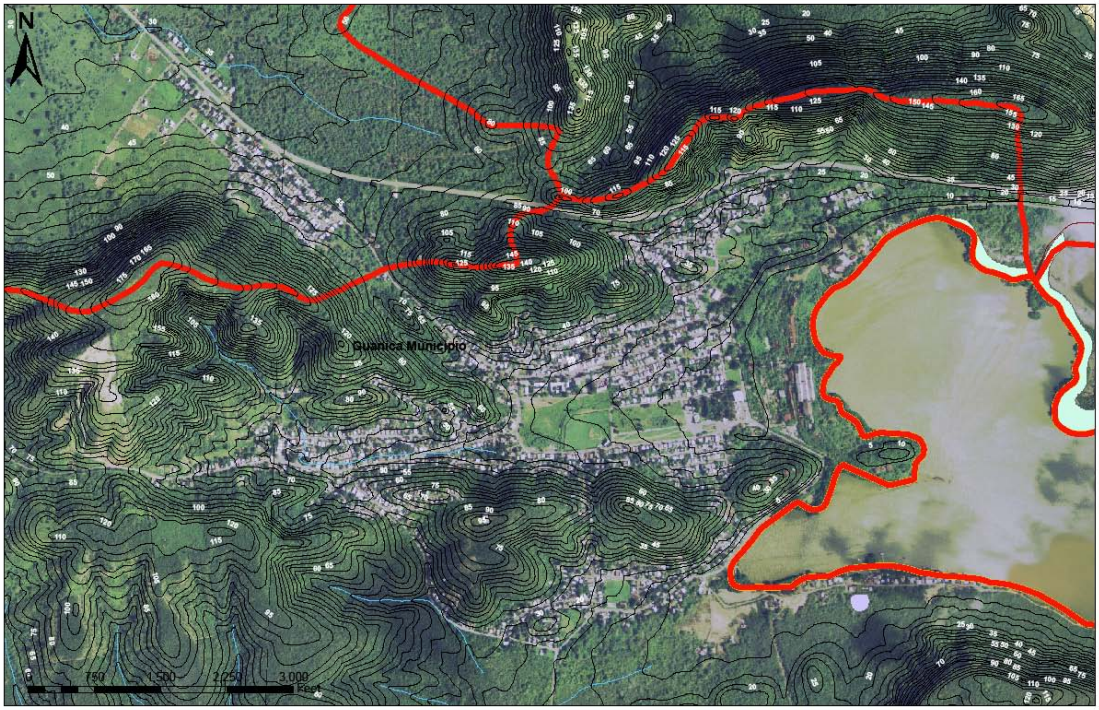
Guánica Bay Watershed Management Plan

A Pilot Project for Watershed Planning in Puerto Rico



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LIST OF ACRONYMS

BMP	Best Management Practice
CWP	Center for Watershed Protection
DRNA	Puerto Rico Department of Natural and Environmental Resources
EPA	United States Environmental Protection Agency
GIS	Geographic Information System
GSF	Guánica State Forest
GB/RL	Guánica Bay/Rio Loco Watershed
TMDL	Total Maximum Daily Load
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resource Conservation Service, USDA
PR	Puerto Rico
PRASA	Puerto Rico Aqueduct and Sewage Authority
PREPA	Puerto Rico Electric Power Authority
PREQB	Puerto Rico Environmental Quality Board
SWPR	Southwest Puerto Rico Project
UPR	University of Puerto Rico
UNESCO	United Nations Education, Scientific and Cultural Organization
USDA	United States Department of Agriculture
USGS	United States Geological Survey

watershed area however increases by 39,883 acres with the increases from the Southwest Water Project are considered (Ortiz-Zayas & Terrasa-Soler, 2001).

Soils are over 90% Class C&D by hydrologic classification. Class C soils are defined by slow infiltration rates due to layers impeding downward movement of water, or soils with moderately fine or fine textures. Class D soils are defined by very slow infiltration rates. They are clayey, have a high water table, or are shallow to an impervious layer. These soil types contribute to high amounts of runoff being generated (STATSGO USDA, 2008).

Mean annual rainfall for Puerto Rico is 63 inches (Diaz et al., 2001), but in this watershed, the rainfall regime varies significantly with elevation from 35 inches at sea-level in Guánica Bay to 80 inches at roughly 3000 feet at the highest point in the watershed in the cordillera (Warne et al., 2005). The near shore region is urban suburban with substantial agriculture on the Lajas plateau, also known as the Lajas Valley Agricultural Reserve. The Reserve, delineated above in Figure 1, encompasses 99,656 acres, 19,665 acres of which receive water from Lago Loco via the Lajas Canal for irrigation. This makes agriculture viable during the dry season (> 4 inches of rain per month), which lasts from December to June.

The watershed historically experienced high levels of deforestation during sugar cane cultivation on the majority of arable land in the watershed. In the 1950s, the Southwest Water Project greatly increased the headwater land area draining to the Rio Loco including significant amounts of highly erodible soils where the majority of coffee growing areas are located. The ditching and draining of Guánica Lagoon, a large historical lagoon and adjacent wetland system, in the 1950s had a profound effect on the filtering capacity in the watershed because the lagoon acted as a huge sponge / filter before Rio Loco passed into the Guánica Bay. Sediment transport in the watershed is exacerbated by the steep slopes, high mean annual rainfall, regular hurricanes and tropical storms every 10-20 years (Scatena and Larsen. 1991). A high proportion of labile minerals in the Cretaceous volcaniclastic and intrusive rocks of the Cordillera Central result in landslides and debris flows especially in areas which have been disturbed by human activity (Warne et al., 2005).

Historic land clearing, agriculture, poor erosion practices and attenuation of that sediment in the valley behind the historic Guanica Lagoon have resulted in large amounts of sediment deposition (20ft thick in some areas as seen in Figure 5) in the Rio Loco valley between Yauco and Ciénaga just above Guánica. This area currently serves as a location for fruit and vegetable agriculture. Further detail on agriculture in Puerto Rico and in RL/GB watershed in particular can be found in Appendix I. Clark and Wilcock 2000 found that between 1830 and 1950 runoff increased by approximately 50% and sediment supply to the river channels increased by more than an order of magnitude after much of northeastern Puerto Rico was cleared for agriculture. A similar historical process also occurred in southwest Puerto Rico since the end of the 19th century (Warne et al., 2005).

Warne et al. (2005) in their comprehensive study of rivers and their potential influence on coral reefs in Puerto Rico added that the irrigation project managed by Puerto Rico Aqueduct and Sewer Authority (PRASA) has greatly expanded the total watershed area of Guánica Bay and the Rio Loco and likely increased the supply of fine clay sediment and nutrients to the Guánica Bay

Table 1. Primary Literature on GB/RL Reviewed		
Study	Description	How Incorporated
	structures, and recommendations for project design, implementation and management for both the lagoon itself and the freshwater marsh known as "El Anegado". Both reports were prepared based on previously published reports and data and unpublished hydrologic data, field visits and interviews as well as modeling, surveying and by DRNA in 1998.	of this natural system.
Greg L. Morris and Associates. 1999. Hydrologic and Hydraulic Analysis: Guánica Lagoon Restoration Impacts on Regulatory [Controlled] Flood Levels	This study analyzes controlled flooding conditions in the Laguna Guánica area to determine the impact of changed lagoon water levels and of flood control structures on controlled flood levels in Lajas Valley and along Rio Loco into which the Laguna Guánica drains.	This document and its sister document provide technical analysis which supports recreation of Guánica lagoon and helps demonstrate political precedent for recreation of this natural system.

CRITICAL ISSUES AND PRIORITY POLLUTANTS IN GUÁNICA BAY / RIO LOCO WATERSHED

A list of priority pollutants, their impacts and the potential sources within the GB/RL watershed were identified and presented in Table 2.

Table 2. Priority Pollutants in the Guánica Bay / Rio Loco Watershed		
Pollutant	Impacts	Sources
Nitrogen	Eutrophication, algae growth, enrichment beyond tolerance of coral reefs.	Wastewater, fertilizers, stormwater runoff, atmospheric deposition (Ortiz-Zayas, 2001; Lapointe 1997)
Sediment	Deposition on reefs, effects on sediment intolerant reef organisms, sediment particles leading to water temperature warming, pollutants attached to sediment particles.	Soil erosion, channel erosion, poor erosion and sediment control practices, African dust (Warne et. al., 2005)
Bacteria	Health related illnesses due to water contact, swimming, beach closures, source of pathogens that effect coral reefs	Untreated wastewater, sewage overflows, stormwater runoff, pet waste, animal waste, wildlife (Schueler, 1999) (Centers for Disease control, 2008) (Henrickson et al., 2001)
PAHs	Toxicity to coral reefs	Stormwater runoff of automobile related contaminants, boat engine discharge particularly 2-stroke engines (NOAA, 2007)
DDT, PCBs	Toxicity to coral reefs	Legacy contaminants, erosion of legacy sediments (NOAA, 2007)

Figure 3. Snapshot of sediment accumulation and flow through Loco Reservoir.

Sediment accumulation of fine clay soils in Lago Lucchetti and Lago Loco were observed in the field and verified in the literature in studies made by USGS and CSA Group in coordination with University of Puerto Rico (Soler-Lopez, 2000; Ortiz-Zayas & Terrasa-Soler, 2001). Clearing for coffee, tree crops and construction as well as exposed soils associated with historical road cuts were observed during a visual tour of the Loco and Lucchetti watersheds in April of 2008. This small area of the largely forested watershed represents the majority of land disturbance in the watershed, as verified in GIS, the accelerated transport of these highly erodible soils is due to the steep slopes and the high annual rainfall.

Hurricanes in combination with current and historic crop production, particularly the cultivation of sun-grown coffee using poor soil stabilization practices have resulted in significant sediment transport. These soils are particularly vulnerable after forest clearing and during coffee crop establishment where significant soil exposure and loss and resulting premature sedimentation of the Lucchetti and Loco reservoirs as indicated by a 2000 study by CSA Group (Ortiz-Zayas & Terrasa-Soler, 2001). Note that Lucchetti and Loco reservoirs have lost 42% and 64% of their original capacity, respectively due to sedimentation (USGS 2000).

Lucchetti also appears to be discharging fine sediment from its intake pipe to Loco Reservoir because the pipe invert is estimated to be at the same elevation or below the estimated current reservoir bottom due to sedimentation as was predicted by Ortiz-Zayas & Terrasa-Soler (2001).