SUBMERGED CULTURAL RESOURCES SURVEY
CONSTRUCTION OF TWO JETTIES
DISCOVERY BAY RESORT & MARINA
AGUADA, PUERTO RICO

STAGE I
BACKGROUND LITERATURE SEARCH (IA)
AND UNDERWATER RECONNAISSANCE (IB)

SUBMITTED TO:

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REQUESTED BY THE STATE HISTORIC PRESERVATION OFFICE
AND THE COUNCIL FOR UNDERWATER ARCHAEOLOGY
SAN JUAN, PUERTO RICO

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1. Introduction

This report documents the methodology and results of the Submerged Cultural Resources Survey, Stage I, for Construction of Two Jetties, Discovery Bay Resort & Marina, Aguada, Puerto Rico (Figures 1 to 5).

The investigation reported herein was conducted on behalf of Thomas Cordero Armstrong and Cordeco Northwest Corp., per request of the State Historic Preservation Office (SHPO) and the Council for Underwater Archaeology, Institute of Puerto Rican Culture (ICP), San Juan, Puerto Rico.

1.1 STUDY AREA

The proposed project is located on the northwest coast of Puerto Rico, towards the south end of Aguadilla Bay, within Barrio Espinar or Espinar Ward of the Municipality of Aguada. The Study Area is limited to the entrance jetties of the new marina, at the mouth of Caño Madre Vieja. The existing entrance has been previously impacted by beach dredging, plus construction of two rock groin structures to be replaced by jetties.
Espinar Ward is the northernmost barrio or municipal subdivision of Aguada. Immediately across Caño Madre Vieja is the Municipality of Aguadilla. Thus the proposed south jetty is within Aguada, and the proposed north jetty is within Aguadilla.

The northern terrestrial access to the Study Area is along State Road PR-440, driving south along the bay, from the town of Aguadilla to Parque de Colón, or Christopher Columbus Park. The Study Area may also be accessed from the south, but it requires following dirt trails along an undeveloped beach, following Aguada’s Road PR-442. The terrestrial access to Discovery Bay Resort & Marina will be along Road PR-442, at Km 0.5, Barrio Espinar, Aguada.

The name of the project derives from Christopher Columbus’ arrival in 1493, during his second voyage of exploration and conquest in the Americas or New World. It is an established historic fact that the legendary navigator landed in Puerto Rico sometime between November 17 and 19, 1493, but the exact landfall is unknown. Most municipalities on the west and southwest coasts of Puerto Rico, from Aguadilla to Guayanilla, have claimed the site of Columbus’ landfall, with Aguada, Aguadilla and Añasco as the strongest contenders among present-day historians.
1.2 PROPOSED PROJECT

The Proposed Project is the Discovery Bay Resort & Marina, Espinar Ward, Aguada, Puerto Rico. This project aims to develop approximately 230 acres of abandoned agricultural lowland into a world-class inland marina, with two hotels and various residential complexes.


A “Conceptual Master Plan” of the Project has been prepared by EDSA, summarized in a descriptive report or Conceptual Descriptivo by Hernández Virella and Cordero Armstrong (2007). The Study Area for this investigation was defined in accordance to the EDSA Conceptual Master Plan.

In addition to the marina, two hotels, three residential towers, apartments, villas, roads, a small bridge and various marina-related structures, the project includes the construction of two levees, north and south of the proposed marina, and the replacement of two existing groin structures with jetties. As
previously indicated, this report is limited to the jetties and entrance channel, an essential but small component of the undertaking. The existing groin structures are depicted in Figure 4, with the proposed jetties in Figure 5.

The entrance channel will be 50 m wide, funneling to 30 m as it approaches the marina. Vessels will enter and leave the channel within the protection of the two jetties (including the North or Aguadilla Jetty, and the South or Aguada Jetty).

The entrance jetties have been designed by Moffatt & Nicholls (Project 5478, Dec. 8, 2005), incorporating marine data provided by oceanographer Jorge E. Capella, Ph.D. (Personal Communication, 2007). Beginning in Southern California in the 1940’s, engineers John Moffatt and Frank Nichol incorporated in 1947 and now operate 22 coastal engineering offices. They have planned and designed over three hundred marinas, including the Marina at Atlantis, Paradise Island, Bahamas, plus a wide variety of waterfront and coastal development projects.

Discovery Bay Resort & Marina is expected to invigorate the economy of both Aguada and Aguadilla, with direct and indirect employment in construction, administration and services, plus a strong boost to west coast tourism, which has been traditionally underdeveloped.
From the perspective of ocean safety and science, the proposed inland marina will provide a safe harbor for sports boating enthusiasts, fishermen and marine researchers in Mona Passage. This is potentially life-saving in rough weather, as there are no existing harbors in this area (Bogunovich 2007). From the perspective of historic preservation, the project will promote popular knowledge of Aguada and Aguadilla’s forsaken maritime heritage through brochures, advertising and publications, beginning with the author’s own renewed interest in the various navigational, anthropological and philosophical controversies surrounding Christopher Columbus and the European conquest of the Americas.

1.3 OBJECTIVE OF THE STUDY

The scope of work of this study is limited to submerged cultural resources, within or adjacent to the Study Area of the proposed jetties at the mouth of Caño Madre Vieja. Terrestrial archaeological and historic investigations are also being conducted for Discovery Bay Resort & Marina by archaeologist Juan González, reported separately.

This investigation has been conducted in compliance with Federal and State laws for historic preservation, including Section 106 of the National Historic Preservation Act of 1966 as amended (16 U.S.C. 470), and Puerto Rico Law Number 10 of 1987 for Submerged Archaeological Sites.
This report provides the methods and results of the Stage I investigation, including a) background environmental and cultural literature search, and b) field investigation for potential underwater archaeological sites. The investigation addresses both historic and prehistoric archaeological sites under water or within the tidal zone.

The information generated by the Stage I cultural assessment determines the sensitivity of an area to specific types of cultural resources, providing a first-line research design or framework for cultural resource management, and recommending additional studies, if necessary.

From the perspective of Federal legislation, a historic or archaeological site must meet one or more of the four National Register criteria, including A) association with events that have made a significant contribution to the broad patterns of our history, B) association with the lives of persons significant in our past, C) embody the distinctive characteristics of a type, period or method of construction, or represent the work of a master, or possess high artistic value, and D) have yielded, or likely to yield, information important in prehistory or history.

The application of National Register criteria to historic vessels, hulks and shipwrecks, is discussed in detail by Delgado (1985). For this investigation,
the author also considered submerged prehistoric sites and port discards, which are often ignored by marine archaeological surveys, but may represent significant cultural resources, potentially eligible to the National Register under criterion D.

For the present investigation, potential submerged archaeological sites in the Study Area were narrowed down to four types: 1) hulks, 2) shipwrecks, 3) historic anchorages, 4) aboriginal canoes, and 5) submerged prehistoric sites.

### 1.4 DATES OF THE STUDY

In 2004, an initial background literature search report (Stage IA), was submitted by the author to Cordeco Northwest Corp. (Vega 2004). This initial report discussed the wide variety of submerged archaeological sites that may be found in the world’s oceans, including hulks and shipwrecks, historic piers and anchorages, aboriginal watercraft, historic and prehistoric salt works, partially or completely submerged prehistoric sites, etc.

For the present report, the original background literature search was translated from the original Spanish, revised and expanded during the months of February and March, 2007. This allowed the author to add new extensive data on Aguadilla Bay and on Columbus’ landfall, refine the list of actual and potential shipwrecks in Aguadilla Bay, add a table on the typology of coastal structures, plus a number of minor changes and corrections.
Underwater investigations were conducted during three days of March 2007, including diving visual inspection, a metal-detection survey, and underwater coring. Sea conditions were rather poor, with constant waves and limited underwater visibility. The Final Report was completed on March 25, 2007.
Figure 1. Puerto Rico, with location of Aguadilla Bay and principal modern ports.
Figure 2. Aguadilla Bay. West Coast of Puerto Rico, NOAA 1992. Depth in fathoms. (One fathom = 6 ft.)
Figure 3. Location of Study Area, Barrio Espinar, Aguada. Topographic Quadrangle of Aguadilla, Puerto Rico 1960,1:20,000. Depth in feet. Red triangle indicates prehistoric site. Blue circle indicates tentative location of two cannon and horseshoe chest salvaged by divers in the 1970’s.
Figure 4. Existing rock groins at entrance to Caño Madre Vieja.
Figure 5. Proposed Jetties at entrance of Caño Madre Vieja.
2. Environmental Background

Environmental information is essential to archaeology, both to understand present conditions and their potential for preserving or destroying the archaeological record, and as the first step for reconstructing past environmental conditions.

All human activity, past or present, occurs within a dynamic biophysical setting, involving a complex interrelationship of solar radiation, climate, geological structures and rocks, ocean currents, rivers, soils, plants, animals, microorganisms, etc. From the perspective of the environmental sciences, all of these organic and inorganic variables may be grouped within four basic components: atmosphere, hydrosphere, lithosphere and biosphere (Butzer 1982:16). By considering all past human activity within these four components, archaeology becomes an extremely complicated and difficult discipline, with nearly unlimited questions about how our species interacts with the world around us.
2.1 PHYSICAL GEOGRAPHY OF PUERTO RICO

Puerto Rico is approximately 161 km (100 miles) long and 56 km (35 miles) wide. The island is divided north and south by a central mountain chain of volcanic and plutonic igneous rocks. About 40% of Puerto Rico is mountain terrain, with 35% hill and 25% level (Picó 1974:26). The highest elevation is Cerro Punta, towards the center of the island, with an altitude of 1,338 m (4,390 ft.). Prominent peaks also rise on the northeastern section of the island, at the Luquillo Range, reaching a maximum elevation of 1,074 m (3,532 ft.).

Although the size and elevation of islands might seem like “hard facts” which remain constant through time, in fact both are relative to the global or eustatic sea level. As discussed in detail in section 3 of this report, periods of lower sea level imply larger islands with higher peaks. Thus, even something as “simple” and “well known” as the size and elevation of Puerto Rico, will not apply to the prehistoric environment of 10,000 years ago.

Puerto Rico’s insular shelf is narrow off the north (N) coast, and wide off the east (E) and southwest (SW) coasts. The composition of the coastline ranges from unconsolidated sediments, to limestone and igneous rock formations. Of 740 km of coastline, 20% are beaches, which are generally short and divided into separate systems with little interaction (Morelock and Trumbull...
Tides average about 30 cm (1 ft.). Shorelines exhibit great variation, with five generalized types in six separate sections (Kaye 1959:51).

The north coast is characterized by high-energy beaches and limestone cliffs. In contrast, the south coast is mostly low-energy mangrove. Both the east and west coasts exhibit fault control (Morelock and Trumbull 1985).

Sea surface temperatures range from 82.5°F in September, to 77.9°F in February. Largely due to the moderating effect of the sea, Puerto Rico’s median temperature of 79°F at sea level varies within the relatively narrow range of 5.9°F through the year. This narrow temperature range leads many people, archaeologists included, to the idea that Puerto Rico lacks seasonal variation: the land of eternal summer. On the contrary, if we try to reconstruct the lifeways of people who were navigators, fishermen, hunters, gatherers or planters, we must recognize significant seasonal variations in winds, currents, waves, air and sea temperatures, rain, etc. These variations were important both for the prehistoric aboriginal peoples, and for the historic Spanish and criollo farmers and fishermen.

Most rainfall and river discharge is to the north, with a semi-arid south coast. Rain is most abundant at El Yunque Rain Forest on the northeast, with over 5 m (200 inches) of annual rainfall. The southwest is the driest part of the island, with an average annual rainfall pf 1 m (40 inches).
Puerto Rico’s position on the northeast corner of the Caribbean Basin exposes it to the mainstream of the Great Northern Equatorial Current (GNEC). This powerful ocean current originates off the West African coast and crosses the Atlantic Ocean in clockwise fashion, veering north as it touches the Caribbean.

The influence of the GNEC provides an additional element of humidity to the island’s tropical climate. The sea-land breezes generally blow offshore at night and a dawn (when the land is cooler than the surrounding ocean), ad inshore during the daytime (when the sea is cooler).

The island is also affected by hurricane winds, which are frequent in the Caribbean during the warmest months, from June to November. In general, hurricanes follow the WNW path of the trade winds.

From the perspective of maritime archaeology, hurricanes are extremely important as a primary cause of shipwreck. In fact, the earliest known historic shipwrecks potentially found in Puerto Rico’s waters, are the ships of Francisco de Bobadilla’s fleet of 1502, with up to sixteen vessels destroyed by hurricane winds somewhere within Mona Passage, between Puerto Rico and the Dominican Republic (Cardona 1989:23-39).
Puerto Rico has approximately 1,300 streams, of which seventeen (17) form true river systems. The largest rivers flow to the north, where low drainage results in swamps and march lagoons. At face value, there appears to be a spatial relationship between rivers and aboriginal chiefdoms, or cacicazgos. Many of the primary settlements were located near large rivers, which provided water, diverse sources of food and natural “water roads” between the coast and the interior. Consider, for instance, the names Bayamón, Loíza, Canóbanas, Turabo, Humacao, Maunabo, Guaraní, Guayanilla, Yauco, Guanajibo, Gurabo, Yagüez, Guajataca, Camuy, Tanamá, Arecibo, Manatí and Cibuco, all names of rivers associated with aboriginal caciques.

Puerto Rico’s soils show great variation. Only about 6% or 129,000 acres are classified at present as first rate. About 75% of the island’s soils are considered of inferior quality, located mostly in the mountainous interior (Picó 1974:214).

Two primary geological features of the coast of Puerto Rico are eolianite and beachrock. Eolianite (Qe) is wind-deposited sand cemented by calcium carbonate (CaCO3). In Puerto Rico, eolianite or cemented dunes may reach a height of 30 m (100 ft.) or more. On the north coast, San Juan’s fortresses of El Morro and San Cristobal rise atop eolianite, of which four generations of cemented dunes are recognizable (E1-E4), each separated by a layer of ancient soils or peleosols.
Beachrock (Qbr) is cemented sand or shingle. As in eolianite, the cementing agent is calcium carbonate, with rare instances of cementation by iron oxides. Beachrock forms a hard pavement along the shore. When found under water, it clearly indicates that marine transgression or has taken place. The pavement generally dips at a slight angle towards the sea, and may reach a width of 60 m (200 ft.) or more. Frills or grooves perpendicular to the shore are often formed on the pavement, produced by mechanical abrasion.

Both beachrock and eolianite are associated with high-energy coasts. This appears to be the best explanation for their absence or limited presence on the south coast of Puerto Rico, which is mostly low-energy. Other geomorphological and biological factors might also be involved in this significant difference between Puerto Rico’s Atlantic north coast and the Caribbean south coast.

2.2 AGUADILLA BAY

The west coast of Puerto Rico is mostly irregular, with broad alluvial coastal plains separated by mountain ridges. This area is characterized by numerous faults, which run mostly northwest (NW), and a narrow insular shelf. Beginning on the northwest corner of the island, the west coast includes the municipios of Aguadilla, Aguada, Rincón, Añasco, Mayagüez and Cabo Rojo.
Aguadilla Bay is a large, exposed bay immediately south of Punta Borínquen. Although the bay is considered the north end of the west coast, in early historic times it was regarded as part of Puerto Rico’s north coast. This little known historic fact has caused some confusion among local historians.

The narrow insular shelf provides rapid access to the deep waters of Mona Passage, which runs between Puerto Rico and the Dominican Republic. Mona Passage connects the Caribbean Sea with the Atlantic Ocean, with its currents running mostly north and northwest. Contrary to the more placed waters of Vieques Sound to the east, the waters of Mona Passage are mostly deep and capable of generating incredible power. At Rincón, immediately south of Aguadilla Bay, surfers ride towering, twenty-foot waves comparable to some of Hawai’s best. Equally impressive are the powerful ocean currents that divers and boaters may encounter off Mona, Monito and Desecheo Islands.

Less than 500 m from the shore in some places, Aguadilla Bay slopes into deep water. In Aguadilla, it is actually is possible to dive off the beach and meet a whale, or at least hear their songs loud and clear under water, which happened to the author many years ago during a beach dive off Crashboat.

Aguadilla Bay includes the coastline of Aguadilla and Aguada. The history of these two towns is deeply related and at times confusing. The town of
Aguadilla is on a narrow strip of coast roughly towards the center of the bay. The town of Aguada is about 1 km inland and a little more than 1 km south of Punta del Boquerón, towards the south end of the bay. The indentation of Aguadilla Bay continues SW all the way to Punta Higuero on the the *Municipio* of Rincón.

The marine geology of Aguadilla Bay is described in detail by Grove (1983), and also discussed by Kaye (1959:53), Morelock and Trumbull (1985) and Pilkey 1976:93). The terrestrial geology of Aguadilla and Aguada is discussed in detail by Monroe (1969).

The sediments in Aguadilla Bay, including the Study Area, consist of mixed terrigenous and calcareous sand, leading to terrigenous mud and sandy mud (Grove 1983).

To mariners, Aguadilla Bay offers protection from easterly winds, but is exposed to winds from the north and west, particularly during the winter (United States Coast Pilot 5, 1991:295).

The piers in Aguadilla Bay include the abandoned U.S. Navy search and rescue pier at Crash Boat, the industrial pier of the Central Coloso, and the Aguadilla small boat harbor and Club Náutico (Cerame Vivas 1988:50). At Caño Madre Vieja, there is an abandoned concrete boat ramp. At present, this
creek is not navigable due to extensive sedimentation. The ruins of an abandoned pier, likely to disappear in the near future, is found about 1 km south of the Study Area. South of the Aguadilla harbor, there are no other harbors in the bay, all the way down to Rincón.

2.3 CAÑO MADRE VIEJA

The Study Area is located at the mouth of Caño Madre Vieja, about 1 km south (S) of the town of Aguadilla, immediately south (S) of Aguadilla’s Parque de Colón, and about 1.5 km northeast (NE) of the Río Culebrinas.

Espinar is the northernmost barrio of Aguada. The Municipality of Aguada includes 30 square miles (72 km2) of mostly coastal lowland controlled by the Río Culebrinas. This old, meandering river begins in Lares, NW of Cerro La Torre, and runs west between the Atalaya and Meseta hilltops. Its tributaries include Río Juncal, Río Cañas, Río Sonador and Quebrada Guatemala (Sánchez Tarniella 1998:14). The Río Culebrinas runs for over 21 miles (33 km) until reaching Aguadilla Bay (Picó 1974:81).

Caño Madre Vieja is a small, freshwater stream that meanders west and northwest along the coastal plain of Quaternary alluvium (Qa), crossing swamp deposits (Qs) just before it reaches Aguadilla Bay. This small stream is partly fed by groundwater and by Caño Espinar from the south.
Caño Madre Vieja is an old channel of the Río Culebrinas, which meanders west and reaches the bay immediately south of the Espinar Community. This caño or creek is the frontier between Aguadilla and Aguada.

The relationship between Caño Madre Vieja and the Río Culebrinas is clearly illustrated in the Geologic Map of the Aguadilla Quadrangle (Monroe 1969). The mouth of the creek appears closed by beach sand (Qb), before the modern dredging conducted at the Study Area. About 5 km SW of the Río Culebrinas, the Río Guayabo reaches the sea towards the south end of Aguadilla Bay. The primary tributaries of the Río Guayabo are Río Ingeniero and Río Culebra.

The Town of Aguada is located about 2.5 km south of the Río Culebrinas and 1 km from the coast. The subdivisions of Aguada include the Urban Center and the barrios of Asomante, Atalaya, Carrizal, Cerro Gordo, Cruces, Espinar, Guanábanas, Guaniquilla, Guayabo, Jaguey, Lagunas, Malpaso, Mamey, Naranjo, Piedras Blancas and Río Grande.

Espinar is the only barrio of Aguada north of the Río Culebrinas. This is lowland made up of alluvium (Qa) and beach deposits (Qb).

The name Espinar or Espinal is derived from Fray Alonso Espinal, a Franciscan friar who arrived in Hispaniola in 1502, establishing the
Order of San Francisco in the New World. In 1520, Fray Espinal relocated to the west coast of Puerto Rico with a group of Franciscan monks (Cardona Bonet 1985:34).
Figure 6. Aerial photograph of 1963, before construction of the groins or moles at the Study Area.
Figure 7. Aerial photograph of 2000, after construction of the groins.
Figure 8. Geologic map of the Study Area, Aguadilla Quadrangle (Monroe 1969).
3. Submerged Prehistoric Sites

This section addresses the probability of submerged prehistoric sites within or adjacent to the Study Area. Caribbean submerged prehistoric sites may include shell middens, lithic quarries and workshops, human burials, post molds of thatched houses, hearths, petroglyphs, ceremonial ball courts, canoes, etc.

Caribbean prehistory is often divided into preceramic and ceramic cultures. Ceramic or pottery-making societies inhabited most of the islands by the late 15th century, including the Taino chiefdoms or ranked societies of Puerto Rico, considered with the chiefdoms of Hispaniola as the most advanced aboriginal societies of the Caribbean.

Although some preceramic or non-pottery making societies were also encountered by Spanish explorers and conquistadors, preceramic groups generally occupied the islands thousands of years before the ceramic societies. Known archaeological evidence indicates that the Greater Antilles were occupied by preceramic hunter-gatherers at least 6,000 years ago, and by
ceramic or pottery-making horticulturalists about 2,500 years ago (Rouse 1992:51; Wilson 1997:4).

Environmental reconstruction of Pleistocene and Holocene sea levels indicate the flooding of Caribbean insular shelves, almost certainly flooding the earliest prehistoric sites in the region. Thus, the 6,000 yrs BP approximate entry date of humans in the Caribbean is probably in error. The oldest prehistoric sites are under the sea and they have yet to be found and dated.

3.1 CHANGING LEVELS OF LAND AND SEA

Marine transgressions, the technical term for the flooding of coastal areas by the sea, may occur due to a variety of local, regional, or global processes. Land may be eroded or subside due to tectonic movement, isostatic depression or sediment compaction. In higher latitudes, postglacial rebound may gradually lift the coast.

Sea level may rise due to changes in the volume of ocean water or ocean ridges (Donovan and Jones 1979). Following current theory, the major agent of coastal change has been a global or eustatic sea level rise due to the melting of land-blocked ice, resulting from cyclical variations in the earth’s orbit (Hays et al. 1976:1121).
According to the glacio-eustatic model, low sea levels are associated with land ice advances called stadials, while high sea levels are associated with the retreat of land ice sheets called interstadials. The more ice on land, the lower the sea level.

Numerous ice ages have occurred as far back as 93 million years ago, but our concern is with the last ice age so far. Beginning about 80,000 yrs BP (before the present), the more recent ice age is defined as the Wisconsin glaciation in North America, and the Würm glaciation in Europe. This glacial episode played a central role in the migration of our species, Homo sapiens sapiens, to the principal archipelagoes of the world, including the Caribbean, by reducing the distances between continental masses and offshore islands world-wide.

There is general consensus that the sea was near its present level by about 35,000 yrs BP. Then the sea level began to drop as the Laurentide and other Pelistocene ice sheets expanded over the Northern Hemisphere.

By 20,000 to 15,000 yrs BP, sea level reached its lowest point in the Wisconsin glaciation. Estimates for this lowest sea level stand include minus 60 m (Blackwelder et al. 1979), minus 85-90 m (Morner 1971), and minus 130 m (Milliman and Emery 1968).
Around 17,000 to 15,000 yrs BP, the Holocene marine transgression began. During the most rapid stage of deglaciation, beginning about 10,000 yrs BP, sea level probably rose at a rate of 10mm per year. By 7,000 yrs BP, sea level may have been some 10 m (32 ft.) below present level (Shepard 1963). Much of the Caribbean Archipelago had been reached by preceramic navigators by that time.

From 7,000 yrs BP onwards, the sea continued rising at a much slower pace. At this stage, there are significant disagreements among researchers. Van Andel and Laborel (1964), Fairbridge (1961) and others have proposed sea level oscillations with higher-than-present sea levels in the late Holocene, while Curray (1961), Scholl and Stuiver (1969), Shepard (1963) and others have reported evidence of a smooth sea level curve approaching the present level by about 4,000 to 2,000 B.P. Indirect corroboration from oxygen isotopic analysis of glacial history supports slightly higher, late Holocene sea levels than at present, but the problem remains an open question.

The rising seas were marked by interruptions or stillstands. These periods of stationary sea levels allowed the development of marine terraces, which may be observed under water. Prominent submarine terraces are found in the Caribbean, the Gulf of Mexico, and the Pacific Ocean at the average depths of 15 m (49 ft.) and 40-45 m (130-165 ft.). The depth of marine terraces may
vary due to local tectonism, so that Pleistocene terraces may be found in
shallower water, and even above present sea level.

Stillstands also allowed the formation of sea caves, beaches, and associated
geomorphological features. From an archaeological perspective, stationary
sea levels also made possible the formation of permanent, or semi-permanent,
stratified coastal sites (Vega 1990, 1995).

Since the early 1930’s, archaeologists speculated that prehistoric peoples lived
on portions of the now submerged, continental and insular shelves. However,
most researchers assumed that such sites would have been destroyed by the
rising seas of the Holocene transgression. Today, the archaeological
community has finally begun to realize that the traditional “sand castle
hypothesis” is false (Vega 1990). During the last three decades, diving
researchers have proven that submerged land sites of virtually any age may
survive inundation in both fresh and salt-water environments, and be
systematically studied under water.

Submerged land sites of prehistoric, classical or historic cultures have already
been found world-wide, including Florida, California, Maine, Canada,
Jamiaca, Puerto Rico, Cuba, Virgin Gorda, Nevis, St. Eustatius, Denmark,,
Russia, Yugoslavia, Sweeden, France, England, Spain, Portugal, Gibraltar,
Searching for submerged prehistoric sites was first proposed in the United States by Goggin (1960), with early discussions by Solecki (1961), Shepard (1964), Emery and Edwards (1966), Salwen (1967), Bullen (1969) and Warren (1964). During this time, the archaeological community was not ready for diving and sea level research, and the problem remained more theoretical than practical.

In the Caribbean, the search for submerged prehistoric sites was first proposed by Nicholson (1976a), following a survey of Antigua, which indicated that shell middens on the NE coast are undergoing marine transgression, while middens on the SW coast are now inland.

Ruppé (1980b) has also encouraged a search for drowned Caribbean sites, based on his own successful underwater research in West Florida.

The first excavation of a submerged prehistoric site in the Caribbean, was conducted by the author, at Isla Verde Site, off Puerto Rico’s north coast (Vega 1981, 1982). Geoarchaeological modeling indicates that all four coasts of Puerto Rico may yield submerged prehistoric sites, with the highest
probability off the NE coast (Vega 1990b). Another submerged prehistoric site has been identified off Joyuda, off the west coast (Vega 1995).

More recently, a submerged preceramic site, probably the first in the Caribbean, was detected off Condado Beach, San Juan, Puerto Rico (Vega 1999).

Modeling of Caribbean sea level indicates that Vieques Sound was dry land during the Pleistocene Epoch or Wisconsin glaciation. A long paleo-island extended from Mona Passage to Anegada Passage, including the main island of Puerto Rico, Vieques, Culebra, the keys of La Cordillera, St. Thomas, St. John, Tortola, Virign Gorda, Anegada and lesser keys of the U.S. and British Virgin Islands.

The paleo-island has been named \textit{Puerto Virgen} by this researcher (Vega 1995:109). Only the island of St. Croix was not included in Puerto Virgen, as it lies outside of the insular shelf of Puerto Rico.

There is some dispute as to the beginning and end of the Pleistocene Epoch. Most researchers in the U.S. agree that the Pleistocene began approximately 1.9 million years ago and ended about 13,000 to 11,500 years ago.
Traditionally, archaeologists believed that humans walked from Siberia to North America around 11,200 years ago. Recent research indicates that people from Siberia and other parts of Asia may have reached the Americas as early as 20,000 years ago (Dillehay 2000). The latest research suggests that the first migrants in the Americas were Ice Age coastal navigators.

During the marine archaeological survey of Vieques Sound, conducted by the author for the installation of a submarine water pipe from Vieques to Culebra, the author detected beachrock at a depth of 62 ft. (19 m) and 4 miles (6.4 km) north of Vieques. Beachrock (Qbr) is cemented sand, forming a hard pavement along the shore. When found under water, it generally indicates that marine transgression has taken place. The beachrock pavement was formed during the flooding of Vieques Sound, sometime during the early Holocene.

Recent studies indicate that beachrock or lithified sandstone may also be formed under water (Mathews 1990:90). Still, the formation of beachrock pavements along the shoreline is a fact corroborated by numerous studies throughout the world.

In addition to the rise in eustatic or global sea level, tectonic factors have played a secondary role in the flooding of Vieques Sound. According to the
model developed by the author (Vega 1990), the northeast end of the Puerto Rico insular shelf is tilting, while the southwest is gradually rising.

3.2 PREHISTORY OF PUERTO RICO

According to Rouse and Allaire (1978:465), people started migrating into the West Indies as early as 6,000 to 7,000 yrs BP. This entry is backed by Pina (1971), Veloz and Ortega (1976), and others. Raggi (1973) suggests a possible entry between 6,000 and 15,000 yrs BP. Nicholson (1976) suggests possible migrations as early as 17,000 yrs BP.

Regardless of the time and reasons of the first Caribbean migrations, it is clear that the first prehistoric explorers used some type of watercraft to cross the passages from the mainland(s), and then from island to island. The first West Indians were navigators in a semi-enclosed sea.

The earliest inhabitants of Puerto Rico and the Caribbean were preceramic peoples. Although there are significant variations within the preceramic cultures, the following criteria are applicable to most groups:

- small population units (<100 individuals per band)
- tendency towards nomadism
- hunting, coastal gathering and fishing
- no use of agriculture
• watercraft without sails
• often associated with coastal middens.

It is important to keep in mind that preceramic peoples were fishermen and coastal hunter-gatherers not because they had yet to invent agriculture and ceramics, but rather because their small numbers and available resources allowed them to live off the land and the sea without the toil of agriculture.

Formal preceramic typologies have been produced by Kozlowski (1974), Pina et al. (1976), Rouse and Allaire (1978), and others. Although there are significant discrepancies, most researchers would agree that there are three primary typological patterns in the archaeological assemblages of preceramic cultures. Pattern 1 is characterized by ground stone artifacts, including stone balls, mortars and grinders. Pattern 2 is characterized by stone artifacts produced by percussion and pressure flaking, including choppers, scrapers, lanceolate points, flint knives, blades and microblades. Finally, Pattern 3 is characterized by shell artifacts, including conch picks and vessels, shell hammers, scrapers and gouges.

Preceramic peoples survived into the Ceramic Age of Arawak and Carib migrations from South America. Moreover, some preceramic bands survived into the early historic period, at least in Cuba, as reported by Spanish geographers Andrés Morales and Alonso de Santa Cruz (Sauer 1969:48).
Ceramic-producing peoples started migrating from South America into the Caribbean about 2,500 yrs BP or more, moving north along the Lesser Antilles and arriving in Puerto Rico as early as 300 BC (before Christ). Originating of Arawak stock, these peoples were characterized by the following traits:

- horticulture
- ceramics
- permanent villages
- watercraft without sails until historic times
- originally settled in coastal areas
- often associated with large shell middens
- sophisticated stone sculptures
- increased dependence on agriculture
- absorption of previous, preceramic peoples
- construction of plazas and ball courts
- eventual development of ceremonial centers
- culmination in regional chiefdoms

At the time of the Spanish arrival in the so-called New World, the aboriginal ceramic cultures of Puerto Rico were exploiting all ecozones, including the sea, the coast, mangrove lagoons, rivers, inland valleys and the rugged mountain interior.
Aboriginal ceramic sites in Puerto Rico are generally grouped into three principal, pottery-making traditions. In chronological order, these include the Saladoid, Ostionoid and Chicoid series or traditions. Again, there are differences of interpretation and stylistic variations within these traditions, but the main traits may be described as follows:

Saladoid: white-on-red wares, often including modeling and incision. Often associated with land-based foods, particularly crabs. Related traits include zemis or three-pointed stones, cohoba pipes, etc. Saladoid sites in Puerto Rico range approximately from 300 BC (before Christ) to 600 AD (after Christ). A distinct Huecoid series has been proposed by Chanlatte, which other researchers interpret as a Saladoid sub-series (Rouse 1992).

Ostionoid: use of red paint on entire surfaces of vessels, evolving into a red slip. Emergence of ball courts and ceremonial centers in Puerto Rico, and apparent increase in the production of zemis, have been related to the Ostionoid series. Often associated with large shell middens. Ostionoid sites in Puerto Rico range approximately from 600 to 1200 AD.

Chicoid: also called Chican-Ostionoid by some authors. Elaborate pottery with smooth surfaces and modeled-incised designs, but little use of paint. Chicoid ceramics are associated with the Taíno chiefdoms encountered by the
first Spanish explorers and settlers (Rouse 1992). Chicoid sites in Puerto Rico range approximately from 1200 AD to the mid-16th century.

No prehistoric archaeological sites, terrestrial or submerged, have been reported for the Study Area, at the site files of the *Consejo Arqueológico Terrestre*, the *Consejo Arqueológico Subacuático*, and the State Historic Preservation Office.

The closest reported prehistoric sites are Aguada 1 (AA-001) and Aguada 2 (AA-002) south of the Río Culebrinas, Aguadilla 2 (AG-002) at Sector Tamarindo, and Aguadilla 3 (AG-003) towards the north end of Aguadilla Bay. These coastal sites are not directly related to the Study Area, but may be significant as potentially eroded material from them may be transported by littoral currents. Additional archaeological materials have been reported by González (2004) for Barrio Espinar, inland of the Study Area. Archaeological investigations near the Study Area are discussed in Section 4.5.

During the contact period, late 15th and early 16th centuries, the area of Aguadilla was referred by some authors as Aymaco, the domain of the *cacique* Aymamón (Coll y Toste 1979). Overall, Caribbean archaeology has not been successful in bridging the gap between sites mentioned by early Spanish chroniclers and archaeological sites. From the perspective of maritime archaeology, preceramic and early ceramic sites are the primary
interest, as Taíno sites are the least likely to be found under water, except in areas of extensive erosion, as discussed below.

3.3 SUBMERGED PREHISTORIC SITES

Puerto Rico’s first submerged prehistoric site was discovered by the author and geologist Arturo Camacho, in the late 1970’s, off the north coast (Vega 1981). Located 6 km E of San Juan Islet, Isla Verde Site is a submerged midden off Punta el Medio, Carolina.

Isla Verde Site is located in shallow, protected water, between an inshore reef and Puerto Rico’s north shore. A small islet is adjacent to the submerged midden.

Following a preliminary survey in 1979, underwater test excavations were conducted in 1980. The site has been subsequently visited for additional observations, up to the present.

Underwater excavations revealed a compact midden, submerged in place. Located at the median point of a compound lunate embayment, Isla Verde was submerged as the embayment expanded. During transgression, the midden was partly protected from surf by the reef and a small islet.
The 1980 excavations yielded late Saladoid and Elenoid pottery shards, petaloid stone celts made of mudstone and volcanic breccia, shell picks and gouges, human bones, turtle and manatee bones, and diverse species of gastropod and bivalve shellfish.

Another possible, submerged prehistoric site has been detected off Joyuda, on the W coast. Numerous other sites are presently at the edge of the sea, including Caño de los Indios in Ceiba, Cayo Cofresí in Jobos, Cayito in Santa Isabel, Magueyes in Lajas, Joyuda in Cabo Rojo, Mar Chiquita in Manatí, Maisabel and Cerro Gordo in Vega Baja, etc. (Vega 1990).

A possible submerged, preceramic site was detected off Condado Beach, San Juan, by the author and oceanographer Vance Vicente, during the installation of a fiber-optic, trans-oceanic cable (Vega 1999). Vega-Vicente Site appears to be a shell midden about 205 m (671 ft.) from shore, at a depth of 6.7 m (22 ft.), behind a submerged beachrock pavement. This discovery supports the author’s model for submerged prehistoric middens (Vega 1990b:13, Fig. 18).

According to mid-to-late Holoene sea level curves for the Caribbean, based on extensive coring and radiocarbon dating of wetlands in Jamaica (Diggerfeldt and Hendry 1987), the depth of the site suggests a tentative dating of 6,250 yrs BP. The site is characterized by large lithic tools, numerous shell points,
absence of pottery, *Strombus* conchs with their tips removed, and diverse species of gastropod and bivalve shells.

Due to the lack of typical lithic tools at Vega-Vicente, the author is now inclined to consider this a potential submerged preceramic site, requiring additional diving research.

So far, no submerged prehistoric sites have been located anywhere in Aguadilla Bay. In theory, submerged prehistoric sites may be found in all four coasts of Puerto Rico. Even the narrow insular shelf off Aguadilla contains land that was above sea level and potentially occupied by preceramic peoples, four to seven thousand years ago.

Areas near river mouths are considered potentially sensitive for prehistoric sites, both above and below present-day sea level. In Puerto Rico, various prehistoric sites near river mouths are currently in the process of marine transgression, or inundation by the sea. Such is the case of Monserrate in Luquillo, and Coco Beach in Río Grande.

As previously stated, the Study Area is located at the mouth of Caño Madre Vieja. In theory, this is a significant factor, although one cannot assume that every river or creek contains a prehistoric site at or near its mouth.
In some cases, it is possible to follow the old course of a stream along the insular shelf, using sonar technology or diving transects. Side-scan sonar, as well as sub-bottom profilers, may detect the course of submerged paleo-streams, which in turn can be mapped as used as a guideline for detecting submerged archaeological sites at or near the flooded river banks.

In the case of Caño Madre Vieja, the stream is rather small and the sedimentation processes within Aguadilla Bay are extensive and complex. Oceanographic analysis for the proposed jetties did not detect any evidence of submerged paleo-streams off Caño Espinar (Dr. Jorge E. Capella, Personal Communication 2007). The same negative results were reported to the author by the marine biological consultant (Dr. Vance Vicente, Personal Communication 2007). Analysis of water depths, in NOAA nautical charts and USGS topographic and geologic quadrangles, did not reveal any pattern of a paleo-stream, not even for the much larger Culebrinas River.

Inspection of the geologic quadrangle (Grove 1983) suggests that Caño Madre Vieja is one of three mouths of the Río Culebrinas, the other two being a closed creek that almost reaches the bay north of Parque de Colón (about 400 m NE of the Study Area), and the actual mouth of the Río Culebrinas (about 1.7 km SW of the Study Area). In terms of historic development, the river may have migrated south, beginning at the now closed mouth north of Parque de Colón, then at Caño Madre Vieja, and finally at its present location at the
Río Culebrinas, which has been the primary mouth at least since the early 16th century. Such migrations of the Río Culebrinas, combined with the high energy and sediment transport of Aguadilla Bay, are likely to have erased any clear evidence of paleo-streams. This preliminary analysis suggests a complex interaction between the river mouth and marine sediment transport in the bay, with the marine sand closing the river mouth and forcing it to migrate south in search of a new outlet.

Except for Rincón, south of Aguada, Aguadilla has the narrowest portion of Puerto Rico’s insular shelf. Off the Study Area, the insular shelf begins sloping about 2 km from shore, soon reaching depths of 100 m. Ocean depths increase sharply towards the northwest, reaching 5000 m and continuing down to 8200 m in the Brownson Deep of the Puerto Rico Trench, the deepest place in the Atlantic Ocean (Athearn 1976:84). The bathymetry off Aguadilla is depicted in Figure 11.

Applying a minus-10 m (-32 ft.) sea level to the bathymetry off the Caño Madre Vieja, we may estimate the Study Area’s paleo-shoreline by 7,000 yrs BP. A simple calculation indicates that the shoreline was about 500 m from its present location. This strip of submerged land extends all along Aguadilla Bay. So far, no evidence exists that this submerged land was occupied in prehistory, but it is certainly a possibility, particularly the shallower areas (<5 m deep), representing the 3,000 BP coastline.
Unfortunately for archaeologists, but good for surfers, the northwest coast of Puerto Rico is also characterized by big waves. Many world-class surfers consider the waves off Puerto Rico’s NW coast to be superior to California and almost equal to Hawaii (Pilkey 1976:74).

Most of Puerto Rico’s best surfing spots are localized along this coast, including Offshores, Wilderness, Gas Chambers, Hole in the Wall and Bridges in Aguadilla, Table Rock, BC’s, Angry Ladies and Punta in Aguada, and Dome, Indicators, Tres Palmas, Steps, Little Malibu, Twist and Sugar Loaf in Rincón.

For marine archaeologists, big surf means potentially dangerous diving and, more importantly, high-energy systems capable of dispersing archaeological materials on the shoreline. Thus, unless our hypothetical prehistoric site was buried prior to inundation, it is likely that such a site would have been disturbed by countless episodes of heavy surf as it was gradually inundated by the prehistoric rising sea level. From this perspective, Aguadilla Bay is not a particularly good place for finding submerged prehistoric sites.

### 3.4 ABORIGINAL WATERCRAFT

The primary aboriginal method of water transport was the canoe, with possible, secondary use of rafts. The antiquity of canoes is well established.
In Florida, prehistoric dugout canoes dating back to 3,000 yrs BP have been excavated in wet sites.

In the Bahamas, Columbus saw canoes “all of one piece hollowed like a tray from the trunk of one tree . . . so large as to contain forty or forty-five men, while others were so small as to hold one person” (McKusick 1970:8). In Jamaica, Columbus measured on finely decorated canoe at 29 m (96 ft.) and 1.8 m (6 ft.) wide (Sauer 1969:82). This was surpassed by another canoe at the Bay Islands, off Honduras, “as great as a galley, eigth feet wide, all of a single trunk” (ibid:128).

Coppier describes a Lesser Antillean canoe that was 27 m (90 ft.) long, which he estimated could carry up to eighty-five persons plus cargo (Cárdenas 1981:143). Columbus reports that the largest canoes traveled with great speed, strictly be paddling. None of the Eurpean explorers mention the use of aboriginal sail. According to the Spanish Friar Blasius, rescued by the British at Dominica in 1606, all of his companions were killed by Carib Indians, who spared him for teaching them how to rig sails to their canoes (Mckusick 1970:5).

Aboriginal canoes were built of mahogany (Swistenia mahogany), cedar (Cedrale odorata Gomier), silk cotton (Ceiba pentranda), and other fine woods. The construction process often included the use of fire. Prehistoric
Caribbean navigation is discussed in detail by Robiou (1993). The structural difference between river and seagoing canoes is discussed by Vega (1990, 1995), including the possible aboriginal invention of the pirogue or keeled canoe.

The use of canoes extended well into the historic period, with rigged pirogues used as late as the 19th century. Prehistoric or historic, the discovery of a canoe in Puerto Rico’s waters would be of primary significance, because not one has been systematically excavated. Such a discovery might occur practically anywhere in Puerto Rico’s coastal waters, including beaches, coastal shallows, river mouths, reefs, lagoons, ports and under modern piers.

To the non-specialist, a broken canoe might be indistinguishable from a rotting tree trunk. In principle, all dredging operations in rivers, estuaries and bays should be conducted under archaeological supervision, in order to avoid the accidental destruction of prehistoric or historic canoes.
Figure 9. Generalized eustatic sea level curve for the last 40,000 years (Komar 1976). Approximately 18,000 years ago, sea level dropped to nearly 130 m below present level, connecting the main island of Puerto Rico to Vieques, Culebra and all the U.S. and British Virgin Islands except St. Croix. By 7,000 BP, a moderate estimate for the beginning of human migration into the NE Caribbean, sea level was about -10 m.
Figure 10. Approximate coastline of Puerto Rico and the Virgin Islands during the Pleistocene. The paleo-island of *Puerto Virgen* extended from Cabo Rojo to Anegada.
Figure 11. Bathymetric map of the sea floor off NW Puerto Rico (Athearn 1976, Plate 5).
Figure 12. Historic illustration depicting construction of Caribbean aboriginal canoes (in Robiou Lamarche 1993).
4. Historic Ports and Shipwrecks

Non-maritime researchers often believe that underwater archaeology is limited to shipwrecks. In fact, a historic port is an archaeological site in itself, with or without shipwrecks (Vega 1995:99-108). In recent years, entire towns and cities have been discovered in the waters of modern-day ports, including Alexandria in Egypt and numerous other Mediterranean submerged towns.

In theory, it is useful to distinguish between cities and towns flooded by catastrophic or gradual changes in relative sea level, and port materials lost in everyday shipping activities. In practice, however, both types of materials may be found together. Decades or centuries after a town is submerged, the same area may be used as a harbor, producing a layer of port discards above the occupation layer of a submerged terrestrial site.
In San Juan Harbor, for instance, it is theoretically feasible to find a historic shipwreck site mixed with historic port discards, underlain by a submerged prehistoric site.

A wide variety of archaeological materials may be found in historic ports, including abandoned piers, hulks, anchors and chains, ballast piles, and all types of artifacts associated with port life.

In addition to the formal ports such as San Juan, Ponce, Mayagüez, Aguadilla, etc, the coast of Puerto Rico contains numerous informal, historic anchorages. These informal anchorages might yield significant archaeological signatures of historic contraband patterns, essential to understanding the early colonial history of Puerto Rico.

Historic charts and documents indicate that the Study Area was never developed as a formal port with piers and other intertidal structures. On the other hand, Aguadilla Bay as a whole may be regarded as a historic anchorage of great significance to the maritime history of Puerto Rico. Beyond the mystery of Columbus’ landfall in 1493, Aguadilla Bay played a key role in the Spanish fleet system, and in the commercial history of Puerto Rico, with intensive port activity and occasional ship losses of interest to maritime archaeologists.
4.1 MARITIME HISTORY OF PUERTO RICO

Puerto Rico was “discovered” in 1493, during Christopher Columbus’ second voyage. As indicated in Section 3, Puerto Rico was actually discovered at least five thousand years before Columbus, by aboriginal hunter-gatherers who may have entered the Caribbean from North, Central or South America. Thus, the reader should be aware of the great anthropological complexity behind this first “official” and “dated” event in Puerto Rico’s history, which also represents the beginning of the Christian Era for this Caribbean island.

Columbus’ landfall in Puerto Rico is discussed in Section 4.2.

In 1504, Vicente Yanés Pinzón briefly explored the island, introducing goats, pigs and horses. The following year, Yanés Pinzón was granted the title of Capitán General y Gobernador of Puerto Rico, but afterwards decided to move his colonial enterprise to Brazil.

During the early 16th century, Puerto Rico was at the core of the Spanish colonial enterprise. The island had excellent harbors, abundant rivers, fertile soil and the promise of gold. Soon, however, the mining decayed, and the island lost much of its initial attraction. By the early 17th century, Puerto Rico and the Caribbean had become peripheral to the main colonial enterprise.
Still, the island retained great strategic importance in relation to the Spanish fleets (Cardona 1989).

At the time of Columbus’ discoveries, Spain was hindered by a weak economy. Financial difficulties were largely due to the 1492 conquest of Granada, the last Islamic bastion in Spain. Thus, the conquest of the Americas became an open door for private investors and adventurers. Their contract with the crown was know as a capitulación. This royal license could be sold or exchanged.

In 1508, already a hero of the Indian wars in Hispaniola, Juan Ponce de León signed a capitulación to settle Puerto Rico. The following year, he founded the settlement of Caparra on the north coast, while Cristobal de Sotomayor founded Guánica on the south coast.

Caparra was built about 3km inland from San Juan Bay (measured as the bird flies, with an estimated walking distance of about 4 km). The settlement was named after the Roman city of Caparra or Capera, near Cáceres, Spain, by Nicolás de Ovado, Governor General of the Indies, who was born in Cáceres (Sepúlveda 1989:33-51).

The new Caparra, described as a ciudad or city in some documents, included various stone houses, a plaza, a church, a small hospital, dozens of bohíos or
thatched houses, warehouses, a brick furnace for gold production, farms, a blacksmith’s shop, wells, etc. The town was close to various aboriginal settlements, which provided labor for the mining and agricultural enterprises.

At the south end of San Juan Bay, the settlers of Caparra built a small port, connected to the city by a dirt road. The location of the port, or desembarcadero, is depicted in a map of 1519, by Rodrigo de Figueroa (Archivo General de Indias, Mapas y Planos, Santo Domingo 1).

Cartographic analysis of over 50 maps, including more recent historic maps up to the early 20th century, clearly identify the port of Caparra at the site of the present-day Army Terminal, on the south end of San Juan Bay (Vega 2001).

Caparra lasted from 1509 to about 1521, when the settlement was abandoned in favor of San Juan. Located on an islet, the new settlement of San Juan had immediate access to the large harbor, and the islet had the natural protection of sea cliffs, dangerous reefs and big waves on the north coast, a narrow entrance to the bay, and a thick mangrove forest and swamp extending all along the south or bay side of the islet.

In 1511, while Juan Ponce de León developed Caparra on the north coast, Cristobal de Sotomayor established a small settlement in Guánica, on the
south coast of Puerto Rico. The following year, Guánica was sacked and burned by Indians, killing Sotomayor during the attack.

In 1512, the survivors of Guánica moved to the port of San Germán, near the mouth of the Río Grande de Añasco. This river is the present-day frontier between the Municipios of Añasco and Mayaguez. During the early 16th century, this area was also known as Guaorabo, the Taíno name for the Río Grande de Añasco (Cardona 1985:6). Another early Spanish name for Añasco Bay was the Aguada de San Antonio.

San Germán was occupied from 1512 to 1556, surviving attacks from Indians and pirates in 1528, 1538, 1543, and finally burned and abandoned in 1556. This time, the settlers moved to Guayanilla Bay. Fourteen years later, the new settlement was burned by French corsairs and Indians. The survivors then moved to the Hills of Santa Marta, inland along the Río Guanajibo, founding the actual town of San Germán in 1521.

By the end of the 16th century, the west coast of Puerto Rico included the ports of San Germán (Añasco Bay), Cabo Rojo, Puerto Vargas (Boquerón), Palmas (Mayaguez), Aguada and Aguadilla.

During the early 16th century, ships en route from Spain to Hispaniola (Dominican Republic) and New Spain (Mexico) generally sailed along the
south coast of Puerto Rico, making a watering stop at San Germán (present-day Añasco Bay). This derrotero or sea route would place the Spanish fleets off the west coast of Puerto Rico on a regular basis.

In order to reach the south coast of Puerto Rico, the vessels entered Vieques Sound through the Virgin Passage, between the islands of Culebra and St. Thomas. In 1522, a Spanish convoy called La Armada was established in order to patrol Vieques Sound and adjacent waters.

As early as 1532, Culebra was called Pasaje or Isla de Pasaje, and the Virgin Passage was called Pasaje Grande or Great Passage (Vega 1988). The smaller, more dangerous passages of La Cordillera, between Culebra and Puerto Rico, were called Pasajes Chicos and avoided by large vessels (Cardona 1985:7-12).

An alternate route for entering the Caribbean Sea was past Deseada (Guadaloupe), in the Lesser Antilles. Then the fleet would sail along the south coast of Puerto Rico and up along the west coast to the aguadas of Añasco Bay and Aguadilla Bay.

By the 17th century, the route from Spain to Mexico was changed, with the fleet sailing along the north coast of Puerto Rico, stopping at San Juan if
necessary. This route was more dangerous in terms of weather, but safer from corsairs and pirates because of the protection of fortified city of San Juan. Upon leaving San Juan en route to Mexico, the ships would sail west past Punta Borinquen, then southwest, between Puerto Rico and Desecheo Island, stopping at the *aguadas* or watering places of the west coast.

On average, sailing from Spain to Mexico lasted seventy-nine days, or two and a half months, including a five-day *feria* on the west coast of Puerto Rico. To appreciate the significance of the Spanish fleet system, of which only a segment has been described here, this was the first global communication network in history. However difficult and rudimentary the Spanish fleet system was, it fused the ports and politics of Europe, Africa, the Americas and Asia into one global history.

During the 17th and 18th centuries, the ports on the west coast of Puerto Rico became official *aguadas* or watering stops for the Spanish fleets en route to the New World. These outbound fleets often carried *azogue* or mercury, an essential component for the extraction of gold and silver in New World mines.

The Spanish trade system actually included two great fleets. One sailed to the Caribbean ports of South America, or *Tierra Firme*. The other fleet sailed to Mexico, or *Nueva España*. 
Both fleets depended on the great ocean current that moves like clockwork between Europe and the Caribbean, circling the Sargasso Sea in the center of the North Atlantic Ocean. This is the great vortex that was used by Columbus and many other sailors after him.

Within this geographic background, it is easy to see the advantageous location of Spain and Portugal in the relation to the New World, as well as the strategic position of Puerto Rico on the outbound journey.

Although we tend to speak of Puerto Rico as a small island, it is in fact a middle-sized island, the first significant land mass to a ship crossing the Atlantic Ocean from the Iberian Peninsula.

For the return voyage, after loading up treasures and other cargo in Cartagena, Veracruz and lesser ports, the two fleet met in Havana, Cuba, sailing northeast along Los Mártires (the Florida Keys), and then either continuing north along the coast of South Florida, or veering east into the Bahama Channel. This is the reason why Cuba, Florida and The Bahamas are considered hot spots for sunken treasure.

Beyond their role in the fleet system, the ports of Añasco Bay and Aguadilla Bay also played a prominent role in Puerto Rico’s trade history, particularly for contraband with vessels of other European nations.
The reasons for the widespread contraband were many, including a weak Spanish economy, limited formal trade between Spain and Puerto Rico, the island’s irregular coast with numerous coves and bays, the limited Spanish coast guard operations, and the participation of many government officers and priests in the contraband operations. According to many historic documents, by the late 17th century, nearly everyone was involved in contraband, from the bishop, priests and high-ranking officers, to soldiers and private citizens (López Cantos 1975: 254; Archivo General de Indias, Santo Domingo 159).

In Puerto Rico, contraband was a necessity, an adaptation to a huge but decadent empire that often failed to provide even the basic necessities of its colonies. Frequently, the smugglers staged an elaborate “pirate play,” threatening to burn the town if the locals wouldn’t trade with them (Morales Carrión 1974).

In 1805, the Spanish crown instructed the Governor of Puerto Rico to open the ports of Fajardo, Ponce, Cabo Rojo, Mayaguez and Aguadilla. The goal was to promote trade with other Spanish-American ports and reduce contraband with non-Spanish vessels (Morales Carrión 1974:121).
4.2 COLUMBUS’ LANDFALL IN PUERTO RICO

Christopher Columbus was a navigator and explorer who achieved legendary and almost mythical status through his “discovery” of “America.” Hundreds of books have been written about him. To many, he was a hero and a visionary; to others, a ruthless imperialist who led the way to an aboriginal holocaust.

Cristoforo Colombo was born in Genoa, Italy, circa 1451. Contrary to the popular view, he was not a professional seaman, but rather a self-taught geographer and persuasive visionary. The idea of reaching the Far East by sailing across the Mar Océano or Atlantic Ocean was not entirely original, but Columbus was the first to actually organize an expedition and go.

Knowledge of the Earth’s roundness had been known at least since the Greek philosopher Aristotle. In 240 B.C., Eratosthenes calculated the size of the Earth by comparing the shadows in Alexandria and Aswan at the same time, during the summer solstice. Based on the difference, he estimated the circumference of the Earth at 250,000 stadia, equivalent to 23,990.4 miles. This was an incredible achievement, as modern scientists with sophisticated instruments have measured the circumference of the Earth at 24,887.64 miles (Axelrod 2003:20-21).
Out of ignorance or as a promotional strategy, Columbus underestimated the circumference of the Earth and, therefore, the distance from Spain to China across the *Mar Océano*, today’s Atlantic Ocean.

As a man of humble origins, Columbus needed state support. He went to Portugal, at the time the most advanced maritime nation in the world. Under the direction of Prince Henry “The Navigator,” Portuguese vessels were already exploring the huge African coast and the offshore Atlantic islands of the Azores, Madeiras, etc.

After the Portuguese turned him down, Columbus found support in the Spanish monarchs, Fernando and Isabel. At the time, Catholic Spain was just completing its *reconquista* of the Iberian peninsula from the Moors. In 1492, the same year that Columbus sailed to the Caribbean, the Moors or Iberian Arabs were expelled from their last European stronghold at Granada.

For the Spanish Catholic monarchs, the idea of trading with China without crossing the Middle East must have been an offer too good to refuse. In addition to avoiding potentially hostile Muslim nations, a westward route to China would also the eliminate the tariffs of middlemen in the Middle East.
In 1492, with three small ships, Columbus crossed the Atlantic Ocean in thirty-three days, reaching the Bahamas and then Cuba and Hispaniola. Off the coast of present-day Haiti, Columbus wrecked his flagship the Santa Mária. Leaving a small group of men in Hispaniola, Columbus returned to Spain, where he was greeted with much enthusiasm.

In September 1943, Columbus returned to the New World with a large fleet of seventeen ships. This second expedition carried about twelve hundred men and women, including soldiers, farmers, priests, artisans and gentlemen. These were not an invading army, as Columbus believed that the natives lacked the technology and the social organization to oppose his enterprise. These people were settlers claiming a new land so vast that it was called the New World.

Although Columbus’ log of the second expedition has never been found, other primary sources are available, including the map of Spanish cartographer Juan de la Cosa, the Relación of Dr. Diego Alvarez Chanca, the Memorial of Antonio Torres, the Crónicas of Pedro Martir, and the summaries of the expedition by Hermando Colón, son of Columbus, and Fray Bartolomé de las Casas (Delgado et al. 1996:9).
The four voyages of Columbus are discussed in detail by Varela (1984), Varela and Gil (1992), Parry (1981), Morrison (1942), Sauer (1969), and others.

In 1788, the first history of Puerto Rico was published by the Spanish friar Iñigo Abbad y Lasierra (2002). Fray Iñigo indicated that the exact site of Columbus’ landfall was unknown, but he believed that it was in the port of Aguada, on a beach called Guadilla, meaning today’s Aguadilla Bay.

Another pioneer historian, Pedro Tomás de Córdova (1824), placed Columbus’ landfall in Aguadilla Bay (Sepúlveda Rivera 2004:58).

Shortly after the Spanish-American War of 1898, war correspondent José de Olivares (1899) continued the tradition of identifying Aguadilla Bay as Columbus’ landfall, with various photographs on the subject, including the book’s artist posing at the beach where Parque de Colón now stands (Olivares 1899, Vol. I:329).

In his Pulitzer-winning biography of Columbus, Samuel Elliot Morrison (1942) proposed that the landfall was in Cabo Rojo. In Spain, Martín Fernández de Navarrete (1945) proposed Mayagüez.
In Puerto Rico, Salvador Brau (1978:10) and Añeses Morell (1949) supported the landfall at Aguadilla Bay. Other noted historians in support of Aguadilla Bay include Agustín Stahl, Cayetano Coll y Toste, Victor Coll y Cuchi and Eduardo Neumann. Aurelio Tío (1961) favored Añasco Bay, while Manuel Zeno Gandía favored Guánica or Guayanilla on the south coast, and Augusto and Salvador Perea favored Boquerón in Cabo Rojo (Cardona Bonet 1985:17).

In addition to the landfall itself, historians have also debated if Columbus sailed along the north or south coast of Puerto Rico. In the Libro Copiador de Cristobal Colón, discovered in an old bookstore in Tarragona, Spain in the 1980’s, it is clearly stated that Columbus sailed along the north coast (Delgado et al. 1996:4). The Libro Copiador was purchased by the Spanish Government, stored at the Archivo General de Indias in Seville, and its text published by Varela and Gil (1992).

Some historians prefer to avoid the enigma of Columbus’ landfall. Arturo Morales Carrión (1998:75) writes that “we shall not penetrate the labyrinth of this debate,” nosotros no vamos a penetrar en el laberinto de este debate ni a dictar sentencia en este complicado pleito.

Francisco A. Scarano (2000:158) simply states that Columbus landed “somewhere on the west coast,” desembarcó por algún punto de la costa.
occidental. Other historians do not even mention the landfall, either regarding it as a small issue of no significance to the broad patterns of history, or as a technical matter beyond their expertise.

In their in-depth study of Columbus’ landfall, Delgado et al. (1996:35) concluded that Columbus’ large fleet sailed along Puerto Rico’s north coast and anchored in Aguadilla Bay. Although somewhat confusing, this study provides an excellent introduction to the various theories.

More recently, Aldo Alvarez (2003) suggested that the landfall occurred in Rincón, Añasco, Mayagüez or Cabo Rojo, but not in Aguadilla Bay. His argument is based on Juan de la Cosa’s map in light of the Earth’s magnetic declination, a geophysical phenomenon observed by Columbus but not understood by cartographers and mariners until the late 17th century.

Because early Spanish navigators and cartographers mistook the magnetic north in their compasses with the Earth’s true north, Aguadilla Bay was initially considered a part of Puerto Rico’s north coast. Since all primary sources indicate that Columbus’ landfall took place on the west coast, sites like Guayanilla Bay on the south coast would have to be eliminated. The same argument was applied by Alvarez (2003) to Aguadilla Bay, because Juan de la Cosa and subsequent cartographers believed that it was on the north coast of Puerto Rico.
A significant discovery occurred at the Archivo de Simancas in Valladolid, Spain, where the payroll of Columbus’ second voyage was found (Varela et al. 1998). Thanks to this document, it is clear that Columbus’ fleet consisted of five *naos* and twelve *carvels*.

The *nao* is a generic name for ship in Catalán. During the late 15\(^{th}\) and 16\(^{th}\) centuries, a *nao* was a large, high-sided cargo ship with a deep hull, two or three decks and two castles, between 120 and 500 tons. In size, shape and rigging, the *nao* was comparable to the carrack and the galleon (Greenhill 2000:400).

In Guadeloupe (also called Deseada), the northernmost Windward Island in the Lesser Antilles, Columbus allegedly rescued a number of Taíno women and a few young men who had been captured by Caribs. These people led him to their home in Borikén, or Puerto Rico. As Columbus’ vessels approached the coast of Borikén, two women and one man jumped overboard and swam to shore.

It is evident that Columbus made landfall in a big bay, large enough to accommodate seventeen sailing ships, five of them large ships, requiring plenty of space.
Another known historic fact is the presence of a large Taíno village where the landfall took place. However, there was no encounter to speak of, because the natives left in haste as the bearded strangers landed on the beach. From the perspective of defining the landfall, all municipalities on the west have evidence of prehistoric occupation, and the largest sites may have been destroyed by construction of the Spanish towns.

By 1532, both Aguada and Añasco were recognized as official Spanish harbors, the other two being San Juan on the north coast and Guánica on the south coast.

Based on all the available evidence, the author is inclined to reduce the enigma to two candidates, Aguadilla Bay and Añasco Bay. Aguadilla is bigger, and therefore better for accommodating a large fleet of sailing ships, if the wind is blowing from the east or southeast. Añasco Bay is smaller and has offshore reefs, but is more protected than Aguadilla Bay.

From an archaeological perspective, a fleet of seventeen ships anchored for two days would have produced a “signature” of trash and accidental losses. However, these artifacts would be indistinguishable from early 16th century trash produced by later settlers. Thus, Columbus’ landfall should remain strictly a historical problem and not an archaeological question. As far as Columbus’ landing is concerned, there is no archaeological site to speak of.
From the perspective of heritage, it is best to see Columbus’ landfall as a regional event involving Aguadilla, Aguada, Rincón and Añasco. These four municipios have a rich and deeply connected maritime history.

4.3 HISTORY OF AGUADILLA BAY

The term *aguada* had various meanings in the maritime history of Puerto Rico. Any watering site was an *aguada*, but the official *aguadas* from the 16th to the 19th centuries were Añasco, Aguada and Aguadilla, the last two within Aguadilla Bay.

An *aguada* is not simply a river mouth, but a large spring or a river fed by springs. A large, muddy river was not an *aguada*, because its water could not be used for drinking directly.

The *aguada* of Añasco was initially the Port of San Germán. As previously indicated, there were two other towns named San Germán, including Guayanilla and the present-day San Germán on the Hills of Santa Marta. Finally, there was also the *Partido de San Germán*, a political division including the western half of Puerto Rico, west of the Río Camuy on the north coast and west of the Río Xacaguas on the south coast. Thus, a shipwreck
anywhere on the west coast of Puerto Rico could be described in archival records as “off San Germán.”

The term *aguada* could also refer to the towns of Aguada and Aguadilla, both within Aguadilla Bay and separated one from the other by the Río Culebrinas.

The name Aguada de San Francisco was originally applied to Añasco in the 18th century, and to Aguada in the 19th century. The 1740 map of the Aguada de San Francisco refers to Añasco Bay. In the 16th century, Aguada was also called Culebrinas, and Añasco was called San Germán.

The original Aguada de San Francisco in Añasco Bay (San Germán) was settled as early as 1502. After the attack on San Germán in 1528, some of the settlers moved to Aguada, within present-day Aguadilla Bay. Instead of being exposed on the coast, the new settlement of Aguada was surrounded by four swamps. It was prone to flooding, but it was easier to defend from pirates and Indians. By 1530, the new Aguada had over one hundred settlers.

Barrio Espinar, where the Study Area is located, was named in honor of Fray Alonso de Espinal, who arrived in Hispaniola with Fray Bartolomé de las Casas in Antonio de Torres’s fleet, and then sailed to San Germán. While Padre Montesinos established the Order of Santo Domingo in San Juan, Fray Alonso established the Order of San Francisco in San Germán. This internal
religious division contributed to the political and financial rivalry between San Juan and the Partido de San Germán. Fray Alonso de Espinal died in 1511.

The Franciscan friars built a small monastery called San Francisco de Asís, (Tío 1961:210). Originally, the Aguada of San Francisco loosely included Añasco, Rincón and Aguada. In 1528, the monastery was attacked by Taíno Indians, torturing and killing five monks while other three managed to escape.

As indicated in Section 4.1, the destruction of the early settlement of Sotomayor in Guánica led to the development of San Germán, whose destruction then led to the development of Aguada, in turn leading to the development of Aguadilla. Thus, the heritage of these towns is deeply related and should not be broken down into municipal histories.

In 1580, Diego Menéndez de Valdéz described three ports on the north coast of Puerto Rico, including Culebrinas (or Aguada in Aguadilla Bay), Arecibo and Puerto Rico (San Juan). The same was reported in 1582 by Juan Troche Ponce de León in the Memorial of Capt. Juan de Melgarejo, Governor of Puerto Rico (Caro Costas 2002:183; Cardona 1985:21).

In 1595, after failing to capture San Juan, Sir Francis Drake arrived on the west coast, where he anchored for water and ship repairs, almost certainly at Aguadilla Bay (Perea 1972:120).
In 1598, English chaplain John Layfield visited the coast of Aguada with Cumberland’s fleet, describing the high quality of the water and a good river with its mouth completely sealed by beach sand (Cardona 1985:24). He mentioned that this was the same bay where Drake had anchored three years earlier.

In 1673, Bertrand d’Ogeron, the legendary Governor of the pirate bastion of Tortuga, wrecked his ship *L’Ecueil* on the coast of Arecibo, on the north coast of Puerto Rico. His intention was to invade Curazao, but a hurricane changed his plans.

A large number of pirates drowned or were killed by the Spaniards. The rest were captured. Pretending to be a lunatic, d’Ogerón was not tied up like the rest and managed to escape. He then stole a canoe and crossed Mona Passage.

Months later, he returned to Puerto Rico, landing at Aguadilla Bay, while another group of pirates landed at Arecibo, where they captured a few people. Repelled by the locals, d’Ogerón lost fifty men but managed to escape once again. He promised to return for his men, but the king of France forbade him to do so (Cardona 1985:40). Many of the captured pirates died from hard labor, with the last two sent to Spain in 1677. Three centuries later, the author had the opportunity of diving at the cannon site of the *L’Ecueil*, where
Spanish salvors dropped them between the wreck and the rocky shore, unable to get them on land.

During the 17th and 18th centuries, the town of Aguada grew as a support station for Spanish fleets en route to Hispaniola, Mexico and Colombia. The arrival of the fleet was a big social and economic event known as La Feria. For the officers, sailors and passengers, the Feria provided water, fresh food and a chance to walk on dry ground. The ships would line up along the bay, using the ships’ boats as well as local boats to taxi people and cargo to and from the shore.

Cardona Bonet (1985b:7) reports three 17th century anchorages in Aguadilla Bay, including the mouth of the Río Culebrinas, the mouth of Caño Madre Vieja, and the now urban waterfront of Aguadilla. He mentions a battery built in the 17th century by the Río Chico, which he interprets as Caño Madre Vieja, followed by a sentry post in the 18th century, and a battery with two artillery pieces in the 19th century. Cardona also indicates that the area was impacted by extensive erosion during the 1840’s, destroying the structures mentioned before.

Although Cardona Bonet has conducted extensive primary research on Puerto Rico’s coastal and maritime history, including some of the author’s own investigations, he does not provide primary data for the structures interpreted.
as being built by the mouth of Caño Madre Vieja. A careful reading of all the available data suggests that Cardona Bonet may have confused Aguadilla’s “Río Chico” with Caño Madre Vieja.

The Río Chico or “little river” is the stream that was fed by the famous Parterre or *Ojo de Agua* in the town of Aguadilla. This is the great spring that was sought by mariners since the early 16th century. A stone structure was built around the Ojo de Agua in 1851-52 by Enrique Hau, which is now listed in the National Register of Historic Places (OEPH 1995).

The Río Chico is clearly depicted in a 1784 map of Aguada de San Juan (Figure 18), yet another name for Aguadilla Bay. In this map, the Río Chico is located towards the north curve of the bay, in present-day Aguadilla.

The mouth of the Río Chico is also depicted in an old watercolor given in Barcelona to Víctor Añeses Méndez, grandson of Ramón Añeses Morell, Mayor of Aguadilla from 1911 to 1933, and reproduced in color in the elder Añeses’ book on the history of Aguadilla (Añeses Morell 2004).

Thus, the batteries and sentry post mentioned by Cardona Bonet appear to have been destroyed by erosion somewhere within Aguadilla’s waterfront, not at the mouth of Caño Madre Vieja.
During the late 18th century, the west coast saw the rise of various new towns, including Rincón, Moca, and Aguadilla and San Sebastián. The founding of these towns represented a great loss of territory for Aguada.

The relationship of the Study Area to the town of Aguada is clearly depicted in a 1737 map by Francisco Fernández Valdelomar (Figures 14 and 15). This map depicts the Spanish fleet anchored off the Río Culebrinas. Near the river mouth is a small fort or battery in construction, with the town of San Francisco de Aguada further inland. Between the Río Culebrinas and Caño Madre Vieja is an area called Los Ranchos, which later became Espinar. There are no fortifications or houses at the mouth of Caño Madre Vieja. All the houses along the creek are located inland, with two dirt roads running between the river and the creek.

During the feria, which celebrated the arrival of the Spanish fleet, the beach between the Río Culebrinas and Caño Madre Vieja was busy with commercial activity. Cardona Bonet (1985b:7) and Pagán Mir (Personal Communication 2007) indicate that historic pottery shards, bottle fragments and even coins may be found occasionally on the beach.

By the early 19th century, Aguadilla Bay was considered within the west coast of Puerto Rico. By this time, sailors and merchants had also realized that the northern side of the bay was more protected. This led to the development of
Aguadilla as the principal port in the bay, as reflected in the actual name of the bay.

In the 19th century, both Añasco and Aguada lost their status as ports, with the rise of Mayagüez and Aguadilla. Mayagüez was always considered a protected bay, but its dangerous reefs of Manchas Interiores and Manchas Grandes made it difficult for large sailing ships. By 1834, the formal ports on the west coast were Aguadilla, Mayagüez and Cabo Rojo (Flinter 2002:111).

By 1837, the first-rate ports of Puerto Rico were San Juan, Ponce and Mayaguez, with the secondary ports of Guayama, Aguadilla and Naguabo, and the third-rate ports of Fajardo, Humacao, Salinas, Cabo Rojo, Guayanilla and Arecibo (Dávila Cox 1996:251). With the development of steam propulsion, the advantages of Mayagüez became evident.

For the year of 1838, a total of 64 vessels entered Aguadilla Bay, including 41 Spanish vessels, 11 U.S.A., 8 Bremen, 1 Danish, 1 French, 1 British, 1 Portuguese (Palerm Rincón 1982:138).

By 1839, Aguadilla was the second largest coffee exporter in Puerto Rico, after Mayagüez. Aguadilla was also a strong exporter of tobacco, cotton, rum and hides. That same year of 1839, a total of 41 vessels entered the Port of
Aguadilla, including 24 Spanish vessels, 3 Bremen, 1 Hamburg, 1 Danish, 8 U.S.A., 2 French and 2 British (ibid 1982:119).

In 1842, Governor Méndez Vigo opened the secondary ports to international commerce, including Aguadilla. In 1866, the Spanish authorities closed down the ports of Aguadilla, Arecibo and Naguabo to international trade, for fear of extensive contraband. This did more harm than good, and the ports were reopened one year later (Dávila Cox 1996:254). Overall, the ports of Aguada and Aguadilla were frequently involved in contraband operations, necessary for the survival of the colonial settlements.

By the end of the 19th century, Aguadilla lost its shipping operations to Mayagüez. In addition to a more protected harbor favored by the more maneuverable steam ships, Mayagüez also had better roads and was closer to the large haciendas and plantations.

In 1918, Aguadilla and Mayagüez were hit by a tsunami. The lighthouse keeper at Aguadilla reported a wave 4.6 m high, running over 100 m inland and wiping out over 300 bohíos or thatched houses. The submarine cables of Puerto Rico, Jamaica and St. Thomas were destroyed. The tsunami was triggered by an undersea quake in Mona Channel, NW of Puerto Rico (O’Loughlin and Lander 2003:199-200; Picó 1974:79).
In the 1940’s, in preparation for World War II, the pier at Crash Boat was built for fueling and rescue operations associated with Ramey Air Force Base (previously Punta Borínquen Army Air Field), which closed down in the 1960’s.

**4.4 HISTORIC SHIPWRECKS IN AGUADILLA BAY**

Potential shipwrecks in Aguadilla Bay and Mona Passage cover the entire range of Puerto Rican history, from the early 16th century to modern times. Within this 500-year time span, numerous types of ships and boats were developed for diverse uses, including scouting, warfare, commerce, fishing, coast guarding, dredging, pleasure sailing, passenger service, mail service, etc.

Vessels known to have sailed along Mona Passage include caravels, pataches, galleons, naos, felipots, urcas, frigates, navíos, schooners, corvettes, barques, polacres, brigs, tartans, pirogues, lighters, clippers, sloops, steamers, rigged canoes, yolas, etc.

Ships were built with wooden hulls until the late 19th century. The first Spanish liner built with a steel hull was the steamship *Antonio López*, built in Scotland in 1881 and lost off Dorado, Puerto Rico in 1898 (Vega 1993). This vessel was the first Puerto Rico shipwreck nominated to the National Register of Historic Places, and the first to become a National Landmark in 1998.
In theory, historic shipwrecks in Aguadilla Bay may include wooden-hulled vessels from the early 16\textsuperscript{th} century onwards, and metal-hulled vessels of the late 19\textsuperscript{th} and early 20\textsuperscript{th} centuries. By the late 1890’s, dozens of steamers operated out of Puerto Rico’s principal ports, including San Juan, Ponce, Mayaguez and Fajardo.

The importance of shipwreck archaeology has been demonstrated by dozens of studies around the world (Bass 1988; Konstam 1999; Muckelroy 1980, etc.). Shipwrecks may yield unique information on ship construction, exploration, colonization, trade, warfare, piracy, contraband, slavery, fishing, and numerous other areas of past human activity.

While terrestrial archaeology consists mostly of what people discarded as garbage hundreds or thousands of years ago, shipwrecks often involve cargo and personal items abandoned intact in a survival crisis. Although some artifacts may be damaged by long-term immersion in salt water, others are preserved in soft sediments.

In addition to providing unique information on the maritime lifeways of sailors, pirates, whalers, fishermen, etc., shipwreck may also provide fine-dated artifacts, which allow archaeologists to date similar finds on land. Unlike terrestrial sites, which might represent dozens or hundreds of years of...
occupation, shipwrecks occur at a specific moment in history, the moment of sinking.

To nautical archaeologists, every shipwreck is a time capsule, a frozen moment in time that in many cases can be dated down to the day and the hour. For instance, the study of bronze and iron cannon in a dated shipwreck will provide important information on the history of technology.

In the Mediterranean, shipwrecks as early as 3,500 yrs BP have been excavated, yielding extensive information on trade, ship construction, navigation, and the daily life of sailors and merchants.

In the case of Puerto Rico, some 2,000 ships were lost prior to 1900 (Vega 1995). Each of these shipwrecks represents a moment in Puerto Rico’s history. Prior to the invention of commercial airplanes, in the late 1920’s, ships were the only contact between Puerto Rico and the rest of the world. Additionally, as late as the 1850’s, travel between Puerto Rico’s coastal cities and towns was often by sea, in order to avoid the narrow roads across the rugged mountain interior.

Shipwrecks may be found in practically any water environment, as well as on dry land due to natural sedimentation or artificial fill.
Finding precise data for ship losses is difficult and time consuming. One document may mention the ship’s name and master, while another may mention its loss without necessarily specifying the exact or even the approximate place of loss, and yet another document might provide data on the ship’s cargo and armaments.

In cases involving treasure, historic documents might be misplaced or stolen by modern researchers, in order to favor a salvage group over potential competitors.

Historically, there were instances of masters sinking their ships on purpose, in order to return to the wreck a few days later and salvage the lost treasure.

Peregrina Reef, between Añasco and Rincón, was named after the grounding of the Spanish ship Reina de los Angeles, alias La Peregrina, in 1754. The author had the opportunity of reading extensive documents on this incident at the Archivo General de Indias. Although the ship was saved, the captain was a suspect of foul play.

Known and potential historic shipwrecks in Aguadilla Bay are presented in Table 1. Known shipwrecks are those whose loss within Aguadilla Bay is documented in archival records. Potential shipwrecks are those lost at
unspecified locations off the west coast of Puerto Rico, some of which may eventually be detected within Aguadilla Bay.

The earliest potential shipwrecks belong to Bobadilla’s fleet of 1502. This large Spanish fleet was hit by a hurricane in Mona Passage, en route back to Spain. These wrecks may be found almost anywhere within Mona Passage, including the east coast of the Dominican Republic, Mona Island and the west coast of Puerto Rico (Cardona 1989:23).

In 1562, the nao San Estevan was lost off the coast of San Germán (Archivo General de Indias). If the document meant the port of San Germán, then it was lost off Añasco. But if the document meant the Partido de San Germán, the wreck may be found anywhere on the west, northwest and southwest coast of Puerto Rico, including Aguadilla Bay.

In 1605, the Capitana or flagship San Antonio went down somewhere off the west coast (Archivo General de Indias; Cardona 1989:224).

In 1653, Prince Maurice of England lost his vessel somewhere north of San Germán (Pickford 1994:164). North of the port of San Germán may mean Aguadilla Bay, while north of the Partido de San Germán might mean the deep waters of the Atlantic Ocean. This ship belonged to a large English fleet under the command of Prince Rupert.
At Aguadilla Bay, Fritz and Pilkey (1976:12) report a historic shipwreck in 15 ft. (4.6 m) of water and 100 ft. (30 m) from shore, Lat. 18º25.7’ N, Long. 67º09.5’ W. This wreck is also reported by Cerame Vivas (1988:154), whose shipwreck list is a repeat of Fritz and Pilkey’s list in the *Marine Atlas of Puerto Rico*, edited by Cerame Vivas.

The Aguadilla “shipwreck” was explored in the 1970’s by Miguel “Pili” Pagán Mir and Jaime Braulio, founders of the Yaguez Diving Club of Mayaguez. They found two iron cannon and a heavy wooden chest with burned wood. Thrilled at the thought of sunken treasure, the wooden chest was salvaged, but it only contained horseshoes (Fritz and Pilkey 1976:24). Braulio and Pagán (Personal Communication, 2007) recently indicated to the author that the cannon and chest were north of the Aguadilla Breakwater, and not south as indicated by the coordinates in the *Marine Atlas* (Fritz and Pilkey 1976:12).

The burned wood initially suggested that this might be the wreck of a Spanish vessel captured and burned in 1743, by the British ship H.M.S. *Litchfield*. In Kingston, Jamaica, the captain of the *Litchfield* reported having sunk a Spanish corsair vessel in Aguadilla Bay, also capturing and burning a sloop in the same bay (Marx 1975:402; 1987:402). As an alternate hypothesis, the cannon and horseshoes might have been half-salvaged from the *Proserpina*, a Spanish brig lost in 1821 and known to carry ten cannon (Marx 1986). In that case, this would be a wreck feature (Figure 3), as opposed to the actual wreck.
Pickford (1994:164) places the wreck of the *Proserpina* north of Punta Borínquen, Lat. 18°30’ N, Long. 67°20’ W, lost in 1821 with a cargo of spices. This location has not been verified by diving archaeologists.

Shipwreck researchers often make mistakes. As an archival consultant who spent three years in the principal archives of Spain, the author detected numerous errors in the literature. For example, the ship *La Victoria* was reported lost in 1720, with treasure, off the coast of Aguada (Marx 1987:401). In fact, *La Victoria* was lost off Anegada, British Virgin Islands, in 1738 (Potter 1972:138 and *Archivo General de Indias*).

Other known shipwrecks in Aguadilla Bay include the English schooner *Isabel*, lost in 1816, and the Spanish schooner *Eugenia*, lost in 1818 (Vega 1995:78; *Archivo General de Puerto Rico*).

The shipwreck file at the *Consejo Arqueológico Subacuático, Instituto de Cultura Puertorriqueña*, mentions the *Hamlet*, wrecked in Aguadilla Bay in 1871.

Salvia (1972) reports the loss of numerous vessels on the west coast, in 1837 and 1846, due to hurricanes. The tsunami of 1918 destroyed many fishing vessels on the beach, while those vessels anchored 300 m from shore were not affected (O’Loughlin and Lander 2003).
The NOAA nautical chart for the west coast of Puerto Rico, reports a 20th century shipwreck on the coast of Aguada, immediately NW of the mouth of the Río Guayabo, in less than 30 ft. of water.

In conclusion, Aguadilla Bay is sensitive to historic shipwrecks and historic airplanes of the WWII era. Still, there are no known historic hulks, shipwrecks, coastal defense structures, harbor structures, or any historic structures or historic archaeological materials reported within or adjacent to the Study Area.

Given the frequent confusion in the nomenclature of coastal structures, which tends to be even more difficult when bilingual scientists, engineers, architects, archaeologists and government personnel discuss them, the author decided to add Table 3 to clarify some of these terms.

4.5 PREVIOUS ARCHAEOLOGICAL RESEARCH

In 1987, the author and Walter A. Cardona Bonet conducted a marine survey of the coast at Sector Tamarindo, for Misión Industrial (Vega 1987). Although no shipwrecks were found, we located extensive evidence of a historic anchorage, including a segment of anchor chain and a wide variety of port discards, such as bottles, fishing lines, beer cans, etc.
An underwater magnetometer survey was conducted for the Aguadilla Breakwater in 1992, for the U.S. Army Corps of Engineers. The study detected three magnetic anomalies (Mid-Atlantic Technology 1992). Only one anomaly (Aguadilla-C) was considered potentially significant, and later discarded as modern metallic trash (Mid-Atlantic Technology n.d.).

In 1945, Superfortress heavy bomber 42-65287 was lost off Aguadilla, after lifting off Borínquen Army Air Field. The bomber’s wreck lies in 120 ft. of water. This historic plane wreck was inspected in 1996 by the Naval Historical Center’s Underwater Archaeology Branch and the Consejo Arqueológico Subacuático (Naval Historical Center 2007). Although this is a plane wreck, it is now considered a marine archaeological site, significant to the history of military aviation.

In 1998, Pan-American Consultants conducted two cultural resource surveys for USACE projects in Aguadilla. The first was a Stage I survey for the Aguadilla Waterfront Erosion Control Study, including shovel testing at 10-m intervals. The study detected the remains of a seawall that was not considered significant. This study concluded that the Aguadilla waterfront had been severely impacted by numerous construction projects, reporting no significant cultural resources (Cinquino and Heyward 1998a).
For the Aguadilla Breakwater, the USACE concluded that intact archaeological materials might be detected beneath the rock and sand fill, recommending archaeological monitoring for further work due to unanticipated sedimentation.

Pan-American Consultant also conducted a cultural resources survey for the USACE Río Culebrinas Flood Protection Project. This project consists of two levees north and south of the Río Culebrinas. This study reported on five archaeological sites, including two previously unrecorded sites, within the flood plain. The findings included early historic ceramics associated with the 16th century Espinar Chapel, as well as prehistoric material, late historic materials associated with the early 20th century Hacienda Concepción, and a late 19th century bridge (Cinquino and Heyward 1998b). These sites and structures are not within, adjacent, or related to the Study Area, and beyond the maritime scope of the present investigation. As indicated elsewhere, the terrestrial cultural background of Discovery Bay Resort & Marina is being investigated by archaeologist Juan González, and reported separately.

In 2000, Medina and Maurás conducted deep terrestrial tests along the entire Paseo de la Real Marina and a Parque de Colón. These mechanical borings were conducted to a depth of 3.66 m. Under the waterfront road, Medina and Maurás detected two concentrations of historic artifacts at a depth of 1 to 1.4
However, dozens of deep borings at Parque de Colón were all negative, reaching south to the existing north rock groin or mole.

Additional archaeological investigations were conducted along the Paseo de la Real Marina by Príncipe (2004), reaching the entrance to Parque de Colón, also reporting negative results.
Figure 13. Aguada, ca.1700, Museo Naval, Madrid.
Figure 14. Plan of Aguada Bay and Añasco Bay, by Francisco Fernández Valdelomar, 1737. Archivo General de Indias, Seville.
Figure 15. Detail of 1737 map in Fig. 14, showing Aguada de San Francisco in Aguadilla Bay. Notice ship anchored off Río Culebrinas. Orange arrow points to Study Area at the mouth of Caño Madre Vieja. There are no defenses, piers or houses at the mouth of Caño Madre Vieja.
Figure 16. Northwest coast of Puerto Rico, 1769, showing Aguadilla Bay as part of the north coast. *Archivo General de Indias*, Seville.
Figure 17. Map of Aguada Bay and Añasco Bay, 1775, by Juan de Surville. *Biblioteca del Palacio Real*, Madrid. North is down. Notice six (6) streams within Aguada Bay, some of them fed by springs and the source of much historic confusion.
Figure 18. Detail, Aguada de San Juan in map of 1784. *Archivo General de Indias*, Seville. This map of Aguadilla Bay indicates that the Río Grande is the Río Culebrinas in Aguada, and the Río Chico is a small, spring-fed stream in Aguadilla.
Figure 19. Funeral procession along Aguada Beach, 1899 (de Olivares 1899).
Figure 20. Communal ossuary in Aguadilla Bay, looking SW. Orange arrow marks “x” placed by photographer at traditional Columbus’ landfall at Parque de Colón.
Figure 21. Columbus Monument in Aguadilla Beach, 1919. The New York and Porto Rico Steamship Co.
Figura 22. Carvel (*Carabela*), c.1500.

Figure 23. Galleon (*Galeón*), ca.1580.
Figure 24. Frigate (*Fragata*), ca.1830.

Figure 25. Schooner (*Goleta*), ca.1860.
<table>
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<th>Master/Owner</th>
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<td>Mona Channel</td>
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<td></td>
</tr>
<tr>
<td>1502</td>
<td>Carvel of 45 tons</td>
<td>A. Venegas</td>
<td>Mona Channel</td>
<td></td>
</tr>
<tr>
<td>1502</td>
<td>La Cansina Vieja</td>
<td>Carvel of 45 tons</td>
<td>G. Alonso Cansino</td>
<td>Mona Channel</td>
</tr>
<tr>
<td>1502</td>
<td>Carvel of 35 tons</td>
<td>Diego Bernal</td>
<td>Mona Channel</td>
<td></td>
</tr>
<tr>
<td>1502</td>
<td>La Rábida</td>
<td>Carvel of 28 tons</td>
<td>A. García Vivas</td>
<td>Mona Channel</td>
</tr>
<tr>
<td>1528</td>
<td>Carvel</td>
<td></td>
<td>Mona Channel</td>
<td></td>
</tr>
<tr>
<td>1528</td>
<td>Carvel</td>
<td>A. Martel</td>
<td>San Germán</td>
<td></td>
</tr>
<tr>
<td>1528</td>
<td>Carvel</td>
<td></td>
<td>San Germán</td>
<td></td>
</tr>
<tr>
<td>1531</td>
<td>San Antón</td>
<td>Nao of 120 tons</td>
<td>J. de León</td>
<td>Puerto Rico</td>
</tr>
<tr>
<td>1537</td>
<td>Spanish Nao</td>
<td></td>
<td>Puerto Rico</td>
<td></td>
</tr>
<tr>
<td>1538</td>
<td>San Antón</td>
<td>Carvel</td>
<td>Mona Channel</td>
<td></td>
</tr>
<tr>
<td>Year</td>
<td>Type</td>
<td>Name</td>
<td>Captain</td>
<td>Location</td>
</tr>
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<td>-----------------------------</td>
<td>----------------------------------</td>
<td>---------------</td>
<td>------------------</td>
</tr>
<tr>
<td>1554</td>
<td>Spanish Nao</td>
<td>J. González</td>
<td>Mona Channel</td>
<td></td>
</tr>
<tr>
<td>1562</td>
<td>Nao of 120 tons</td>
<td>L. Morel</td>
<td>San Germán</td>
<td></td>
</tr>
<tr>
<td>1577</td>
<td>Portuguese navío</td>
<td>H. Suárez de Melo</td>
<td>San Germán</td>
<td></td>
</tr>
<tr>
<td>1591</td>
<td>Portuguese slave ship of 300 tons</td>
<td></td>
<td>San Germán</td>
<td></td>
</tr>
<tr>
<td>1592</td>
<td>Carvel</td>
<td></td>
<td>Mona Channel</td>
<td></td>
</tr>
<tr>
<td>1595</td>
<td>English ship</td>
<td>Capt. Winter</td>
<td>Mona Channel</td>
<td></td>
</tr>
<tr>
<td>1595</td>
<td>Spanish ship</td>
<td></td>
<td>Mona Channel</td>
<td></td>
</tr>
<tr>
<td>1605</td>
<td>Galleon of 500 tons</td>
<td>L. Guillén</td>
<td>Mona Channel</td>
<td></td>
</tr>
<tr>
<td>1608</td>
<td>English ship</td>
<td></td>
<td>Mona Channel</td>
<td></td>
</tr>
<tr>
<td>1626</td>
<td></td>
<td>P. de Vargas</td>
<td>Mona Channel</td>
<td></td>
</tr>
<tr>
<td>1662</td>
<td>English ship of Prince Rupert</td>
<td></td>
<td>San Germán</td>
<td></td>
</tr>
<tr>
<td>1699</td>
<td>Spanish ship, fleet of Enrique Enriquez</td>
<td></td>
<td>Aguadilla Bay</td>
<td></td>
</tr>
<tr>
<td>1700</td>
<td>Small English vessel</td>
<td></td>
<td>Puerto Rico</td>
<td></td>
</tr>
<tr>
<td>1720</td>
<td>Spanish corsair</td>
<td></td>
<td>Puerto Rico</td>
<td></td>
</tr>
<tr>
<td>1742</td>
<td>Spanish sloop</td>
<td></td>
<td>Puerto Rico</td>
<td></td>
</tr>
<tr>
<td>1743</td>
<td>Spanish corsair</td>
<td></td>
<td>Mona Channel</td>
<td></td>
</tr>
<tr>
<td>1743</td>
<td>Spanish sloop</td>
<td></td>
<td>Aguada</td>
<td></td>
</tr>
<tr>
<td>1764</td>
<td>English merchantman</td>
<td></td>
<td>Puerto Rico</td>
<td></td>
</tr>
<tr>
<td>1780</td>
<td>English merchantman</td>
<td>Capt. Kerr</td>
<td>Puerto Rico</td>
<td></td>
</tr>
<tr>
<td>1787</td>
<td>English slave ship</td>
<td>Capt. Alworthy</td>
<td>Mona Channel</td>
<td></td>
</tr>
<tr>
<td>1799</td>
<td>French corsair sunk by English corsair</td>
<td></td>
<td>Aguadilla Bay</td>
<td></td>
</tr>
<tr>
<td>1799</td>
<td>English pinnace</td>
<td></td>
<td>Aguadilla Bay</td>
<td></td>
</tr>
<tr>
<td>Year</td>
<td>Type</td>
<td>Name</td>
<td>Location</td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>-------------------------------------</td>
<td>-----------------------</td>
<td>-----------------------</td>
<td></td>
</tr>
<tr>
<td>1804</td>
<td>Numerous ships in hurricane</td>
<td></td>
<td>Mona Channel</td>
<td></td>
</tr>
<tr>
<td>1800</td>
<td>English schooner</td>
<td>Aguadilla Bay</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1800</td>
<td>U.S. schooner</td>
<td>Aguadilla Bay</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1806</td>
<td>English assault gunboat</td>
<td></td>
<td>Aguadilla Bay</td>
<td></td>
</tr>
<tr>
<td>1807</td>
<td>U.S. schooner</td>
<td>Mona Channel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1815</td>
<td>Danish schooner</td>
<td>Aguadilla Bay</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1816</td>
<td>Isabel</td>
<td>English schooner</td>
<td>Aguadilla</td>
<td></td>
</tr>
<tr>
<td>1818</td>
<td>Eugenia</td>
<td>Spanish schooner</td>
<td>F. Gómez, Puerto Rico</td>
<td></td>
</tr>
<tr>
<td>1821</td>
<td>Proserpina</td>
<td>Spanish brig</td>
<td>Aguadilla Bay</td>
<td></td>
</tr>
<tr>
<td>1822</td>
<td>Fountain</td>
<td>English ship</td>
<td>Capt. Howard, Puerto Rico</td>
<td></td>
</tr>
<tr>
<td>1825</td>
<td>Rob Roy</td>
<td>Danish schooner</td>
<td>Puerto Rico</td>
<td></td>
</tr>
<tr>
<td>1829</td>
<td></td>
<td>Spanish schooner</td>
<td>Aguadilla Bay</td>
<td></td>
</tr>
<tr>
<td>1837</td>
<td>Numerous vessels lost in hurricane</td>
<td></td>
<td>Aguadilla Bay</td>
<td></td>
</tr>
<tr>
<td>1846</td>
<td>Numerous vessels lost in hurricane</td>
<td></td>
<td>Aguadilla Bay</td>
<td></td>
</tr>
<tr>
<td>1871</td>
<td>Hamlet</td>
<td>English vessel</td>
<td>Aguadilla Bay</td>
<td></td>
</tr>
<tr>
<td>1878</td>
<td></td>
<td>Spanish brig</td>
<td>Aguadilla Bay</td>
<td></td>
</tr>
<tr>
<td>1894</td>
<td></td>
<td>Spanish schooner</td>
<td>Aguadilla Bay</td>
<td></td>
</tr>
<tr>
<td>1918</td>
<td>Small fishing boats hit by tsunami on shore</td>
<td></td>
<td>Aguadilla Bay</td>
<td></td>
</tr>
<tr>
<td>1942</td>
<td></td>
<td>Motorized Cuban schooner</td>
<td></td>
<td>Aguadilla Bay</td>
</tr>
<tr>
<td>1942</td>
<td>Delfina</td>
<td>Cargo vessel of 3,480 tons</td>
<td>Mona Channel</td>
<td></td>
</tr>
<tr>
<td>1955</td>
<td></td>
<td>Lifesaving vessel, 63 ft.</td>
<td>Aguadilla Bay</td>
<td></td>
</tr>
</tbody>
</table>
Table 2

Bilingual Typology of Coastal Structures

<table>
<thead>
<tr>
<th>Coastal Structure</th>
<th>Spanish Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakwater</td>
<td>rompeolas, escollera, quebrantaolas</td>
<td>Protects shore area from wave action, usually parallel to shore and consisting of rock blocks</td>
</tr>
<tr>
<td>Bulkhead</td>
<td>“muro,” not to be confused with ship’s bulkhead or mámparo</td>
<td>Type of seawall in quiet water area</td>
</tr>
<tr>
<td>Dike</td>
<td>dique</td>
<td>Impermeable breakwater that acts as a dam</td>
</tr>
<tr>
<td>Dock</td>
<td>dársena</td>
<td>Water next to a pier, also any cargo loading platform</td>
</tr>
<tr>
<td>Gabion</td>
<td>gabión</td>
<td>Rectangular, rock-filled steel wire mesh for erosion control</td>
</tr>
<tr>
<td>Groin</td>
<td>espigón</td>
<td>Structure built perpendicular to shore to inhibit movement of beach material; made of rock, wood, concrete or steel</td>
</tr>
<tr>
<td>Jetty</td>
<td>espigón, escollera, malecón</td>
<td>Rock structure built at a harbor, river mouth or any area of ship passage, usually in pairs; not designed to protect shore</td>
</tr>
<tr>
<td>Mole</td>
<td>malecón</td>
<td>Large masonry structure, usually a breakwater, used as wharf</td>
</tr>
<tr>
<td>Term</td>
<td>Gloss</td>
<td>Definition</td>
</tr>
<tr>
<td>------------</td>
<td>---------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Pier</td>
<td>muelle</td>
<td>Structure to which vessels can be secured, perpendicular to shore and supported by piles</td>
</tr>
<tr>
<td>Quay</td>
<td>muelle</td>
<td>Cargo wharf, usually filled with solid masonry</td>
</tr>
<tr>
<td>Revetment</td>
<td>revestimiento</td>
<td>Seawall built of loose rock or construction debris</td>
</tr>
<tr>
<td>Rip Rap</td>
<td>rip-rap</td>
<td>Loose assemblage of stone and broken masonry that forms base of seawall or lighthouse</td>
</tr>
<tr>
<td>Seawall</td>
<td>dique, muro de contención</td>
<td>Structure built at the shoreline to separate land and water; manmade equivalent to rocky cliff</td>
</tr>
<tr>
<td>Wharf</td>
<td>embarcadero</td>
<td>Pier parallel to shore, made of concret, wood or steel</td>
</tr>
</tbody>
</table>
5. Field Investigation

5.1 SHORELINE INSPECTION

The field investigation was conducted during the month of March, 2007. An initial shoreline inspection was conducted in 2004 by the author and assistant archaeologist Erik Rivera Marchand, including Caño Madre Vieja, the limestone rock groins at the mouth of the creek, and the Parque de Colón.

For the present investigation, the Study Area was limited to the rock groins and the adjacent submerged land to be impacted by the proposed jetties. The rock groin itself is a modern structure built ca.1984 with limestone boulders. The larger north groin (or mole) contains concrete debris, apparently added towards the end of construction. These are rather haphazard structures of no historic significance (Figures 26 to 30).

In addition to the underwater cores reported below, six (6) shovel tests were conducted on the beach, in order to test for any evidence of prehistoric or historic materials buried in the sand (Figure 32).
All shovel tests revealed loose beach sand with the water level at approximately -20 cm. As expected, all shovel tests crumbled almost immediately. This simple test indicated that the Study Area is controlled by the bay, not by the creek. This area is subjected to constant and extensive sand movement. There is a subtle battle between the creek, which wants to reach the sea, and the beach, which intends to stop it.

All five shovel tests yielded loose sand, with occasional, very small (<1cm) gastropod shells. The loose sand allowed a maximum depth of 60 cm. No artifacts were detected, except for small fragments of drift-glass, which are very common on the beach surface. The results of the shovel tests are presented in Table 3.

The shoreline inspection detected no evidence of historic ruins at the mouth of the creek. At present, the mouth of Caño Madre Vieja is a very small stream, so shallow and slim that locals have dropped boulders in order to cross it without wetting their feet.

The surface inspection around the mouth of the creek revealed drift-glass, possibly including 19th century glass fragments, as well as brick fragments and very small shell fragments and other organic debris, terrestrial and marine. All artifacts are very small and rounded out by the sea. Given the amount of energy at the Study Area, these artifacts are the product of littoral drift in the bay. Artifacts may also be transported overland, in floods due to storms and hurricanes.
A dead spiny puffer, *Diodon holacanthus*, was found in the sand. This is a non-edible fish (Randall 1968:282) presumably thrown aside by local fishermen who operate both north and south of the Study Area.

### 5.2 DIVING INSPECTION

The Study Area is shallow, mostly under 12 ft. and reaching a maximum depth of 18 to 20 ft. It is not, however, a good place for diving. The waves tend to be frequent and large, any time the wind blows from the north. As indicated in the previous chapters, the northwest coast of Puerto Rico is surfer’s territory. Additionally, the underwater visibility tends to be poor.

A visual reconnaissance dive was conducted simultaneously with the metal detection survey. Except for the two groin structures, the entire Study Area is sand. Contrary to what the author anticipated in 2004, there was no evidence of a beachrock pavement, which is typical of high-energy, tropical coasts and is extremely common along the north coast of Puerto Rico.

The visual inspection detected no coral or rocky reefs, no evidence of historic shipwrecks, and no harbor artifact patterns. Compared with Tamarindo, an anchorage in use at least since the 18th century, the Study Area does not reflect the pattern of a historic anchorage. There are no lost anchors, chains, bottles and beer cans, no abandoned outboard motors, no pieces of fishermen’s *yolas*, nothing but sand with
occasional small gastropods, drift-glass and fragments of limestone rock eroded from
the groins on shore. The only interesting finds were four (4) very small, eroded
fragments of red brick, rounded by the sea and the sand, and a modern cow bone.

In addition to the author’s visual inspection, an underwater video of the Study Area
was made for Discovery Bay by Dr. Vance Vicente.

5.3 UNDERWATER METAL DETECTION SURVEY

The Study Area was considered too small and dynamic for a magnetometer survey
towed behind a boat. Instead, an underwater metal detection survey was conducted
with a hand-held, Fishers Pulse 8X metal detector (Figures 33 to 35). This a
professional, highly sensitive instrument capable of detecting ferrous and non-ferrous
metal objects buried in sand, silt, mud or coral. The Pulse 8X ignores magnetic
minerals in sediment, which is the case at the Study Area, where the sand is rich in
magnetite.

The metal detection survey was conducted in two stages. First, simple transects were
conducted parallel to the beach, beginning in the navigation channel and then on the
outside of each rock groin. The metal detector was swung from side to side, covering
an area 3 m wide with each sweep. This procedure was employed from the edge of
the water to a depth of about 1.5 m. An assistant on shore held small, numbered
buoys with lead weights, for marking any potentially significant targets.
This part of the survey detected a small piece of iron on the surface of the sea floor, followed by a segment of iron pipe buried in the sand, near the south groin (Figure 34). These are isolated finds of no cultural significance.

The second stage consisted of three diving transects, for the north groin, the navigational channel and the south groin. Each transect consisted of a simple linear search pattern in a northwest direction, conducted with standard diving gear and compass, and extended to an approximate depth of 18 ft. No artifacts were detected in the sandy bottom.

5.4 UNDERWATER CORING

Underwater coring was conducted with a manually operated steel corer, 1.5 m long and c cm in diameter. Two steel pressure grips are used to drive the pipe into the sea floor, which are then employed for removing the corer after the top is sealed to create vacuum.

Underwater coring was conducted at 20 m intervals in the channel and around the existing groin structures, with two transects following the length of the proposed jetties (Figures 37 to 40).
All cores were negative for historic or prehistoric artifacts, yielding only loose sand stained with magnetite and occasional, very small organic debris, terrestrial and marine.

Considering that the Study Area is located at the mouth of a creek, the author initially expected to find silt beneath a thin layer of beach sand. Instead, the cores revealed loose sand down to 1.2 m. The sand is stained by magnetite from the Caño Madre Vieja and other streams.

The location of underwater coring stations and beach shovel tests is shown in Figure 42, with results presented in Table 3.

No archaeological sites or significant cultural materials were detected by the underwater investigation. The rounded brick fragments were interpreted as secondary materials transported along the shoreline by marine currents, or overland by storm floods along the coastal lowland of Espinar.
Figure 26. Panoramic view of Study Area from Aguadilla Mirador, looking southwest.
Figure 27. View of Espinar Beach, looking south from north groin.

Figure 28. Groin made of limestone rock and concrete debris, looking west.
Figure 29. Mouth of Caño Madre Vieja, looking west.

Figure 30. Concrete boat ramp at Caño Madre Vieja, built ca.1984.
Figure 31. Statue of Columbus at Aguadilla’s *Parque de Colón*.

Figure 32. Shovel test #18 on Espinar Beach, SE of south groin.
Figure 33. Metal detection survey in shallow water around south groin.

Figure 34. Segment of iron pipe detected under sand in navigation channel.
Figure 35. Metal detector in south groin transect.

Figure 36. Modern cow bone found on surface of sea floor.
Figure 37. Underwater coring in navigation channel, looking NW.

Figure 38. Underwater coring south of south groin.
Figure 39. Underwater coring in north groin transect.

Figure 40. Underwater coring in south groin transect.
Figure 41. Rounded brick fragments found on the beach and under water. These fragments are generally 4 to 7 cm long, with rounded surfaces, and are too small to be dated.
Figure 42. Location of underwater cores (blue) and beach shovel tests (red).
**Table 3**

**Underwater Cores and Beach Shovel Tests**

<table>
<thead>
<tr>
<th>Core/Test Pit</th>
<th>Location &amp; Core Depth in Meters</th>
<th>Sediments</th>
<th>Artifacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>UW Core #1</td>
<td>Channel Near Shore (1)</td>
<td>Loose beach sand</td>
<td>Negative</td>
</tr>
<tr>
<td>UW Core #2</td>
<td>Channel, NW of #1 (1)</td>
<td>Loose beach sand</td>
<td>Negative</td>
</tr>
<tr>
<td>UW Core #3</td>
<td>Channel, south tip of N groin (1)</td>
<td>Loose beach sand</td>
<td>Negative</td>
</tr>
<tr>
<td>UW Core #4</td>
<td>Aguadilla Beach, N of groin (1)</td>
<td>Loose beach sand</td>
<td>Negative</td>
</tr>
<tr>
<td>UW Core #5</td>
<td>Aguadilla Beach, W of #4 (0.6)</td>
<td>Loose beach sand</td>
<td>Negative</td>
</tr>
<tr>
<td>UW Core #6</td>
<td>West tip of N groin (0.8)</td>
<td>Loose beach sand</td>
<td>Negative</td>
</tr>
<tr>
<td>UW Core #7</td>
<td>W of #6 (1)</td>
<td>Loose beach sand</td>
<td>Negative</td>
</tr>
<tr>
<td>UW Core #8</td>
<td>W of #7 (0.8)</td>
<td>Loose beach sand</td>
<td>Negative</td>
</tr>
<tr>
<td>UW Core #9</td>
<td>S of south groin (1.2)</td>
<td>Loose beach sand</td>
<td>Negative</td>
</tr>
<tr>
<td>UW Core #10</td>
<td>W of south groin (0.3)</td>
<td>Loose beach sand</td>
<td>Negative</td>
</tr>
<tr>
<td>UW Core #11</td>
<td>W of #10</td>
<td>Loose beach sand</td>
<td>Negative</td>
</tr>
<tr>
<td>UW Core #12</td>
<td>W of #11</td>
<td>Loose beach sand</td>
<td>Negative</td>
</tr>
<tr>
<td>Shovel Test #13</td>
<td>Espinar Beach, S of south groin</td>
<td>Loose beach sand</td>
<td>Negative</td>
</tr>
<tr>
<td>Shovel Test #14</td>
<td>Espinar Beach, SW of #13</td>
<td>Loose beach sand</td>
<td>Negative</td>
</tr>
<tr>
<td>Shovel Test #15</td>
<td>Espinar Beach, SW of #14</td>
<td>Loose beach sand</td>
<td>Negative</td>
</tr>
<tr>
<td>Shovel Test #16</td>
<td>Espinar Beach SW of #15</td>
<td>Loose beach sand</td>
<td>Negative</td>
</tr>
<tr>
<td>Shovel Test #17</td>
<td>Aguadilla Beach, NE of north groin</td>
<td>Loose beach sand</td>
<td>Negative</td>
</tr>
<tr>
<td>Shovel Test #18</td>
<td>Between groins, S of Madre Vieja</td>
<td>Loose beach sand</td>
<td>Negative</td>
</tr>
</tbody>
</table>
6. Results, Conclusions and Recommendations

6.1 Results and Conclusions

- The proposed action is the development of approximately 230 acres of abandoned agricultural lowland into a world-class inland marina.
- In addition to the economic boost to Aguada and Aguadilla, the Discovery Bay Resort & Marina will be beneficial to mariners in distress and will increase awareness of the region’s rich maritime heritage.
- The Study Area for this investigation is limited to the site of two jetties at the mouth of Caño Madre Vieja, at the proposed entrance to the inland marina. Terrestrial cultural resources for this project are evaluated in a separate report by archaeologist Dr. Juan González.
- The coast of Aguada in Aguadilla Bay is associated with many significant events in Puerto Rico’s maritime history, including Columbus’ landfall in 1493. Although the exact landfall remains an enigma, it is an established fact that Columbus sailed along the north coast of Puerto Rico, reaching the coast of Aguada.
- Some researchers disclaim Aguada, because Aguadilla Bay was mistakenly considered part of the north coast, and Spanish chroniclers reported the landfall
on the west coast. This was due to the confusion of magnetic north and true north. Still, Aguada remains a very strong candidate for Columbus’ landfall.

- In any case, Columbus’ landfall should be studied and reflected upon as a regional event of the west coast, which brought Puerto Rico into the ongoing process of globalization.

- Aguadilla Bay is highly sensitive to historic shipwrecks. There are at least eighteen (18) reported shipwrecks in the bay, plus many more potential losses reported for the west coast, some of which may be located in the bay.

- Aguadilla Bay is also a highly dynamic coastal environment, with big surf and large-scale sand movement likely to contain eroded materials from coastal prehistoric and historic sites. These materials, if found, are out of context and not considered archaeological sites.

- Additionally, the mouth of Caño Madre Vieja was severely impacted by two groin structures and a navigational channel dredged ca.1987.

- Espinar Beach immediately SW of the Study Area was a historic anchorage since the early 16th century, and used extensively by Spanish fleets in the 17th and 18th centuries. The arrival of the fleet was known as *la feria*, a rendezvous of merchants, officers, sailors, passengers and local crowds.

- The Study Area was evaluated for historic hulks and shipwrecks, harbor artifact patterns, coastal historic structures, and submerged prehistoric sites.

- A magnetometer survey was not employed because of the shallow water, rock structures and heavy surf, plus the small size and previous impact to the Study Area. Instead, a methodology of underwater visual inspection, electronic survey
with a hand-held, JW Fisher Pulse 8X professional metal detector, and underwater coring at 20 m intervals, was implemented.

- All tests were negative. The field investigation did not detect any archaeological sites at the Study Area.

- In conclusion, Discovery Bay presents no known adverse effects to submerged cultural resources, or any historic properties potentially eligible to the National Register of Historic Places.

6.2 Recommendations

- No additional marine archaeological investigations are recommended for Discovery Bay as proposed.

- Given the extensive, possibly cyclical sand movement within Aguadilla Bay, plus its rich maritime history, archaeological monitoring is recommended for the removal of the rock groins and the dredging of the new navigational channel. From a geoarchaeological perspective, sediment data from this operation will be useful even if no archaeological sites or materials are located.

- If the developers of Discovery Bay in the future decide to dredge beyond the proposed jetties, in order to provide access to mega-yachts, a magnetometer and sub-bottom profiler survey is recommended. These remote-sensing technologies are not recommended for the small, impacted and restricted Study Area for the proposed jetties.
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