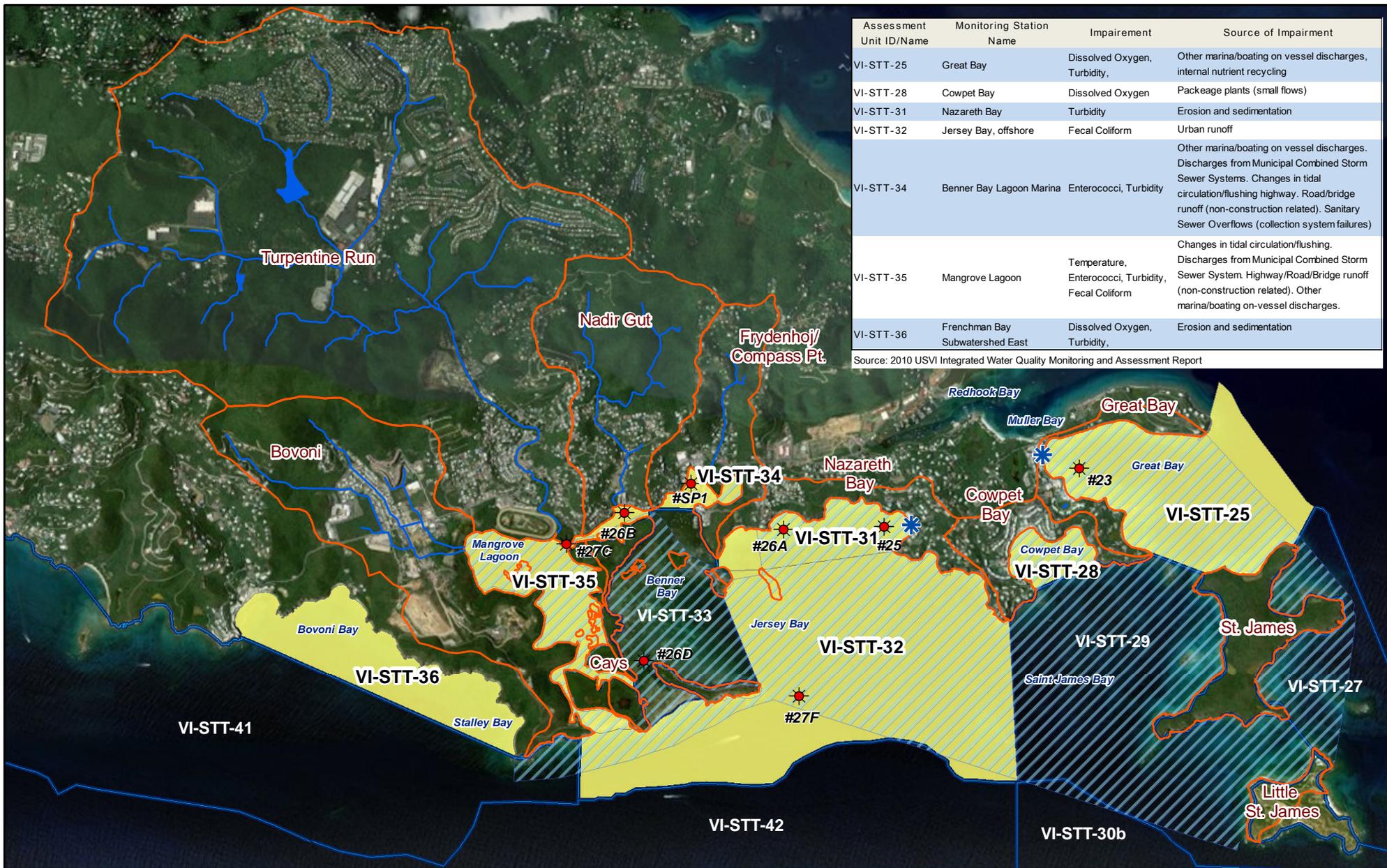


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**Map 13: Benthic Habitats
STEER Watershed**

Date: 3/31/2013 - eym

All data provided by DPNR, 2011 unless otherwise noted



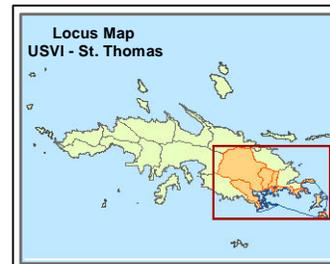
Assessment Unit ID/Name	Monitoring Station Name	Impairment	Source of Impairment
VI-STT-25	Great Bay	Dissolved Oxygen, Turbidity,	Other marina/boating on vessel discharges, internal nutrient recycling
VI-STT-28	Cowpet Bay	Dissolved Oxygen	Package plants (small flows)
VI-STT-31	Nazareth Bay	Turbidity	Erosion and sedimentation
VI-STT-32	Jersey Bay, offshore	Fecal Coliform	Urban runoff
VI-STT-34	Benner Bay Lagoon Marina	Enterococci, Turbidity	Other marina/boating on vessel discharges. Discharges from Municipal Combined Storm Sewer Systems. Changes in tidal circulation/flushing highway. Road/bridge runoff (non-construction related). Sanitary Sewer Overflows (collection system failures)
VI-STT-35	Mangrove Lagoon	Temperature, Enterococci, Turbidity, Fecal Coliform	Changes in tidal circulation/flushing. Discharges from Municipal Combined Storm Sewer System. Highway/Road/Bridge runoff (non-construction related). Other marina/boating on-vessel discharges.
VI-STT-36	Frenchman Bay Subwatershed East	Dissolved Oxygen, Turbidity,	Erosion and sedimentation

Source: 2010 USVI Integrated Water Quality Monitoring and Assessment Report

Legend

- Watershed Boundary (HW, 2011)
- STEER Boundary
- Parcels
- Freshwater Ponds (UVI-ECC, 2000)
- Guts (HW revised from UVI 2007 wetlands inventory)

- DPNR Water Quality Assessment Units
- 2010 Impaired Waters
- DPNR Beach Monitoring Sites
- DPNR Ambient Monitoring Sites



Map 14: Impaired Waters & DPNR Monitoring STEER Watershed

Date: 3/31/2013 - eym

All data provided by DPNR, 2011 unless otherwise noted

St. Thomas East End Reserves Watershed Existing Conditions Report

Appendix B

Field Briefings





MEMORANDUM

TO: Jean-Pierre Oriol, DPNR Division of Coastal Zone Management (CZM); David Simon, Division of Environmental Protection (DEP); Roy Pemberton, Division of Fish and Wildlife (DFW); and Stuart Smith, Comprehensive and Coastal Zone Planning (CCZP)

CC: Rob Ferguson, NOAA; Marlon Hibbert, NOAA; Anne Marie Hoffman, TNC; Alex Holocek, CZM; Renata Platenberg, DFW; Stephen Hale, DFW; Anita Nibbs, DEP; and Pedro Nieves, CZM

FROM: Anne Kitchell, Horsley Witten Group

DATE: March 7, 2012

RE: STEER Watershed Field Assessment Briefing

An on-the-ground assessment of pollution sources and potential restoration activities was conducted the week of February 26-March 2, 2012 by the Horsley Witten Group in the watershed area draining to the St. Thomas East End Reserves (STEER). This effort is sponsored by the NOAA Coral Reef Conservation Program, and supported by The Nature Conservancy and other members of the STEER Committee. During this week, two public meetings were held to solicit input from local businesses and residents on pollution sources and solutions in the watershed. We are in the process of organizing our field notes and drafting a summary report of our findings for your review within the next few months. However, there are a few items I wanted to bring to your attention in advance that are related to DPNR staff involvement, key watershed issues, and follow-up information needs.

A few members of DPNR staff have assisted in preliminary data collection, project coordination, and field investigations. Their involvement has been critical to our team's ability to efficiently access important sites in the watershed and communicate with the local residents and businesses. Pedro Nieves and Alex Holocek have provided us with a lot of existing watershed mapping information. Alex also spent the week in the field with us; her knowledge of existing conditions proved valuable, as did her assistance with compiling mapping data, coordinating with schools, representing DPNR at one of the public meetings, and safely navigating the watershed. Renata Platenberg and Stephen Hale spent two days in the field as well. Their knowledge of guts and other wetland conditions on the East End was extremely helpful, as was Stephen's attendance at one of the public meetings. Anita Nibbs participated in an initial watershed reconnaissance back in October, and has maintained close communication regarding the project since that time. We know these DPNR staff are extremely busy, and we appreciate the willingness to dedicate a portion of their time to this project.

Some of the key land-based pollution issues that we observed during our assessment are summarized below. There are a number of requests for additional information to help clarify some of these issues prior to drafting of preliminary watershed recommendations.

Stormwater

- Much of what we were looking at in the field relates to how stormwater runoff is currently being managed, or how it could be improved, for existing development. We have mapped the existing stormwater management facilities we observed including: Raphune Vista (detention basin); Cost-U-Less (two detention basins), Price Smart (detention basin), BCB School (detention basin); Ritz Carlton (constructed wetland, two stormceptors, and a small detention basin); and Tutu Park Mall (detention basin). Any information you have on the design, maintenance, and performance of these facilities would be helpful. Who is the appropriate contact for the TPDES program? We will provide you with a new GIS shapefile of existing stormwater facilities.
- There are a few sites where a copy of the site plans for active construction projects would help our understanding of the long-term drainage plans. We are primarily interested in the erosion and sediment control (ESC) and post-construction stormwater management plans for Grandview and for the construction site behind the Curriculum Center/Fire Station/Gomez Elementary School. It appeared during our investigation of the Grandview construction site that runoff is being discharged directly to the gut without an adequate mechanism for stormwater management. In addition, there were open sewer manholes and a construction access road in the gut. Stabilization of some slopes using erosion control blankets and riprap channels was observed. At the construction site behind the Curriculum Center, no ESC practices were observed and extensive excavation and reshaping of the gut channel was occurring. Any clarification you could provide on these issues would be useful.
- The most significant sources of stormwater and illicit discharges (failing septic, cesspools, etc) that we observed within Tier 1 include the Bovoni landfill, the adjacent commercial area south of Bovoni Rd., and the businesses along marina row. A number of good practices were observed at the Independent Boatyard (e.g., ground tarps, dust control, paint chip vacuum systems, and collection sump at slip). Your input on the descriptions and recommendations associated with these sites will be critical.
- One of the more significant sources of TSS in the Tier II portion of the watershed is Heavy Materials (the Quarry). Would it be possible to review a copy of their TPDES industrial permit and stormwater pollution prevention plan (SWPPP) to better understand expectations for on-site management?
- There are a number of opportunities for large and small stormwater retrofit projects at the schools, public housing facilities, and community centers. Prior to and during the field assessment work, we contacted the VI Housing Authority and the School District to inform them of this effort. We are also planning to send them a follow-up letter noting the potential for stormwater and pollution prevention opportunities on these properties. One

concern we have is that there seems to be a trend away from the use of cisterns and rainwater reuse, which is a key strategy for comprehensive stormwater management.

- Residents from our two public meetings identified undersized culverts, particularly on Brookman Rd. where Turpentine Run crosses the road north of the Quarry, as key culprits for flooding issues in the watershed. Road repaving and maintenance was also blamed for flooding issues at the Independent Boatyard. As part of the watershed plan, we intend to discuss the culvert sizing and road maintenance procedures. We are open to any thoughts you might have on engaging DPW or FHWA.
- During our review of existing reports, a hydrologic model comparing changes in drainage patterns in Turpentine Run by Pedro Nieves and Stevie Henry was referenced. Are you aware of this and can we get a copy of a more detailed report?

Wastewater

- We met with VIWMA to discuss the extent and condition of infrastructure associated with the Mangrove Lagoon WWTP and associated infrastructure in the sewer service area. We will provide you with a sewer map based on our meeting that will include the approximate location of trunk lines, pump stations, non-service areas. VIWMA explained the process for treatment at the ML WWTP from aeration/settling/decanting to the UV disinfection prior to discharge offshore in Stalley Bay. We also discussed the process of accepting septic pump-outs (currently accepting without fee) and the challenges associated with accepting vessel pump-out loads (e.g., salt and bilge). We discussed the influence of old pipes, leaking manholes, bad joints, and I&I on the amount of flow coming to the plant during rain events and high groundwater scenarios.
- We anticipate highlighting sewer line infrastructure repair, strategic expansion, and illicit discharge surveys as priorities for watershed management in order to elevate future funding discussions amongst federal partners.
- In addition, we have completed Alex's mapping of all small wastewater package systems for the East End. It would be helpful to fill in the data attributes for small wastewater plants (TPDES permit #, plant type, capacity, effluent monitoring, etc). Please let us know who the best person to coordinate the compilation of that data might be. This information may be useful for the EPA's Clean Watersheds Needs Assessment survey currently underway.

Other Land-Based Sources of Pollution

- We met with VIWMA to discuss pending closure plans for the Bovoni landfill, used oil drop off and household hazardous waste collection programs, as well as constraints on regulated waste that can be burned by WAPA. Despite our inability to secure documentation from EPA or from VIWMA on the administrative orders and mitigation plans concerning contaminated leachate draining from this site, we have enough information to highlight this area as one of the major sources of water quality contamination due to scrap metal disposal into the adjacent mangroves, uncontrolled

leachate drainage, unmanaged stormwater runoff, and methane buildup/combustion, etc. We do have a copy of an administrative order related to scrap metal disposal in the wetland, but we would welcome any additional effort on your part to secure reports/orders related to other issues.

- Based on these discussions with VIWMA, it is our understanding that landfill mitigation alternatives in the watershed include:
 - Previous restoration of a section of white mangrove (within last 5 years)--have there been any monitoring reports of the success of this effort? Any insights you may have on the success of this effort would be useful;
 - Leachate collection system—includes pretreatment and final treatment at WWTP, and would require the relocation of the service road to the east of its current location;
 - Top cover and reshaping of the landfill, which will redirect drainage for a portion of the site into Bovoni/Stalley Bay;
 - Installation of three detention basins to manage surface runoff; and
 - Methane gas system and construction of a gas-to-energy facility (started).

The timeframe for completion/adoption of the closure plan and implementation of many of these actions items is unknown; however, we anticipate highlighting these (particularly the leachate collection and pretreatment) as priority restoration activities in the watershed plan.

- Mapping data of land-based sources of pollution appears limited for the East End. Any assistance you could provide on determining if mapping data exists for regulated discharges (TPDES permits); underground storage tanks, etc would be helpful. Mr. Syed Syedali provided us with a map of wellhead locations, which appears to lose accuracy at small scales, but is suitable for this current effort.
- The Tutu Wellfield Superfund Site is within this watershed area. We have communicated directly with EPA on the status of the cleanup effort. Groundwater contamination issues may limit the options for improving stormwater management in that portion of the watershed.
- Residents from our two public meetings identified trash as one of the key pollution issues in the watershed area. If you are aware of any DPNR public education or involvement activities in the watershed related to trash, please let us know. As part of the watershed plan, we will likely suggest trash prevention and cleanup activities (e.g., cover of roll-away dumpsters and locations for community cleanups).

Natural Areas

- A portion of Turpentine Run spanning between the Clinton Phipps Race Track and Price Smart was walked by DFW and HW staff to get a sense of the impacts on the gut from adjacent development and infrastructure, as well as to identify opportunities for floodplain restoration, gut stabilization, and/or discharge prevention. Portions of the gut network in the Nadir and Frydenhoj subwatersheds were also evaluated; however, no

extensive effort was made to walk the entire drainage network across the East End. We will provide you with a copy of our revised baseline gut GIS shapefile.

- Extensive construction activity appears to have recently taken place in the natural gut behind the curriculum center and Gomez Elementary School. Clarification on the role DFW plays in the permitting of such activities, if any, would help us better understand the permitting process in the USVI.
- No formal natural area/wetland inventory was conducted during this assessment period. We observed conditions of many of the freshwater wetlands and salt ponds in the watershed, but we intend to incorporate into the watershed management plan recommendations from existing studies and by project partners to address wetland restoration and conservation priorities. January Murray has provided management strategies for the Compass Pt. Salt Pond. Any information you can provide on the ecology and status of Tutu Park Marsh (aka, Tutu Reservoir) would be helpful. Originally used as a farm pond, sedimentation and vegetative establishment over time have reportedly led to the loss of storage capacity. There is active and proposed construction in the area draining to the reservoir and it has been recently drained (reportedly). How do you see this marsh from a wildlife conservation perspective?
- In addition to two approved TMDLs for bacteria and dissolved oxygen in Mangrove Lagoon/Benner Bay, there are a number of additional impairments within STEER listed by DPNR in the 2010 Integrated Waters Report. Completion of this study will help provide watershed-based information for use during future TMDL development.
- We have reviewed the conservation strategies presented in the 2005 USVI Marine Resources and Fisheries Strategic and Comprehensive Conservation Plan. The watershed plan will help identify specific activities for managing stormwater runoff, wastewater discharges, and enhancing wetland buffers as emphasized in the 2005 Conservation Plan. Opening of the second false entrance to improve flushing in Mangrove Lagoon has been mentioned by DFW, CZM, and others on the STEER committee. If there is any documentation supporting this management approach that you feel should be reviewed and incorporated into the overall watershed plan, please let us know.
- We have asked TNC to provide us with a summary of the public and non-governmental process for land conservation in the USVI. Please let us know if any additional information on DPNR's interests in land conservation in the watershed is available, beyond what we discussed in October related to the Luton property.

Thank you, again, for the attention DPNR has provided to this watershed assessment project. I look forward to discussing these watershed issues with you further. Please don't hesitate to contact me directly with any questions or comments you may have at 508-833-6600, or via email at akitchell@horsleywitten.com.

Horsley Witten Group

Sustainable Environmental Solutions

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March 7, 2012

Ms. May Cornwall
Executive Director
Virgin Islands Waste Management Authority
#1 La Grande Princess, Suite BL1
Christiansted, VI 00820

Re: STEER Watershed Field Assessment Briefing

Dear Ms. Cornwall:

As you are aware, an on-the-ground assessment of pollution sources and potential restoration activities was conducted the week of February 26-March 2, 2012 by the Horsley Witten Group in the watershed area draining to the St. Thomas East End Reserves (STEER). This effort is supported by the NOAA Coral Reef Conservation Program (CRCP), The Nature Conservancy, and other STEER members. I wanted to inform you that our meeting with Mr. Steve Aubin and Mr. James Grum was more productive than anticipated. Mr. Aubin clearly is a notable asset for VIWMA; in addition to explaining the Mangrove Lagoon WWTP operations, he also marked up a field map with the locations of trunk lines, pump stations, non-service areas, and potential areas for system improvements and expansion. Mr. Grum was equally patient in his explanations regarding stormwater management, leachate interception, and other mitigation options for the Bovoni landfill.

We are in the process of organizing our field notes and plan to have a draft summary report available for review within the next few months. There are a few items I wanted to bring to your advance attention:

- Mr. Aubin explained the process for treatment at the ML WWTP from aeration/settling/decanting to the UV disinfection prior to discharge off shore in Stalley Bay. He also discussed the process of accepting septic pumpouts loads and the problems associated with accepting vessel pumpout loads (i.e., salt and bilge). We discussed the influence of old pipes, leaking manholes, bad joints, and I&I on the amount of flow coming to the plant during rain events and high groundwater scenarios.
- Based on the information sketched out by Mr. Aubin, we will provide you with GIS sewer service area shapefiles that will include the approximate location of trunk lines, pump stations, non-service areas, and potential expansion plans. In addition, we will provide a shapefile of locations for the small, private wastewater plants in the east end.
- We anticipate highlighting sewer line infrastructure repair, strategic expansion, and illicit discharge surveys as priorities for watershed management in order to elevate future funding discussions amongst federal partners.

March 7, 2012

Ms. Cornwall

Page 2

- At this time, we do not have copies of reports documenting required mitigation measures for the Bovoni Landfill (with the exception of the administrative order related to solid waste encroachment in the wetland), and would welcome any additional effort on your part to provide copies. That being said, we do have a general understanding of the major issues including: scrap metal disposal into the adjacent mangroves, uncontrolled leachate drainage, unmanaged stormwater runoff, and methane buildup/combustion, etc.
- Based on our discussions with Mr. Grum and Mr. Aubin, our understanding of landfill mitigation alternatives in the watershed includes:
 - Previous restoration of a section of white mangrove (have there been any monitoring reports of the success of this effort?);
 - Leachate collection system, which includes pretreatment and final treatment at WWTP, which would require the relocation of the service road to the east of its current location;
 - Top cover and reshaping of the landfill, which will redirect drainage for a portion of the site into Bovoni/Stalley Bay;
 - Installation of three detention basins to manage surface runoff; and
 - Methane gas system and construction of a gas to energy facility (started)

Mr. Grum reported the closure plan should be available by the end of the year. The timeframe for finalization/adoption of the closure plan and implementation of many of these actions items is not clear; however, we anticipate highlighting these (particularly the leachate collection and pretreatment) as priority restoration activities in the watershed plan.

- Mr. Aubin discussed the used oil drop off and household hazardous waste collection programs, as well as constraints on regulated waste that can be burned by WAPA.

We appreciate VIWMA's willingness to dedicate a portion of their time to the watershed planning project. I look forward to discussing watershed issues with you further, and recommendations related to your activities. Please don't hesitate to contact me directly with any questions or comments at 508-833-6600, or via email at akitchell@horsleywitten.com.

Sincerely,

HORSLEY WITTEN GROUP, INC.



Anne Kitchell, LEED AP
Project Manager

Cc: Rob Ferguson, NOAA CRCP; Anne Marie Hoffman, STEER Coordinator, TNC