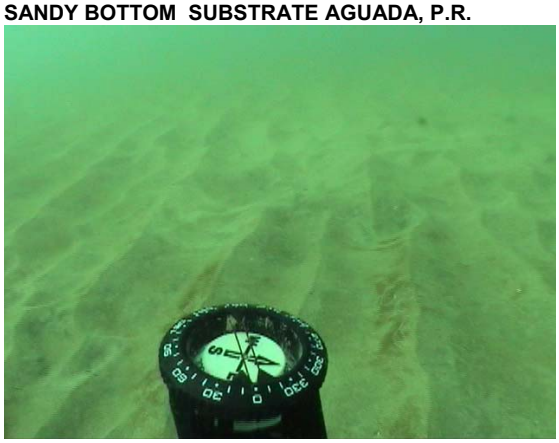
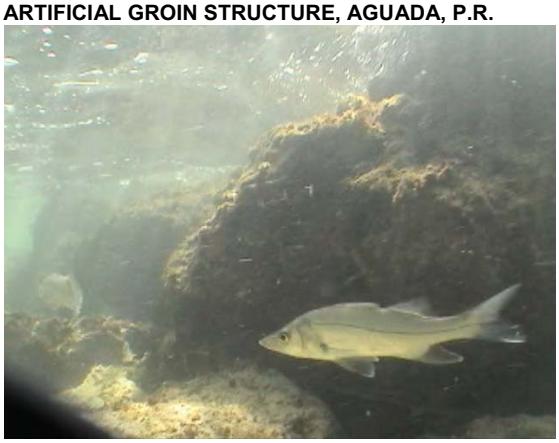
FOOTPRINT BENTHIC STUDY OF THE PROPOSED PARALLEL JETTY STRUCTURES AND ENTRANCE CHANNEL DESIGNED BY Moffatt & Nichol, Inc., FOR THE DISCOVERY BAY RESORT & MARINA PROJECT.

SANDY BOTTOM SUBSTRATE AGUADA, P.R.



ARTIFICIAL GROIN STRUCTURE, AGUADA, P.R.



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1.0 BACKGROUND

The *Discovery Bay, Resort & Marina* is a complex marine-terrestrial project which involves the development of approximately two hundred and thirty (230) acres of abandoned agricultural land for touristic-residential purposes. The proposed site is located in Barrio (= ward) Espinar which is under the jurisdiction of the Municipality of Aguada, Puerto Rico. In view of the extended spatial and long term economic benefits of the project, the proponents of the Project include two municipalities: the Municipality of Aguada, and, the Municipality of Aguadilla, which are the leading agencies of the project. The municipality of Aguadilla is contiguous with the northern limits of the Aguada municipality.

This project (The *Discovery Bay, Resort & Marina* Project) consists of five principal components which will have five different or combined impacts on the topography, hydrology and ecology of the coastal zone of the proposed site. These components are:

1. the construction of an <u>inland marina</u> which will be created by the partial excavation of an abandoned sugar cane field outside the Colosso Agricultural Reserve,

2. the enlargement of an existing opening (the outlet of Caño Madre Vieja between the proposed inland marina and the Mona Channel (west Atlantic coast of Puerto Rico) to create the <u>navigation channel</u> of the marina.

3. the development of <u>upland facilities</u> such as a hotel, villas and other upland structures.

4. the construction of <u>two levees</u>: one north and one south of the proposed inland marina, and,

5. the modification and extension of two rustic existing groin structures on the shore to construct <u>two jetties</u>.

This study specifically addresses the direct impacts that the proposed jetties would have (if constructed as planned) on the <u>benthic</u> resources within and immediately next to the proposed jetty footprint. It is important to note, that during August 28, 2004, Vicente & Associates, Inc., also conducted a benthic survey within the sublittoral zone of the project to a depth of 113 ft ("*Reporte Preliminar: Recursos Marinos (Flora Y Fauna) Bentónicos en el Área del Proyecto Discovery Bay Resort & Marina, Aguada, Puerto Rico*").

However, the aforementioned study covered a much larger area than the proposed jetty location with a different objective in mind (i.e. determining the general marine benthic composition and marine benthic habitat quality of the site. Details on the nature and sensitivity of the benthic habitats surrounding the project site are given in Vicente & Associates, Inc., (2004).

It is also important to understand the limitations of this study which is qualitative in nature. For example, this study was designed to characterize the general physical and biological components of the proposed jetty structure.

The sampling design captures only those species which are obvious and which can readily be identified by a qualified and certified marine specialist. These larger species are the principal components of resources protected by state and national laws and regulations.

Therefore, the species listed in this report are limited to common, larger (macro) epibenthic species occurring at a given time, and do not include many other species which are inconspicuous to the human eye (i.e. microscopic), migratory or highly motile species, and do not include all the burrowing and infaunal organisms which are typical of sandy habitat environments, thus psammophillic.

In addition, many epibenthic motile or even sessile species become obvious at different times. This study however, with its spatial and temporal limitations we believe does provide the necessary information on the benthic natural resources of the proposed site for the decision process of regulatory (USEPA, PRDNRE, USACE) and advisory (USFWS, NMFS, SHPO) agencies on the future of this project (the *Discovery Bay, Resort & Marina*).

In **FIGURE 1** we show the two rustic existing "groin" (= "espuelones" in vernacular) structures. These rock structures (one north and one south of the Caño Madre Vieja) delineate to some extent the outlet of Caño Madre Vieja into the Mona Channel. These artificial structures were built with limestone rock laid one on top of the other in a poorly arranged fashion with inadequate cementing material. In Figure 1 we also show the approximate proposed extension of the jetties (black dots) from the original structures, and the location of some of the benthic stations previously sampled by Vicente & Associates, Inc. (2004).

The detail footprint drawings of the proposed, parallel jetty structures as designed by Moffait & Nichols (M&N Project 5478, December 28, 2005) are shown in **FIGURE 2**. As shown in Figure 2, access to and from the inland marina consists of a north and a south jetty built from rock material. The north jetty incorporates the larger existing rock groin and extends it offshore along a NW direction for approximately 100m. The north jetty head will lay at a depth of approximately -4.5m (= 14.8ft). This jetty will protect the marina entrance from northern swells.

The south jetty (see Figure 2) also integrates the southern smaller existing rock groin and extends it offshore, also along a NW direction to the same offshore distance as the northern structure as shown in Figure 2. The crest elevations of both jetties will be +3.0m with a slope of 1V:2H. The south jetty head will lay at a depth of approximately -4.5m (= 14.8ft). The purpose of these jetties is to provide safe entry and exit conditions to the vessels utilizing the inland marina of the *Discovery Bay, Resort & Marina* project.

2.0 METHODOLOGY

2.1 Underwater transects and *in situ* spot-diveinspection.

The benthic studies to determine the specific benthic communities occurring within the proposed jetty foot prints were initiated in January 26, 2007. *In situ* "**spot-dive** underwater inspections were conducted in specific stations, which, according to Figure 2, fell within the proposed jetty structures. A bounce dive is defined as the action of a SCUBA diver plonging to the sea floor and characterizing all benthic features within a specified area. In this benthic study each underwater *in situ* spot-diveinspection was conducted using an underwater video camera, a Global Positioning System (= GPS), SCUBA diving gear and accessories, a digital underwater computer console, an U/W compass, and an underwater writing slate board.

A boat and a captain provided surface support during each underwater survey. The Principal Investigator in the field was Vance P. Vicente, Ph.D. Dr. Vicente, President of Vicente & Associates, Inc., was in charge of the sampling design, of the underwater filming and of the characterization of the bottom (the seafloor) and is responsible for all taxonomic determinations. Assistant biologist/diver Alexander Méndez, was in charge of all SCUBA diving logistics and safety and served as a field biological assistant during this study.

Each underwater *in situ* spot-dive inspection consisted of the following seven (n = 7) steps:

1. mobilization to each station with SCUBA and filming gear,
2. registration of the station location with a Ground Positioning System (EE = 10-20 ft),
3. measuring the depth of the station using an advanced U/W computer console system,
4. description of the substrate composition of the station (*in situ*),
5. estimating the dominant fauna and flora of the benthos within a 5m radius (apx.),
6. writing the information underwater on the slate board.,
7. filming all the biological and physical features encountered.

After concluding each spot-dive inspection, the PI (Principal Investigator) with his assistant mobilized to the next station in schedule while filming and documenting all benthic features between stations. Therefore, between each station (e.g. NGN1-NGN2) a **qualitative transect** sample was obtained which considerably increased the sampling size of the seafloor.

A Digital Megapixel Handycam Sonny PC-110 or 120 camcorder camera with a 120x Carl Zeiss Digital Zoom lens is used for filming . For each transect, the camcorder camera was loaded with a 60 SP Mini DVC and with a linfo-Lithium battery. The camera, after tested, was placed inside an underwater housing unit (GATES U/W), which mechanically controls all the principal functions of the camera system. The underwater housing is made of a fully anodized marine grade aluminum casting.

The lens which was utilized for filming has a view angle of 90º with full macro and zoom capabilities. The lens has a focus distance ranging from 0 to infinity. Prior to filming each transect, all U/W equipment filming control units were tested and a short strip of the 60 SP Mini DVC tape is shot to inspect if the system is functioning adequately prior to conducting any underwater transects. Segments of each U/W video are "frozen" for extracting images used in this report.

In addition, a new high definition (HD) video-camera (the SONY HDR-HC3) is being used for filming. This Camcorder has a 4.0 mega pixels still image recording, and is equipped with a Carl Zeiss, Vario-Sonar lens (1.8/5.1-51). This sophisticated video camera is placed inside the GATES HC3 U/W housing equipped with the Super Wide Angle Port which provides a 110º field of view and full zoom (0 – infinity). When necessary U/W lightning equipment (NiteRider halogen lamps) are used.

In general, the stations were arranged and numbered from 1 – 10, beginning with station 1 (shallowest, nearest to shore) to station 10 (deepest, farthest from shore). The stations were coded based on whether they occurred within the propose northern jetty structure (= NG) or within the southern jetty structure (= SG). In addition, each station was further classified with respect to their location on either the north side (N) or south side (S) of each jetty. Stations 1 - 9 for example, in the northern side of the proposed north jetty are coded as Station NGN1…NGN9. Stations 1-10 in the southern side of the north jetty are coded as NGS1…NGS10.

The locations (coordinates) of all stations inspected within the proposed North Jetty, North Side (NGN) are presented in **TABLE 1**. The locations (coordinates) of all stations inspected within the proposed North Jetty, South Side (NGS) are presented in **TABLE 2**. The locations (coordinates) of all stations inspected within the proposed South Jetty, North Side are shown in **TABLE 3,** while those of the South Jetty, South Side are given in **TABLE 4.** The locations (coordinates) of all stations inspected within the proposed dredge channel (= CHAN) are given in **TABLE 5**.

2.2. Discovery Bay: Geographical Information System Analysis (GIS).

ArcGIS® 9 was utilized to construct an accurate map and a Geographic Information System (GIS) of Discovery Bay benthic studies. In order to overlay the information layers, all layers were projected in the same Projected Coordinated System. In the case of Discovery Bay Assessment, was assigned the State Plane NAD83 Puerto Rico & Virgin Islands as the common Projected Coordinated System.

The *ArcGIS Geo-referencing Tool* was utilized to fit the Aguadilla's aerial photos (North Aguadilla aerial photo and South Aguadilla aerial photo) into the same spatial reference of USGS Aguadilla's Topographic Map. In the geo-referencing process of both photos we utilized ten (n = 10) Geographic Control Points with a Root Mean Square Error (RMS) of ≤1.

After having the Aguadilla aerial photos and the USGS Topographic Map overlaid, the *ArcGIS Add XY Data Tool* was used to represent the Vicente & Associates Inc. station locations in the map. Having the station locations in the map and its geographic information system, helped represent the benthic assessment values in a real spatial reference. The spatial precision of the stations depended on the Estimated Position Error (EPE) of the Global Positioning System (GPS) instruments utilized by Vicente & Associates, Inc. The EPE of the GPS instruments used in this studied ranged between 10-20 ft.

To build the spatial surface model of the seagrass percent cover we used the *ArcGis 9 Geostatistic Extension*. Within all options of interpolation methods, the Kriging Interpolation was chosen. Kriging is a moderately quick interpolator that can be exact or smoothed depending on the measurement error model. It is very flexible and allows you to investigate graphs of spatial autocorrelation. Kriging uses statistical models that allow a variety of map outputs including predictions, prediction standard errors, probability, etc. The type of Kriging Interpolation used in this assessment was the Simple Kriging Interpolation. Simple Kriging Interpolation produces interpolation values by assuming a constant but known mean value, allowing local influences due to nearby neighboring values. Because the mean is known, it is slightly more powerful than the ordinary Kriging (ArcGIS® 9).

The majority of the area assessed is classified by the NOAA's NBHs as Unidentified. The surface model of the seagrass percent cover built by Simple Kriging Interpolation was the base for the NBHs addition. The NBHs addition was based on the digitalization of common values in the surface model of the seagrass percent cover.

Four (4) new classes were added to the NBHs:

- Seagrass/Patchy/10-30%,
- Seagrass/No SAV Category/0-10%,
- Seagrass/0-10%/Infauna Borrows,
- Seagrass/0-10%/Infauna Borrows/Octocorallia.

2.3. Taxonomy.

Proper taxonomic determinations is a crucial step in evaluating the impacts of the proposed jetty structures which form an integral part of the he *Discovery Bay, Resort &* Marina project. There are very few experts, or trained marine benthic invertebrate taxonomists or marine botanists in Puerto Rico. Therefore it is imperative that taxonomic determinations made during an environmental assessment study are accurate enough to make an environmental assessment report sufficiently valid for interagency evaluation.

The taxonomic determinations conducted in this jetty foot print study were made by *in situ* determinations and by utilizing "frozen" relevant images from high quality digital images taken during the study.

The external morphological characters (shape, size, color etc.) were the primary basis utilized to describe each species observed during the spot-divestations or transects conducted between stations. Close-up footage (up to 1 cm of distance between lens and subject) which captures fine external morphological features (e.g. conules, septae, etc.) is used for species confirmation in the laboratory. The general criteria utilized for identifying the benthic taxa found during this study are given below.

CORALS and GORGONIANS. Hard corals (Cnidaria: Scleractinia) and gorgonians or "soft corals" (Cnidaria: Octocorallia) were identified to the lowest taxa possible by using external morphological criteria such as shape patterns (e.g. branching, encrusting, pillar, brain), corallite characteristics (embedded, protruded, porous, septa, callice), habitat (e.g. depth, light conditions, exposed, cryptic), color (including fluorescence and pigment oxidation), and others (e.g. behavior, symbionts).

Most coral species are identified to a species level by the principal investigator (i.e. Vance P. Vicente, Ph.D.). Some of the hard coral (Cnidaria Scleractinia) taxonomic determinations and coral conditions are consulted with coral expert Daisy Durant, Ph.D.

When necessary hard coral taxonomic references (Colin, 1978; Human, 1993; Cairns, 1982; Almy and Carrión-Torres, 1963; George and George, 1979; Bouchon, 1990) were consulted with other specialists. Soft corals or gorgonians were identified using the expertise of the PI, and when necessary, references such as Bayer (1961) and personal communications with other coral experts were consulted.

SEAGRASSES. Experts, such as the PI Vance P. Vicente, utilize leaf external morphological characters to identify most of the 49 species of seagrasses which are known to exist on a global basis. Sometimes additional plant components need to be inspected (e.g. number of leaves per shoot, reproductive bodies, rhizomes, roots). When necessary, microscopic inspections of seagrass blades are performed by the PI in Vicente & Associates, Inc., Offices and Lab., in order to determine blade shape (e.g. oval, lanceolate), basal sheaths, ligules, tannin cells, leaf veins, and leaf blade margins (e.g. entire, spinulose) among others (flaccidity, transparency etc.).

The seagrass species found in Puerto Rico and in the West Indian (Caribbean) Region in general are well known and have been reported in Vicente (1992). However, exotic seagrass species such as *Halophila stipulacea* (from the Red Sea) have recently been reported in Caribbean waters (Ruiz and Ballantine, 2004) and could also be found in Puerto Rico. Exotic seagrass invasions have also occurred elsewhere (i.e. *Zostera japonica*, from Japan to the eastern Pacific (Harrison, 1982).

There is also a possibility that *Halophila johnsonii*, which is the only marine plant listed as threatened by the U.S. Fish and Wildlife Service (under the TESS system) may be found within Puerto Rico territorial waters. This species (*Halophila johnsonii* Eiseman) has been found only in coastal lagoons in SE Florida in the intertidal zone where the substrate consists of fine sand.When necessary, Phillips (1992) and Hartog (1975) among others (Littler and Littler, 2000) are consulted by Vicente & Associates, Inc., to verify seagrass taxonomic determinations. The author discusses dubious species with Dr. Dave Ballantine (UPR/DMS) who is a world expert in the taxonomy of macroalgae and other macrophytes.

SPONGES. Sponges are dominant in coral reef systems and hardgrounds throughout the tropics. However they may also dwell in mud bottoms as well as in sandy bottoms such as those found within the Discovery Bay Marina & Resort. Sponges are a very complex, primitive taxa belonging to the Parazoa. There are only very few experts capable of identifying them to a species level. One of such experts is the PI of Vicente & Associates, Inc.

Sponges are also identified in the field using external morphological characters such as shape (e.g. vase-shape, encrusting, dendritic, massive etc); color of the "ectosome" or exopinacoderm and of the mesohyl, consistency of the individual sponge in question (e.g. spongy, solid, crumbly), texture (velvety, slimy, rough), exudates, stellate patterns of the exopinacoderm, and habitat among others. Sponges are almost all identified to a species level in the field using the author's expertise.

When necessary, the following taxonomic references among others were consulted: (Alcolado, 1986; Hechtel, 1965; Human, 1992; Laubenfels, 1936; Pang, 1973; Rutzler, 1981; Soest 1978, 1980, 1984, 1988; unpublished, Vicente, 1982; Wiedenmeyer, 1977; Zea and van Zoest, 1986; Zea, 1987). Only when necessary, a portion of the sponge is cut free for megasclere/microsclere analysis including spiculometry.

ALGAE. Many macrophytic algae, mostly consisting of red (Rhodophyta), brown (Phaeophyta) and some green (Chlorophyta) algae were found in the rocks forming the existing northern and southern groin of Aguada within the project (Discovery Bay resort & Marina) site. We used the standard taxonomic criteria for this type of macrophytes.

Macrophytic algae are classified into the following categories as proposed in the Coral Reef Monitoring Manual for the Caribbean and Western Atlantic (see Rogers et al., 1994). These categories are FLESHY ALGAE, CALCAREOUS ALGAE, CRUSTOSE CORALLINE, ARTICULATED CORALLINE RED, and TURF ALGAE (= thin algal mat).

FLESHY ALGAE. Fleshy red algae include species which are large, branching, have well developed thalli, and are not calcified thus rendering a "fleshy" consistency. Minor calcification levels, such as those found in *Liagora* spp. are not considered significantly calcified and therefore, this genus is kept under the "fleshy algae" category.

The following taxa are included under this category in this study: red algae (Rhodophyta) such as *Acanthophora spicifera, Dictyurus occidentalis*, *Bryothamnion triquetum* and *Acanthophora spicifera*, *Amansia multifida, Gracilaria dominguensis,* and brown algae (Phaeophyta) such as *Dictyota* and *Dictyopteris* spp. and green algae (Chlorophyta) such as *Caulerpa* spp.

CALCAREOUS ALGAE. Calcareous algae include red (RHODOPHYTA), calcareous, segmented algae such as the genera *Amphiroa, Galaxaura, Jania* and *Corallina*. These algae also are referred to as "*articulated coralline red algae*". This category also includes green algae (CHLOROPHYTA) such as the various common tropical species under the genus *Halimeda* (e.g. *Halimeda opuntia*, *Halimeda incrassata*, *Halimeda monile* and *Halimeda discoidea*). Dead fragments of *Halimeda* result in the formation of calcareous sand.

CRUSTOSE CORALLINE ALGAE. This category includes red algal species, which form smooth pavements over dead coral bottoms, and includes genera such as *Peyssonnelia, Sporolithon, Mesophyllum* and, *Cruoriella.* These genera may invade cryptic or illuminated habitats.

TURF ALGAE. Turf algae include many species, which do not develop much tissue (thalli) above the substrate. In coral reef habitats as well as in other rocky non-biogenic substrates these species normally include rhodophytes such as *Coelothrix irregularis, Gelidium pusillum, Ceramium,* and *Polysiphonia* among others.

Turf algae (thin algal mats) have become the principal benthic component of many reefs and hardgrounds since *Diadema antillarum* populations became ecologically extinct throughout most of the Caribbean Region between 1983-87. References which were consulted to verify species of marine plants are Littler et al., (1989), Woelkerling (1976) and Dawson, (1956). Other lesser abundant benthic species are identified by using the following references: Colin, (1978); George and George, (1979); Human (1992) among others (e.g. Tucker and Morris, 1995; Warmke and Abbot, 1962).

REEF FISH. Reef fish, when mentioned in this report were identified in situ by the expert and by using the following references listed in the reference section when necessary (i.e. Robins et al., (1986); Fischer, (1978); Human, (1992); Idaz and Greenberg, (1986) among others).

3.0 RESULTS

3.1 The northern jetty: north side.

As indicated above, the relative size, extension, and dimension of the proposed northern jetty is shown in Figure 2. As indicated in the figure, the construction of this jetty, in addition to creating the jetty trunk, conveys a revetment along the northern side of the existing groin. Therefore, our survey began near shore on the north side of the groin where the revetment is proposed (i.e. Station NGN1, latitude 18°24.823' N, longitude 67°09.756' W) in shallow water (2.0 ft).

A western panoramic view of the northern side of the existing north groin is shown in **FIGURE 3** below. An interrupted algal zone consisting of *Sargassum* sp. and of other brown algae (Thallophyta: Phaeophyta) was observed fringing portions of the intertidal rocky zone on this side of the artificial structure.

The depth, substrate type, the dominant flora and fauna, as well as notes taken in each station (Station NGN1 – Station NGN9) along the northern side of the existing north groin are presented in **TABLE 6**. Each of these stations are described below.

Station NGN1. This station is very shallow (2ft) and very much exposed to physical disturbances such as high wave action, sand abrasion and sediment deposition. This station consists of two different type of substratum: fine siliceous sand (the natural substrate) and limestone boulders from the groin structure (the artificial substrate). Only the artificial rock surfaces, particularly surfaces above the ground, are colonized by epibenthic macroflora and by epibenthic macrofauna.

The dominant marine macroflora consists of thin algal mats composed of articulated coralline red algae (Thallophyta: Rhodophyta) such as *Jania* spp., and *Amphiroa* spp., of fleshy brown algae (Thallophyta: Phaeophyta) such as *Padina* cf *sanctae-crucis*, *Dictyopteris* sp., *Dictyota* sp., and *Sargassum* spp., and, of an unidentified green filamentous algae (Thallophyta: Chlorophyta) and of clumps of *Jania* sp. (Rhodophyta).

The only marine epibenthic macroinvertebrates observed occurred on the hard artificial substrates. Perhaps the only single dominant invertebrate in Station 1 was the mussel *Brachiodontes exustus*. In some areas, clusters of *B. exustus* monopolized 100% of the rock bottom receiving the full impact of waves (i.e. the westernmost section of the existing groin).

Two species of regular echinoids were found: the non-cryptic White sea urchin *Tripneustes esculentus* (which however does exhibit “heaping” behavior) and the semi-cryptic Red sea urchin *Echinometra lucunter*. It is very likely that a third species, *Eucidaris tribuloides*, which is a boring echinoid, could be found in the subtidal zone of the groin. Both of the echinoid species observed are grazers (herbivorous) and feed on macroalgae.

No “isoyake” (algal-denuded patches) areas were observed, suggesting that the sea urchin populations found on the submerged sections (i.e. sublittoral zone) of the groin are relatively low.

Several reef fish species were observed among the building units of the north groin. Some of these fish species consisted of an unidentified clinid, schools of surgeon fish (i.e. *Acanthurus* spp.), wrasses (i.e. *Thalassoma bifasciatum*), and snappers (i.e. *Lutjanus synagris*). Possibly many other reef fish species inhabit this side of the artificial reef structure. A quantitative fish study of this groin has not been requested at the moment.

Hard corals (Cnidaria: Scleractinia) were only found on the building blocks of the existing north groin. These hexacorallians consisted of *Siderastrea siderea* or “ the Massive Starlet coral”, of its sympatric species *Siderastrea radians* and of *Stephanocoenia michilini*. All corals observed were encrusting. There were no gorgonians or soft corals (Cnidaria: Octocorallia) found in this station nor in any of the other stations surveyed within the north groin and within its proposed expansion. Far west into the Mona channel some soft corals, as discussed later were found but in very limited numbers and outside the zone of impact.

All the coral colonies observed were also scarse and small (< 4.0 “ ID), which is typical of these species when they grow in harsh environments (pers.obs.). The estimated coral cover for the submerged portion of the northern side of the groin is <<0.5%. This insignificant coral cover and the very low diversity do not render this structure neither as a coral reef nor as a coral community. In addition, the bedrock or framework of this system is not biogenic , and it is in fact of an anthropogenic nature. The typical competitive dominance of macroalgae under this type of wave-exposed rocky habitat conditions probably preempts coral development by displacement competition.

The sandy fraction within this rock/sand station was literally barren of visible (=macro) epibenthic life. The only possible biotic elements which could be found in such a physically controlled system are those which are psammophilic and eurytopic such as the so called “infauna”. The infauna consists of normally burrowing invertebrates (e.g. clams, polychaetes) living within the sand particles. Representative underwater photographs of the sediments, epibenthic macroflora and of the epibenthic macrofauna observed along the northern side of the north groin are shown in **FIGURE 4**.

Station NGN2. This benthic station is six feet deep (z = 6 ft) and it is located just west of the western tip of the northern groin. The substrate consists mostly of a fine sandy bottom but with few outcrops from the building blocks of the groin. Although the sand appears to be mostly of a siliceous nature, black “stains” were found which is indicative of the presence of the ferrous mineral magnetite. This sandy bottom was devoid of seagrasses and macroalgae. In fact, the bottom was totally devoid of vegetation except for floating terrestrial plant debris and for some macrophytic algae attached to the rocks of the north groin structure (i.e. *Dictyota* sp., and *Dictyopteris* sp.).

The epibenthic fauna consisted mostly of the Scorched mussel *Brachidontes exustus* which monopolized much of the intertidal-shallow subtidal surfaces of the groin structure and of regular echinoids. Isolated, small encrusting coral colonies of *Siderastrea siderea* were also found on some of the rocky outcrops. In addition, occasional school of fish species (i.e. *Caranx latus*) were observed.

Station NGN3. The depth of station NGN3 is eight feet (8 ft). Similar to the previous station (NGN2), the bottom consists mostly of fine sand with magnetite residues. Also, similar to the previous station, the sandy bottom is totally devoid of macrophytic vegetation and of macrobiotic invertebrate or vertebrate bottom dwelling species except perhaps for infauna or demersal fish species.

Station NGN4. The depth of station NGN4 is thirteen feet (13 ft) and consists of fine sand with black magnetite sediment particles and some white calcareous matter. There was no macrophytic vegetation (e.g. fleshy or calcareous algae or seagrasses) attached to the sand. The station was also barren of motile or sessile epibenthic macroinvertebrates.

Station NGN5. The depth of station NGN5 is eighteen feet (18 ft). The bottom substrate consists of fine sand with magnetite. Thin films (layers) of apparent benthic diatoms (= diatomaceous ooze) were found over some areas of the prevailing sandy bottom. Like in the previous sandy bottom stations, the bottom was barren of macrophytic vegetation and of macro-epibenthic invertebrates (whether motile or sessile).However, like in most instances, small burrows, probably created by infaunal biota were observed. The only hard objects found consisted of small stones and pebbles. Diatomaceous oozes were observed over some portions of the sand.

Station NGN6. The depth of station NGN6 is twenty feet (20 ft). The bottom consists of fine sand with ripple marks, and with some diatomaceous layers over the sand. The bottom is barren of macrophytic vegetation and of epibenthic invertebrates. However valves of the pelecypod (Mollusca: Pelecypoda) *Tagelus plebeius* (the Stout Tagelus) and polychate (Annelida: Polychaeta) tubes were observed. Some anthropogenic debris was also found over the seafloor.

Station NGN7. The depth of station NGN7 is twenty-two feet (22 ft). The bottom consists of fine siliceous sand with diatoms forming a thin layer over some of the ripple marks. Valves of “razor”-like clams (Mollusca: Bivalvia) occur over the sand (possibly *Tagelus plebeius* or the Stout Tagelus). The bottom is barren of live macrophytic vegetation and of epibenthic invertebrates. Non-sand particles such as pebbles and stones were observed over and within the sand. Suspended organic debris, probably derived from vascular plants were found within the water column.

Station NGN8. The depth of station NGN8 is twenty-three feet (23 ft). The bottom consists of fine sand with magnetite deposits and of randomly distributed pebbles and polished pieces of limestone. Molluscan shells, rubble and some clay material were found in the sand. The bottom is barren of live macrophytic vegetation and of epibenthic invertebrates.

Station NGN9. The depth of station NGN9 is twenty-six feet (26 ft). The bottom consists of fine sand. Debris and detritus of terrestrial vegetation (probably derived from the Rio Culebrinas discharge) was found over the bottom. Like in previous stations, the bottom was found to be barren of live macrophytic vegetation and of macro-epibenthic invertebrates. Shells of possibly *Tagelus plebeius* and of unidentified gastropods were found in the sand. Like in previous stations, burrows, probably induced by the infauna, were found.

The transition area between stations or the transects conducted between stations (NGN1-NGN10) within the proposed footprints of the northern jetty are described in **TABLE 7**. Remains of the Forceps crab *Lupella forceps* were seen on none occasion over the sand suggesting the presence of this species in the proposed jetty site.

Representative underwater photos taken between stations (TR NGN1-NGN2…TR NGN9-NGN10) along the northern section off the northern groin are presented in **FIGURE 5**. Similar to the stations themselves (NGN1…NGN10) the benthos between stations consisted mostly of a sandy bottom barren of seagrasses and of coral reefs. However, small, isolated coral encrustations (e.g. *Siderastrea siderea* and *Stephanocoenia michelinni*) have colonized some of the submerged groin surfaces.

3.2 The northern jetty: south side.

As described below, the substrate type found along the south side of the proposed north jetty structure are very similar to the substrate type found along the northern side of the structure. That is, a non-consolidated sandy bottom with submerged limestone rocks scattered from the existing groin near shore and a barren sandy bottom extending offshore from the groin to a depth of twenty feet (20 ft).

Similar to the northern side, the only significant epibenthic development has occurred on the exposed, submerged and intertidal surfaces of the existing groin (an artificial structure).

A northern panoramic view of the southern side of the existing north groin is shown in **FIGURE 6**. The limestone boulders above sea level serve as roosting or resting grounds for shore birds. The submerged portion of the groin provide the only adequate habitat conditions for macrophytic algae and invertebrates in this zone. High wave energy conditions, absence of protective coral reefs, siltation, sand abrasion and scouring apparently preempts the development of seagrass beds in this zone. The photo was taken in January 26, 2007 by V&A, Inc., from Station NGS1, latitude 18°24.823' N, longitude 67°09.756' W.

Station NGSI. This station is the shallowest (4.0 ft of depth) and nearest to shore. The substrate consist of unconsolidated sediments (i.e. fine sand with magnetite deposits) and of consolidated substrates (the limestone building blocks used to construct the north groin). The submerged portion of the existing groin as well as the intertidal zone of the groin structure provide adequate habitat conditions for the development of macroalgal communities, epibenthic sessile and mobile invertebrates and reef fish species. In other words, this groin (the northern groin) acts as an artificial reef-like structure.

Some of the macrophytic (submerged vegetation) organisms observed attached to the hard bottom surfaces of the existing groin consisted of the brown algae *Dictyopteris* sp. and *Padina* sp., (Thallophyta: Phaeophyta), the articulated coralline red alga *Amphiroa* spp., and of the encrusting red alga *Peyssonnelia* sp., (Rhodophyta) among others such as the green algae (Chlorophyta) *Caulerpa sertularioides* and *Dictyospheria cavernosa*).

The only visible motile large macroinvertebrates observed on the consolidated surfaces of the existing groin were the regular echinoids *Echinometra lucunter* and the White sea urchin *Tripneustes esculentus* (Echinodermata :Echinoidea). *T. esculentus* was far more common (obvious) than *E. lucunter* due to its non-cryptic habits (although theycan exhibit “heaping”behavior. The building units (limestone rock) utilized for the construction of the existing northern groin are found below sea level adjacent to the groin adding habitat and biodiversity diversity to this zone. Schools of surgeon fishes

(*Acanthurus* sp.) and of wrasses (*Thalassoma bifasciatum*) were found swimming and grazing among the rocks.

Station NGS2. The benthic Station NGS2 is at five feet (5 ft) of depth and consists of a sandy bottom composed of fine sand granules. Some magnetite deposits were found over the sand. There were no visibile (i.e. macro) invertebrates or plants (i.e. macroalgae and seagrasses) over the sand. Irregular ripple marks were observed.

Station NGS3. The depth at benthic Station NGS3 is seven feet (7 ft). As in the previous station the substrate consists of a sandy bottom composed of fine sand granules. Some magnetite deposits were found within the sand. There were no visibile (i.e. macro) invertebrates or plants (i.e. macroalgae and seagrasses) over the sand. The bottom was devoid of macro-epibenthic forms probably due to the physically harsh conditions of this zone.

Station NGS4. The benthic Station NGS2 is at a ten foot (5 ft) depth. The bottom consists of a sandy bottom composed of fine sand granules with sparse pebbles of unknown origin. Some magnetite deposits were also found within the sand. There were no seagrass beds, algal mats nor live corals within this station.

Station NGS5. Station NGS5 is located within the twelve foot (12 ft) depth contour line. Thick magnetite deposits were found within the sand which are probably of riparian origin. There were no seagrass beds, algal mats nor live corals of any kind found in this station. In fact, the bottom was barren of any macroepibenthic forms.

Station NGS6. Station NGS6 is at thirteen feet of depth (13 ft). The bottom consisted of fine sand. However, rubble, pebbles and stones were found to be mixed with the sand fraction. Again, the bottom was found to be barren of visible macroepibenthic forms such as algae, seagrasses, sponges and corals among others. Dead limpet shells formed part of the sediments, probably derived from the groin structure or elsewhere.

Station NGS7. Station NGS7 is located in fourteen feet (14 ft) of depth. Like in Station NGS6, rubble, pebbles and stones were found to be mixed with the dominant fine sand fraction. No macroepibenthic life forms were detected during this bounce dive.

Station NGS8. Station NGS8 is at sixteen feet (16 ft) of depth. The bottom, as in all previous stations, consists primarily of fine sand. Some diatomaceous oozes were found over the sand. Thick bands of magnetite were also found in the sand (like in some of the previous stations described).

Station NGS9. Station NGS9 is at eighteen feet (18 ft) of depth. The bottom, as in all previous stations, also consists primarily of fine sand. Magnetite was also found intermixed with the siliceous sand particles. Pebbles and riparian debris were also found on and within the sand.

Station NGS10. Station NGS10 is at twenty feet (20 ft) of depth. The bottom, as in all previous stations, consists primarily of fine sand. Some diatomaceous oozes were found over the sand. Magnetite particles and pebbles were also found over and within the sand.

Representative underwater photographs of the substrate and epibenthos within the sublittoral zone of the southern side of the north groin are presented in **FIGURE 7**. (photographs by V&A Inc., January 26, 2007). Sandy bottom and rocky bottom with the brown algae *Dictyopteris* sp. (TR), The articulated coralline red alga *Amphiroa* (MRL) and the sea urchin *Echinometra lucunter* (MRR). Fine sand with an apparent rich magnetite deposit (BRR). Other species such as the encrusting red alga *Peyssonnelia* sp. And others were also observed.

The depths, substrate types, the dominant flora and fauna, as well as the notes taken in situ during each station inspection (i.e. NGS1 – NGS10) along the southern side of the existing north groin are given in **TABLE 8**.

The transition area between stations or the transects conducted between stations (NGS1-NGS10) within the proposed footprints of the northern jetty are described in **TABLE 9**.

Representative underwater photos taken between stations (TR NGS1-NGN2…TR NGS9-NGS10) along the southern section of the southern groin are shown in **FIGURE 8**. As shown in the figure, the seafloor between stations or transects (TR NGS1-NGS2…TR NGS9-NGS10) consisted of the same nature as the seafloor of each station. The hard bottom or the submerged part of the groin (TR NGS1-NGS2) consisted of brown algae such as *Dictyota* and *Dictyopteris* with some green algae (i.e. *Caulerpa sertularioides*). Two sea urchins, the white sea urchin Tripneustes esculentus and the red sea urchin appeared to be the principal herbivores within the submerged rocky system. However other herbivores such as acanthurids (*Acanthurus bahianus* or Surgeon fish) were also observed in this shallow transect. One coral species (i.e. a small encrustation of *Stephanocoenia michelinni*) was observed on the surface of one of the rocks. Offshore of the groin structure only one coral colony was found in the sand (i.e. one recent fossil of the rocking coral *Manecina areolata*).

3.3 The southern jetty: north side.

The depth (ft), substrate type, the dominant flora and fauna, and notes taken in each station (Station SGN1 – Station SGN10) along the northern side of the existing south groin are presented in **TABLE 10**. The south groin benthic stations were inspected in April 13, 2007. Selected representative underwater photographs taken along the northern side of the south groin in April 13, 2007 are presented in **FIGURE 9**.

Station SGNI.

Station SGN1 was inspected in April 13, 2007 and is located at a depth of 1.0 ft (the intertidal zone). The bottom consists of sand and artificial hard limestone rocks which form part of the existing southern jetty. There were no dominant epibenthic species on the sand. The rocky surfaces consisted of macroalgae (algal tufts) species above the sediments, but close to the bottom of the rocks the surfaces were barren of of epibenthic growth.

TR SGN1-SGN2: technical problems with the U/W video system and groundwater density refraction prevented obtaining an adequate filming of the seafloor between station SGN1 and SGN2.

Station SGN2.

Station SGN2 is also located within the existing southern groin and consists of the artificial limestone rocks and sand. The sand appeared to contain at least some amount of magnetite. At this depth (2 ft) we observed significant amount of sediment resuspension which probably accounts for the lack of epibenthic development on the sand. Ripple marks were disoriented. Epiphytic mmacro algae such as Sargassum sp., Padina sp., and other macroalgae (i.e. thin algal mats) covered more than 90% of the exposed surfaces of the groin rocks. Fragments (thalli) of chlorophytes (green macroalga) were found suspended in the water column. Although visibility in terms of turbidity was excellent, refraction in the water column from the mixing of fresh and salt water prevented high resolution filming.

TR SGN2-SGN3: The bottom consists of limestone rocks from the groin structure and sand. Ripple marks poorly defined and with no directional pattern. Mixture of sea water with fresh water (from submarine aquifer?) caused refraction of the water column which prevented high quality filming of this transect.

Station SGN3.

Station SGN3 consists of a sandy bottom at 5 ft of depth. The sand contained ripple marks, magnetite deposits, and terrestrial ligneous debris. Apparently some offshore objects were washed inshore due to the presence of Goose barnacles (i.e. Lepas sp.).

Since specimens were not collected we did not distinguish among the members of the lepadid (Lepadidae) family. The only marine macrophytes consisted of unattached (drifting) rhodophyte balls or fragments.

TR SGN3-SGN4: This transect consisted of a sandy barren bottom. Some magnetite deposits and terrestrial debris were found in or over the sand. There was no dominant flora or fauna components.

Station SGN4.

Station SGN4 consists of a sandy bottom with magnetite deposits, barren of autochtonous vegetation and of epibenthic fauna. Some conglomerates (*cf* beach rock fragments) however were found. Terrestrial organic debris and detached algae were found drifting over the sand or in the water column. The depth of this station is 7 ft.

TR SGN4-SGN5: This transect consisted of a sandy barren bottom with no autochtonous floral or faunal assemblages.

Station SGN5

Station SGN5 consists of a barren sandy bottom with magnetite deposits but with no development of typical psammophilic flora or fauna components. Red mangrove (Rhizophora mangle) leaves and other terrestrial organig, ligneous debris were observed over the sand. The depth of this station is 8 ft.

TR SGN5-SGN6: Like in the previous transect, this transect consisted of a sandy barren bottom with no autochtonous floral or faunal assemblages.

Station SGN6.

Like in the previous station, Station SGN6 consists of a barren sandy bottom with magnetite deposits but with no development of typical psammophilic flora or fauna components. However, legume pods, ligneous debris, mangrove leaves and other organic sources of terrestrial origin (*Thespesia populnia*) leaves) were found on the sand or drifting in the water column. Eampty shells of the pelecypod *Tagelus plebeius* were also found in the sand. The depth of this station is 9.0 ft.

TR SGN6-SGN7: Like in the previous transect, this transect consisted of a sandy barren bottom with no autochtonous epibenthic development. Similar to Station SGN6 terrestrial vegetation sources were found on the sea floor which include Indian almond fruits (*Terminalia cattapa*) and legume pods.

Station SGN7.

Like in the previous station, Station SGN7 consists of a barren sandy bottom (fine sand) with magnetite deposits but with no development of typical floral or faunal epibenthic species. Also like in previous stations, debris/detritus of terrestrial plants as well as loose macroalgal fragments were found drifting over the seafloor within this station. The depth of this station is 10.0 ft.

TR SGN7-SGN8: Like in the previous transect, this transect consisted of a sandy barren bottom with no autochtonous epibenthic development.

Station SGN8. This station consists of a sandy bottom with some magnetite deposits but with no dominant, authentic (attached) vegetation or epibenthic faunal components. However some polychaetes (Annelida: Polychaeta) tubes were found sparsely distributed over the sand. One *Callinectes* sp. (a portunid crab) was found within this station. The depth of this station is 11.0 ft.

TR SGN8-SGN9: Like in the previous transect and station, this transect principally consisted of a sandy barren bottom with no autochtonous epibenthic development.

Station SGN9.

Station SGN9 consists of a sandy bottom with some magnetite deposits but with no dominant, authentic (attached) vegetation or epibenthic faunal components. On the sand, some abraded limestone rubble were found. Ripple marks like in all stations were found. White recent skeletal deposits and diatomaceous oozes were found over the sand. The depth of this station is 12.0 ft.

TR SGN9-SGN10: Like in the previous transect and station, this transect principally consisted of a sandy barren bottom with no autochtonous epibenthic development. Pebbles and fragments of allochtonous material. Infaunal evidence.

Station SGN10.

Station SGN10 consisted of a sandy bottom with ripple marks and pebbles of unknown origin. Magnetite deposits as well as diatomaceous oozes were also found over the sediments. Skeletal fragments of scutellid echinoids (i.e. *Mellita quinquesperforata*) were found over the sand. The depth of this station is 13.0 ft.

3.4 The southern jetty: south side.

The depth (ft), substrate type, the dominant flora and fauna, and notes taken in each station (Station SGS1 – Station SGS10) along the southern side of the existing south groin are presented in **TABLE 11**. These southern jetty benthic stations were all inspected in April 13, 2007. Selected underwater photographs of the southern side of the south groin and of the bottom along its proposed extension are presented in **FIGURE 10**.

Station SGSI.

Station SGSI consists of limestone rocks scattered over the bottom. This rocks are ≥ 1meter in diameter and were used for the construction of the artificial southern groin. Among the rocks, a sandy bottom was found at a depth of 3ft. The dominant macrophytes on the rocks consisted of brown algae (Phaeophyta), principally *Sargassum* sp. and *Padina* sp. A red demosponge, possibly *Tedania ignis*, or fire sponge in vernacular, was found attached to one of the rocks. There was no epibenthic development on the sand, in other words the sand was barren of macrophytic or macrofaunal growth.

Several species of reef fish were found associated with the submerged portion of the artificial groin. Some of these reef fish were *Abudefduf saxatilis*, *Abudefduf taurus*, *Acanthurus* sp., and labrids (= wrasses) among others as discussed later.

TR SGS1-SGS2: This transect consisted basically of the same features found in Station SGS1. Macroalgae, principally brown algae as described previously prevailed on the exposed surfaces of the rocks. No epibenthic development was found on the sand.

Station SGS2.

Station SGS2 is also located at 3.0 ft of depth and consisted of the same features found in StationSGS1. Like in all nearshore stations, macroalgal development was only found on the upper surfaces of the rocks but not close to the sediments where sand particles abrade the rock surfaces preventing epibenthic settlement and growth. No epibenthic development was found on the sand. Some reef fishes (i.e. Gerreidae or moharras)) were found hovering and feeding over the sand

TR SGS2-SGS3: This transect consisted of a barren sandy bottom.

Station SGS3.

Station SGS3 is located at a depth of 3.0 ft and consists of a sandy bottom. There was no epibenthic development on the sand. In other words the sand was barren of authentic, epibenthic flora or fauna, perhaps due to the harshness of the physical conditions of the site. However, terrestrially derived organic matter such as fruits, ligneous debris, leaves and other sources were found over the sand or drifting in the water column.

TR SGS3-SGS4: This transect consisted of a barren sandy bottom with terrestrial debris (i.e. legumes, leaves, ligneous fragments, detritus) with all the features of the previous station (i.e. SGS3).

Station SGS4.

Station SGS4 is located at a depth of 4.0 ft and consists, like the previous station, of a sandy bottom but with some magnetite and scarce calcareous material. There was no macro-epibenthic development .

TR SGS4-SGS5: This transect consisted of a barren sandy bottom with no macro-epibenthic species (flora or fauna).

Station SGS5.

Station SGS5 consists of a barren sandy bottom with some magnetite. We found no evidence of macroalgal or macro-epibenthic invertebrate species over the sand at this depth (5 ft).

TR SGS5-SGS6: This transect consisted of a barren sandy bottom with no macro-epibenthic species (flora or fauna).

Station SGS6.

Station SGS6 is located at 6.0 ft of depth and consists of sand with some magnetite deposits. At this depth small infaunal borrows are noticeable. We found however no macroalgal development over the sand. The only macro-invertebrate found was the Keyhole scutellid urchin *Mellita quinquiesperforata* (Echinoidea: Scutellidae). This “sand dollar “ is quickly recognized by the fife (5) holes found through the test (itaque, quinque).

TR SGS6-SGS7: This transect consisted of a barren sandy bottom, with some magnetite and pebbles, and with no macro-algal species. However, within this transect we did find the scutellid urchin *Mellita quinquiesperforata* (Echinoidea: Scutellidae).

Station SGS7.

Station SGS7 is located at a depth of 8.0 ft along the trajectory of the proposed extension of the southern jetty. In this station we found a sandy bottom with magnetite deposits and with no macrofloral development. However we did find the scutellid urchin *Mellita quinquiesperforata* (Echinoidea: Scutellidae) in this station.

TR SGS7-SGS8: Similar to previous station.

Station SGS8 is located at a depth of 9.0 ft. The bottom consists of sand with no development of macroalgal or macro-invertebrate assemblages except for very juvenile individuals of the scutellid urchin *Mellita quinquiesperforata* (Echinoidea: Scutellidae). Many of the individuals of *Mellita quinquiesperforata* were less than an inch in diameter.

TR SGS8-SGS9: Sandy barren bottom with valves of the pelecypod *Tagelus plebeius* (n = 2) or similar species. No individual of *Tagelus plebeius*, or similar species was found alive perhaps due to the infaunal nature of this taxa.

Station SGS9

Station SGS9 was found to occur at a depth of 10ft. We found no epibenthic development (no macroalgae nor seagrasses, no epibenthic macro-invertebrates) in this station. Valves of the pelecypod *Tagelus plebeius* were however found.

TR SGS9-SGS10: Sandy barren bottom except for the presence of polychaetes tubes . Some magnetite deposits were found in the sand.

Station SGS10.

Station SGS10 consisted of a barren sandy bottom with magnetite deposits. We found no development of authentic (*vs* allochtonous) macrophytic growth nor macro-epibenthic vegetation. However evidence of infauna was found (i.e. sand polychaetes tubes). The depth of this station is 11 ft.

3.5 The NAVIGATION CHANNEL.

The depth (ft), substrate type, the dominant flora and fauna, and notes taken in each station (CHAN1 – CHAN10) along the proposed navigation channel which will serve as the inlet to the marina are presented in **TABLE 12**. The channel stations were all inspected in April 13, 2007. Selected, representative underwater photographs taken along the proposed navigation channel (CHAN1-CHAN11) in April 13, 2007 are presented in **FIGURE 11**.

Station CHANI.

Station CHANI is located at a 2.0 ft depth within the proposed dredge channel on a sandy bottom with no hard substrate within the surroundings except for the north and south groin structures. A diatomaceous ooze was observed over some of the sand surfaces. No epibenthic development was observed.

TR CHAN1-CHAN2: Sandy barren bottom except for the presence of the scutellid urchin *Mellita quinquiesperforata* (Echinoidea: Scutellidae).

Station CHAN2.

Station CHAN2 is located within the proposed dredge channel at a depth of 4.0 ft. Terrestrial plant debris derived from the watershed was found over the sand. Calcareous white particles were found sparsely distributed over the sand with some magnetite deposits.

TR CHAN2-CHAN-3: Like in the previous transect, the bottom was found to consist of a sandy barren bottom except for the presence of the scutellid urchin *Mellita quinquiesperforata* (Echinoidea: Scutellidae).

Station CHAN3.

Station CHAN3 consists of a sandy bottom with magnetite deposits. The bottom was barren of macro-epibenthic species except for the scutellid urchin *Mellita quinquiesperforata* (Echinoidea: Scutellidae).Station CHAN3 is located at a depth of 6.0 ft.

TR CHAN3-CHAN-4: Like in the previous transects, the bottom was found to consist of a sandy barren bottom (with magnetite deposits) except for the presence of the scutellid urchin *Mellita quinquiesperforata* (Echinoidea: Scutellidae). *Mellita quinquiesperforata* was found but not in sufficient quantities to be considered as a dominant species.

Station CHAN4.

Station CHAN4, like the previous station consisted of a sandy bottom with magnetite deposits. The bottom was barren of macro-epibenthic species except for the scutellid urchin *Mellita quinquiesperforata* (Echinoidea: Scutellidae). No authentic (autochtonous) macrophytes or macro-epibenthic invertebrates were found other than *Mellita*.Station CHAN 4 is located at a depth of 7.0 ft.

TR CHAN4-CHAN-5: Like in the previous transects, the bottom was found to consist of a sandy barren bottom. No seagrasses or other type of macrophytic vegetation was found within this transect.

Station CHAN5.

Station CHAN5 is located at a depth of 9.0 ft. the bottom consists of sand with some magnetite. Similar to previous near shore stations, terrestrial plant debris such as leaves and leaf litter (detritus) derived from the upland was found over the bottom. The bottom was barren of authentic vegetation such as attached seagrasses and macroalgae and was also barren of epibenthic macro-invertebrates.

TR CHAN5-CHAN-6: Like in the previous transect, the bottom was found to consist of a sandy barren bottom. No seagrasses or other type of macrophytic vegetation or macro-epibenthic invertebrates were found within this transect.

Station CHAN6.

Station CHAN6 consisted of a sandy bottom with magnetite deposits. A diatomaceous ooze was found over the sand in some areas. Suspended detrital matter of vascular plant origin was found in the water column. Some plant debris was found on the bottom. This could be a case of “outwelling”. Station CHAN6 is located at a depth of 11.0 ft.

TR CHAN6-CHAN-7: Like in the previous transects and stations, the bottom was found to consist of a sandy barren bottom. No seagrasses or other type of macrophytic vegetation or macro-epibenthic invertebrates were found within this transect. However a diatomaceous ooze was observed over some areas of the sandy bottom.

Station CHAN7.

Station CHAN7 like Station CHAN6 consisted of a barren sandy bottom with magnetite deposits with a diatomaceous ooze over some of the sand. Suspended detrital matter of vascular plant origin was found in the water column. Some plant debris and leaves of *Thespesia populnia* were observed in this station. No authentic macrophytes or macroinvertebrates were observed in this station. Station CHAN7 is located at a depth of 12.0 ft.

TR CHAN7-CHAN-8: Like in the previous transects and stations, the bottom was found to consist of a sandy biologically barren bottom in terms of authentic macrophytes and macro-epibenthic invertebrates. No seagrasses or other type of macrophytic vegetation or macro-epibenthic invertebrates were found within this transect. However, magnetite deposits, pebbles of unknown origin, and terrestrial plant debris were found over the sand.

Station CHAN8.

Station CHAN8 is located at a depth of 13 ft and consists of a sandy bottom with magnetite deposits and a layer of benthic diatoms (= diatomaceous ooze) in some areas. Small pebbles of unknown origin were found scattered over the seafloor. There were no authentic (autochtonous or attached) macrophytic vegetation nor macroepibenthic species found on the sand. Terrestrial plant organic debris, pebbles, some calcareous particles, and green algal balls were found in the water column and/or drifting over the sandy bottom.

TR CHAN8-CHAN-9: Like in the previous transects and stations, the bottom was found to consist of a sandy biologically barren bottom in terms of authentic macrophytes and macro-epibenthic invertebrates. However, magnetite deposits, pebbles of unknown origin, and egg masses (presumably from an annelid species) were found.

Station CHAN9.

Station CHAN9, like Station CHAN8 is located consists of a sandy bottom with magnetite deposits and a layer of benthic diatoms (= diatomaceous ooze) in some areas. No macrophytes were found attached to the seafloor and, like in all previous stations, there were no dominant macro-epibenthic invertebrate species on the sand. Terrestrially derived debris, like in most previous stations, was found over the seafloor. Station CHAN9 is located at a depth of 15.0 ft.

TR CHAN9-CHAN-10: Like in the previous transects and stations, the bottom was found to consist of a sandy, biologically deprived bottom in terms of authentic macrophytes and macro-epibenthic invertebrates. However, magnetite deposits and a diatomaceous ooze were found over the sand.

Station CHAN10.

Station CHAN10 consists of a sandy barren bottom in terms of macro-epibenthic development. In other words, no seagrass species nor other forms of macrophytes were found. In addition, like in all previous stations and transects conducted within the proposed dredge channel, no dominant macro-epibenthic invertebrates were found. The sand contains magnetite deposits and in some areas, a diatomaceous ooze over the sediments were found.

One unidentified shrimp, of a very small size, was observed on the sand. In addition, one fresh arm of the asteroid *Astropecten* sp. (Echinodermata: Asteroidea), was found on the sand, perhaps the result of predatory attack. The depth of Station CHAN10 is 17.0 ft.

TR CHAN10-CHAN-11: This transect was conducted to optimize the use of resources in view of the unusual and exceptional oceanographic and atmospheric conditions found in April 13, 2007. In this transect we extended the proposed navigation channel study along the same trajectory from 17 ft of depth to 35 ft of depth to span a total distance of 330m from shore. Along this transect we found an increase in diatomaceous ooze coverage, an increase of infaunal borrows including infaunal mounds, anaerobic (black) reduced sediments under the sand layer, an unidentified mud-dwelling coral, black mud deposits, increase of infaunal activity, a callianasid-like mound, attached *Caulerpa* sp. (possibly *taxifolia*), mud, brick fragments, rubble about 10” in diameter, anthropogenic debris, and *Halophila decipiens* on a drifting object. *Caulerpa* sp. was the only attached macrophyte at a depth of 32 ft. or more. The maximum depth of this transect was 35 ft. far northwest of the proposed jetty structure reconstruction.

4.0 CONCLUSIONS

Northern jetty

- The bottom at all stations (NGN1-NGN-9; NGS1-NGS10) within the proposed northern jetty structure consists of a shifting sandy bottom with ripple marks. The only stable hard bottom substrates consisted of the limestone rocks used to construct the existing groin several decades ago.

- The sand is classified as fine sand and often contains either thick or sparse magnetite deposits, pebbles, fruits, pods, leaves, detritus and diatomaceous oozes. In twelve of the nineteen stations (63%) the sand was found with magnetite deposits which varied in magnitude. The thick magnetite deposits rendered the sand with a black color.

- There are no sensitive Essential Fish Habitats (*sensū* NOAA) within the proposed northern jetty footprints. For example, there were no seagrass beds nor algal beds found on natural substrates.

- Coral reefs, coral communities and gorgonians do not exist within the existing rock structures of the groin nor in the footprints of the proposed northern jetty.

- The proposed northern jetty footprint do not enclose any designated critical habitat for any species listed under the U.S. Fish and Wildlife Service TESS (Threatened and Endangered Species System) nor under the "Reglamento Número 6766" (Reglamento para Regir las Especies Vulnerables y en Peligro de Extinción en el Estado Libre Asociado de Puerto Rico).

- No marine sea turtles (e.g. *Eretmochelys imbricada*, *Chelonia mydas*) nor manatees (i.e. *Thrichechus manatus*) were observed in the northern jetty nor within its surrounding.

Southern jetty

- Similar to the northern jetty, the benthos or seafloor of the southern groin and its proposed extension to form a jetty, consists of a sandy bottom except for the existing groin structure which consists of fill material (limestone rock).

- The sand is fine grain, and in 11 of the 20 stations (55%) contained magnetite deposits. Terrestrial plant debris, pebbles and diatomaceous oozes were found in different stations over the sand. The source of magnetite is possibly the Culebrina's River and not Caño Madre Vieja.

- Similar to the northern jetty stations, there were no sensitive Essential Fish Habitats (*sensū* NOAA) (seagrass beds, algal beds, coral reefs, coral communities) found within the proposed southern jetty footprints.

- Similar to the northern jetty stations, no designated critical habitat for any species listed under the U.S. Fish and Wildlife Service TESS (Threatened and Endangered Species System) nor under the "Reglamento Número 6766" (Reglamento para Regir las Especies Vulnerables y en Peligro de Extinción en el Estado Libre Asociado de Puerto Rico) were found.

- No marine sea turtles (e.g. *Eretmochelys imbricada*, *Chelonia mydas*) nor manatees (i.e. *Thrichechus manatus*) were observed in the southern jetty nor within its surrounding.

The Navigation Channel.

- The proposed navigation channel (or inlet channel of the proposed Discovery Bay Marina) consists strictly of a sandy bottom.

- There were no seagrass beds, coral reefs, coral communities or other sensitive type of Essential Fish Habitats found within the proposed dredge areas.

- The only obvious macro-invertebrate found within or close to the proposed channel was the common sand dollar *Mellita quinquesperforata*.

- No marine sea turtles (e.g. *Eretmochelys imbricada*, *Chelonia mydas*) nor manatees (i.e. *Thrichechus manatus*) were observed within the proposed navigation channel nor in its surroundings.

General conclusion.

1. After examining more than ninety (90) benthic stations and transects, and after surveying more than 5,000 m^{-2} (>0.5 ha) of seafloor between one foot (1ft) and 35 ft of depth we have found that:

2. The site proposed for the construction of the two parallel jetties which will serve as the inlet-outlet of the Discovery Bay Marina consists of a sandy beach barren of seagrass beds, coral reefs and of coral communities.

3. The only significant benthic development has occurred on the fill material (i.e. limestone rock) used to create the existing groins.

4. The major direct impact of the construction of the proposed jetties on the bottom consists of a permanent change of a sandy bottom to an artificial hard, rocky bottom.

5. In view of the abundant, low diversity and unstable condition of the sand, the artificial structure will create a new habitat which should enhance local benthic diversity and production, similar to the existing groins.

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STATION	WAYPOINT/ GPS #	LATITUDE	LONGITUDE	NOTES
NGN1	448/ GPS#2	18°24.823' N	67°09.756' W	Shallowest (2.0 ft) and most near shore benthic station.
NGN2	343/ GPS#1	18°24.831' N	67°09.800' W	Sandy bottom.
NGN3	344/ GPS#1	18°24.833' N	67°09.814' W	Sandy bottom.
NGN4	345/ GPS#1	18°24.840' N	67°09.841' W	Sandy bottom.
NGN5	346/ GPS#1	18°24.842' N	67°09.849' W	Sandy bottom.
NGN6	347/ GPS#1	18°24.848' N	67°09.862' W	Sandy bottom.
NGN7	348/ GPS#1	18°24.852' N	67°09.878' W	Sandy bottom.
NGN8	349/ GPS#1	18°24.852' N	67°09.889' W	Sandy bottom.
NGN9	350/ GPS#1	18°24.855' N	67°09.904' W	Deepest (26.0 ft), and most offshore station.

TABLE 2. Discovery Bay, Resort & Marina *PROPOSED JETTY FOOTPRINT BENTHIC STUDY*: North Jetty, South Side (= NGS), Station number (NGS1-NGS10), waypoints, GPS unit utilized, and coordinates. January 26, 2007.

STATION	WAYPOINT #	LATITUDE	LONGITUDE	NOTES
NGS1	351/GPS#1	18°24.805' N	67°09.809' W	Shallowest (4.0 ft) and most near shore benthic station.
NGS2	352/GPS#1	18°24.808' N	67°09.813' W	Sandy bottom.
NGS3	353/GPS#1	18°24.811' N	67°09.824' W	Sandy bottom.
NGS4	354/GPS#1	18°24.816' N	67°09.837' W	Sandy bottom.
NGS5	355/GPS#1	18°24.818' N	67°09.846' W	Sandy bottom.
NGS6	356/GPS#1	18°24.818' N	67°09.852' W	Sandy bottom.
NGS7	357/GPS#1	18°24.821' N	67°09.856' W	Sandy bottom.
NGS8	358/GPS#1	18°24.825' N	67°09.872' W	Sandy bottom.
NGS9	359/GPS#1	18°24.828' N	67°09.884' W	Sandy bottom.
NGS10	360/GPS#1	18°24.825' N	67°09.900' W	Deepest (20.0 ft), and most offshore station.

TABLE 3. Discovery Bay, Resort & Marina *PROPOSED JETTY FOOTPRINT BENTHIC STUDY*: South Jetty, North Side (= SGN), Station number (SGN1-SGN10), waypoints, GPS unit utilized, and coordinates. April 13, 2007.

STATION	WAYPOINT/ GPS #	LATITUDE	LONGITUDE	NOTES
SGN1	449/GPS#2	18° 24.773' N	67° 09.787' W	Sand and rocks.
SGN2	450/GPS#2	18° 24.779' N	67° 09.802' W	Sand and rocks.
SGN3	451/GPS#2	18° 24.796' N	67° 09.816' W	Sand
SGN4	452/GPS#2	18° 24.801' N	67° 09.823' W	Sand
SGN5	453/GPS#2	18° 24.804' N	67° 09.828' W	Sand
SGN6	454/GPS#2	18° 24.808' N	67° 09.832' W	Sand
SGN7	455/GPS#2	18° 24.812' N	67° 09.825' W	Sand
SGN8	456/GPS#2	18° 24.817' N	67° 09.842' W	Sand
SGN9	457/GPS#2	18° 24.819' N	67° 09.850' W	Sand
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TABLE 4. Discovery Bay, Resort & Marina *PROPOSED JETTY FOOTPRINT BENTHIC STUDY*: South Jetty, South Side (= SGS), Station number (SGS1-SGS10), waypoints, GPS unit utilized, and coordinates. April 13, 2007.

STATION	WAYPOINT/ GPS #	LATITUDE	LONGITUDE	NOTES
SGS1	459/GPS#2	18° 24.769' N	67° 09.797' W	Sand and rocks.
SGS2	460/GPS#2	18° 24.778' N	67° 09.803' W	Sand and rocks.
SGS3	461/GPS#2	18° 24.780' N	67° 09.813' W	Sand
SGS4	462/GPS#2	18° 24.782' N	67° 09.822' W	Sand
SGS5	463/GPS#2	18° 24.786' N	67° 09.829' W	Sand
SGS6	464/GPS#2	18° 24.788' N	67° 09.838' W	Sand
SGS7	465/GPS#2	18° 24.789' N	67° 09.845' W	Sand
SGS8	466/GPS#2	18° 24.793' N	67° 09.858' W	Sand
SGS9	467/GPS#2	18° 24.794' N	67° 09.868' W	Sand
SGS10	468/GPS#2	18° 24.797' N	67° 09.878' W	Sand

TABLE 5. Discovery Bay, Resort & Marina *PROPOSED JETTY FOOTPRINT BENTHIC STUDY*: Proposed dredge channel (= CHAN), Station number (CHAN1-CHAN10), waypoints, GPS unit utilized, and coordinates. April 13, 2007.

STATION	WAYPOINT/ GPS #	LATITUDE	LONGITUDE	NOTES
CHAN1	469/GPS#2	18° 24.794' N	67° 09.805' W	Sand
CHAN2	470/GPS#2	18° 24.798' N	67° 09.812' W	Sand
CHAN3	471/GPS#2	18° 24.802' N	67° 09.822' W	Sand
CHAN4	472/GPS#2	18° 24.806' N	67° 09.823' W	Sand
CHAN5	473/GPS#2	18° 24.812' N	67° 09.831' W	Sand
CHAN6	474/GPS#2	18° 24.820' N	67° 09.832' W	Sand
CHAN7	475/GPS#2	18° 24.827' N	67° 09.836' W	Sand
CHAN8	476/GPS#2	18° 24.835' N	67° 09.839' W	Sand
CHAN9	477/GPS#2	18° 24.843' N	67° 09.838' W	Sand
CHAN10	478/GPS#2	18° 24.851' N	67° 09.841' W	Sand
CHAN11	479/GPS#2	18° 24.951' N	67° 09.888' W	Sand and Mud.

TABLE 6. The depth (ft), substrate type, the dominant flora and fauna, and notes taken in each station (Station NGN1 – Station NGN9) along the northern side of the existing north groin. January 26, 2007.

NORTH GROIN NORTH (= NGN)						
STATION	GPS WPT#	DEPTH (ft)	SUBSTRATE (sand, rock other)	DOM FLORA	DOM FAUNA	NOTES
NGN1	GPS2 #448	2.0	Fine sand with overlaying limestone rocks.	Rhodophyta and Phaeophyta.	*Brachidontes exustus*.	High wave energy environment. Physically-controlled system.
NGN2	GPS1 #343	6.0	Fine sand with magnetite.	NONE	NONE	This station is next to the terminal point of the groin.
NGN3	GPS1 #344	8.0	Fine sand with magnetite.	NONE	NONE	Siliceous sand with magnetite. Ripple marks on sand.
NGN4	GPS1 #345	13.0	Fine sand.	NONE	NONE	Fine sand with magnetite.
NGN5	GPS1 #346	18.0	Fine sand.	Diatomaceous ooze over some ripple marks.	NONE	Fine sand with some diatomaceous ooze (Chrysophyta).
NGN6	GPS1 #347	20.0	Fine sand. Ripple marks.	NONE	NONE	Fine sand. Diatomaceous ooze prominent.
NGN7	GPS1 #348	22.0	Fine sand. Diatomaceous ooze.	NONE	NONE	Valves of the “razor” clam *Tagelus plebeius*.
NGN8	GPS1 #349	23.0	Fine sand with magnetite.	NONE	NONE	Molluscan shells, some rubble, some clay material.
NGN9	GPS1 #350	26.0	Fine sand.	NONE	NONE	Ligneous detritus from terrestrial vegetation.
NGN10	N/N	N/N	N/N	N/N	N/N	N/N

TABLE 7. Descriptions of the underwater transects conducted between stations along the proposed footprints of the northern side of the north groin.

TRANSECT	DISTANCE (km)	DEGREES	DEPTH RANGE (ft)	DESCRIPTION
NGN1 - NGN2	0.08 km	281°	2.0-6.0	Sandy bottom with buried groin building blocks. Barren.
NGN2 – NGN3	0.03 km	281°	6.0-8.0	Sandy bottom with ripple marks. Schools of jacks (Carangidae). Barren.
NGN3 – NGN4	0.05 km	284°	8.0-13.0	Sandy bottom with some calcareous sediments. Barren.
NGN4 – NGN5	0.02 km	0.00°	13.0-18.0	Sandy barren bottom with some polychaetes tubes.
NGN5 – NGN6	0.02 km	0.00°	18.0-20.0	Sandy barren bottom. Pebbles, infaunal burrows, and some calcareous sediments.
NGN6 – NGN7	0.03 km	286°	20.0-22.0	Sandy barren bottom. Ripple marks and no outcrops.
NGN7 – NGN8	0.02 km	0.00°	22.0-23.0	Sandy barren bottom with diatom ooze. Ripple marks.
NGN8 – NGN9	0.03 km	284°	23.0-26.0	Sandy barren bottom. Suspended organic particles. *Synodus saurus*. and clam shells.
NGN9 – NGN10	N/A	N/A	N/A	N/A
Total distance 0.28 km = 280 m				

TABLE 8. The depth (ft), substrate type, the dominant flora and fauna, and notes taken in each station (Station NGS1 – Station NGS10) along the southern side of the existing north groin . January 26, 2007.

NORTH GROIN SOUTH (= NGS)						
STATION	GPS WPT#	DEPTH (ft)	SUBSTRATE (sand, rock other)	DOM FLORA	DOM FAUNA	NOTES
NGS1	GPS1 #351	4.0	Sand and submerged limestone rocks from groin.	Brown algae (Phaeophyta).	*Brachiodontes exustus* and regular echinoids.	Fine sand, barren bottom.
NGS2	GPS1 #352	5.0	Sandy bottom.	NONE	NONE	Some magnetite on sand.
NGS3	GPS1 #353	7.0	Fine sandy bottom.	NONE	NONE	Sand with some magnetite.
NGS4	GPS1 #354	10.0	Fine sandy bottom.	NONE	NONE	Fine sand with some magnetite.
NGS5	GPS1 #355	12.0	Fine sandy bottom.	NONE	NONE	Thick bands of magnetite as part of the sand.
NGS6	GPS1 #356	13.0	Fine sand, some stones (rubble).	NONE	NONE	Magnetite prominent in the sand.
NGS7	GPS1 #357	14.0	Fine sand, some stones (rubble).	NONE	NONE	Polished stones or rubble within the sand.
NGS8	GPS1 #358	16.0	Fine sand and magnetite.	NONE	NONE	Sand with thin layer of diatomaceous ooze.
NGS9	GPS1 #359	18.0	Fine sand and magnetite.	NONE	NONE	Pebbles, within the sand, magnetite, detritus.
NGS10	GPS1 #360	20.0	Fine sand and magnetite.	NONE	NONE	Pebbles, magnetite and diatomaceous ooze on the sand.
Total distance: 0.18km = 180m						

TABLE 9. Descriptions of the underwater transects conducted between stations along the proposed footprints of the southern side of the north groin.

TRANSECT	DISTANCE (m)	DEGREES	DEPTH RANGE (ft)	DESCRIPTION
NGS1 - NGS2	0.01 km	0.00°	4.0-5.0	Sandy bottom. Submerged groin structure. Macroalgae and sea urchins.
NGS2 – NGS3	0.02 km	0.00°	5.0-7.0	Fine sand, ripple marks, magnetite, pebbles and calcareous sediments.
NGS3 – NGS4	0.03 km	293°	7.0-10.0	Fine sandy bottom. Barren substrata.
NGS4 – NGS5	0.02 km	0.00°	10.0-12.0	SFine sand. Magnetite. Some calcareous deposits. Barren substrata.
NGS5 – NGS6	0.01 km	0.00°	12.0-13.0	Fine sandy bottom. No outcrops or hard bottom. Barren
NGS6 – NGS7	0.01 km	0.00°	13.0-14.0	Sandy bottom with some calcareous deposits. Pebbles.
NGS7 – NGS8	0.03 km	287°	14.0-16.0	Fine sandy bottom. Magnetite deposits.Ripple marks. Barren.
NGS8 – NGS9	0.02 km	0.00°	16.0-18.0	Sandy bottom (fine sand). Magnetite deposits. Ripple marks.
NGS9 – NGS10	0.03 km	258°	18.0-20.0	Sandy bottom. Magnetite deposits. Ripple marks.
Total distance: 0.18 km = 180 m				

TABLE 10. The depth (ft), substrate type, the dominant flora and fauna, and notes taken in each station (Station SGN1 – Station SGN10) along the northern side of the existing south groin . The south groin benthic stations were inspected in April 13, 2007.

SOUTH GROIN NORTH (= SGN): April 13, 2007						
STATION	GPS WPT#	DEPTH (ft)	SUBSTRATE (sand, rock other)	DOM FLORA	DOM FAUNA	NOTES
SGN1	449/GPS#2	1.0	Sand and Rocks	None on sand. Macroalgae on rocks.	NONE	*Digenia simplex*-like clumps.
SGN2	450/GPS#2	2.0	Sand and Rocks	On Rocks: *Padina* sp.	NONE	Barren sandy bottom.
SGN3	451/GPS#2	5.0	Sand	NONE	NONE	Barren sandy bottom.
SGN4	452/GPS#2	7.0	Sand with magnetite	NONE	NONE	Drifting red coralline algal balls
SGN5	453/GPS#2	8.0	Sand with magnetite	NONE	NONE	Mangrove leaves on bottom.
SGN6	454/GPS#2	9.0	Sand with magnetite	NONE	NONE	Ligneous debris, mangrove leaves, *Thespesia* leaves
SGN7	455/GPS#2	10.0	Sand with magnetite	NONE	NONE	Ripple marks
SGN8	456/GPS#2	11.0	Sand with magnetite	NONE	NONE	Ripple marks reduced.
SGN9	457/GPS#2	12.0	Sand with >magnetite	NONE	NONE	Ripple marks reduced. Pebbles.
SGN10	458/GPS#2	13.0	Sand with >magnetite	NONE Diatomaceous ooze	NONE	Some pebbles.
Total distance: 0.15km = 150m						

TABLE 11. The depth (ft), substrate type, the dominant flora and fauna, and notes taken in each station (Station SGS1 – Station SGS10) along the southern side of the existing south groin. The south groin benthic stations were all inspected in April 13, 2007.

SOUTH GROIN SOUTH (= SGS): April 13, 2007						
STATION	GPS WPT#	DEPTH (ft)	SUBSTRATE (sand, rock other)	DOM FLORA	DOM FAUNA	NOTES
SGS1	459/GPS#2	3.0	Rock and sand	*Padina* sp.	NONE	Reef fish within artificial structure (see report).
SGS2	460/GPS#2	3.0	Rock and sand	*Padina* sp.	NONE	Reef fish within artificial structure (see report).
SGS3	461/GPS#2	3.0	Sand	NONE	NONE	Barren sand.
SGS4	462/GPS#2	4.0	Sand	NONE	NONE	Barren sand with some magnetite.
SGS5	463/GPS#2	5.0	Sand	NONE	NONE	Barren sand with some magnetite.
SGS6	464/GPS#2	6.0	Sand	NONE	NONE	*Mellita sexiesperforata*
SGS7	465/GPS#2	8.0	Sand with magnetite	NONE	*Mellita sexiesperforata*	Sandy bottom with ripple marks
SGS8	466/GPS#2	9.0	Sand	NONE	NONE	Ripple marks with juvenile *Mellita sexiesperforata*
SGS9	467/GPS#2	10.0	Sand	NONE	NONE	*Tagelus plebeius* valves.
SGS10	468/GPS#2	11.0	Sand with magnetite	NONE	NONE	Sand with magnetite, Some polychaetes
Total distance: 0.15 km = 150m						

TABLE 12. The depth (ft), substrate type, the dominant flora and fauna, and notes taken in each station (CHAN1 – CHAN10) along the proposed navigation channel which will serve as the inlet to the marina. The channel stations were all inspected in April 13, 2007.

NAVIGATION CHANNEL (= CHAN) : April 13, 2007						
STATION	GPS WPT#	DEPTH (ft)	SUBSTRATE (sand, rock other)	DOM FLORA	DOM FAUNA	NOTES
CHAN1	469/GPS#2	2.0	sand	NONE	NONE	Between groins
CHAN2	470/GPS#2	4.0	sand	NONE	NONE	Some magnetite, algal drifts.
CHAN3	471/GPS#2	6.0	Sand with magnetite	NONE	*Mellita quinquesperforata*	No seagrass drift. *Mellita* present but not dominant.
CHAN4	472/GPS#2	7.0	Sand with magnetite	NONE	*Mellita quinquesperforata*	*Mellita* present but not dominant.
CHAN5	473/GPS#2	9.0	Sand, some magnetite	NONE	NONE	Ligneous debris.
CHAN6	474/GPS#2	11.0	Sand, Magnetite	NONE Diat.ooze.	NONE	Organic debris on bottom.
CHAN7	475/GPS#2	12.0	Sand, Magnetite	NONE Diat.ooze.	NONE	*Thespesia* leaves.
CHAN8	476/GPS#2	13.0	Sand, Magnetite	NONE Diat.ooze.	NONE	Small pebbles.
CHAN9	477/GPS#2	15.0	Sand, Magnetite	NONE Diat.ooze.	NONE	Annelid egg mass.
CHAN10	478/GPS#2	17.0	Sand, Magnetite	NONE Diat.ooze.	NONE	Unid. Benthic shrimp.
CHAN11	479/GPS#2	35.0	Sand and Mud.	NONE	NONE	See figures.
Total distance: 0.33km = 330m						

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FIGURE 11. Selected representative underwater photos taken along the proposed navigation channel (CHAN1 – CHAN11) in April 13, 2007.	**64**

FIGURE 1 (GIS). The existing “groin” structures at the mouth of Caño Madre Vieja, the proposed offshore jetty extension (black dots) from the original shore structures, and the location of some of the benthic and wetland stations previously sampled by Vicente & Associates, Inc. in 2004 (red dots).

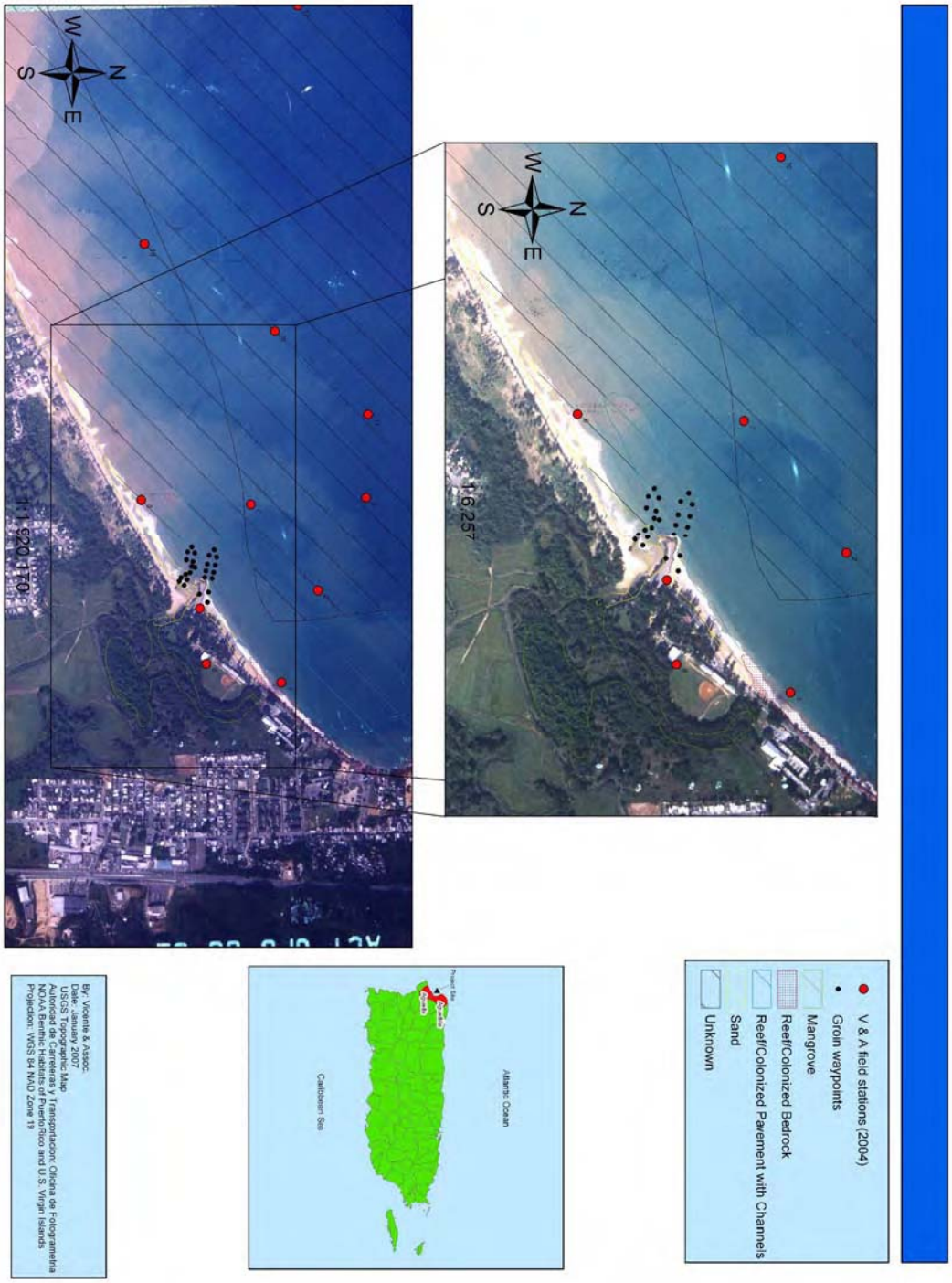


FIGURE 2. The detail footprint drawings of the proposed, parallel jetty structures as designed by Moffait & Nichols (M&N Project 5478, December 28, 2005). The two parallel jetties will extend from shore along a NW direction (approximately 300°) for approximately 100m.

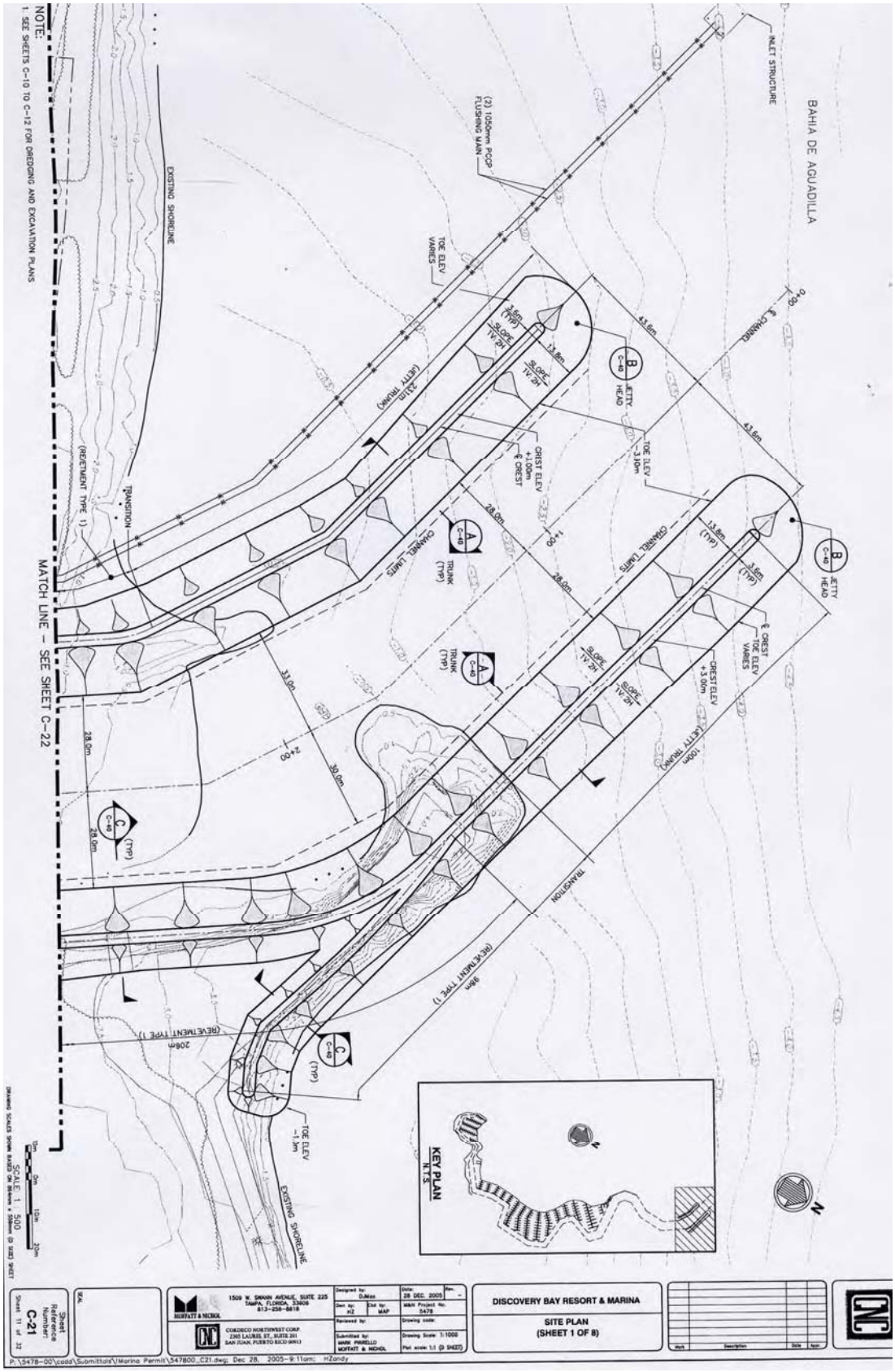


FIGURE 3. Western panoramic view of the northern side of the existing north groin showing the limestone boulders and the intertidal *Sargassum* sp. zone (red arrow). The photo was taken in January 26, 2007 by V&A, Inc, from Station NGN1, latitude 18°24.823' N, longitude 67°09.756' W.

FIGURE 4. Representative underwater photographs of the substrate and epibenthos within the sublittoral zone of the northern side of the north groin (photographs by V&A Inc., January 26, 2007). *Siderastrea* spp. (TR, ML), *Tripneustes esculentus* (LR), *Sargassum* sp. (LL), *Brachiodontes exustus* (MR).

FIGURE 5. Representative underwater photos taken between stations (TR NGN1-NGN2…TR NGN9-NGN10) along the northern section off the northern groin.

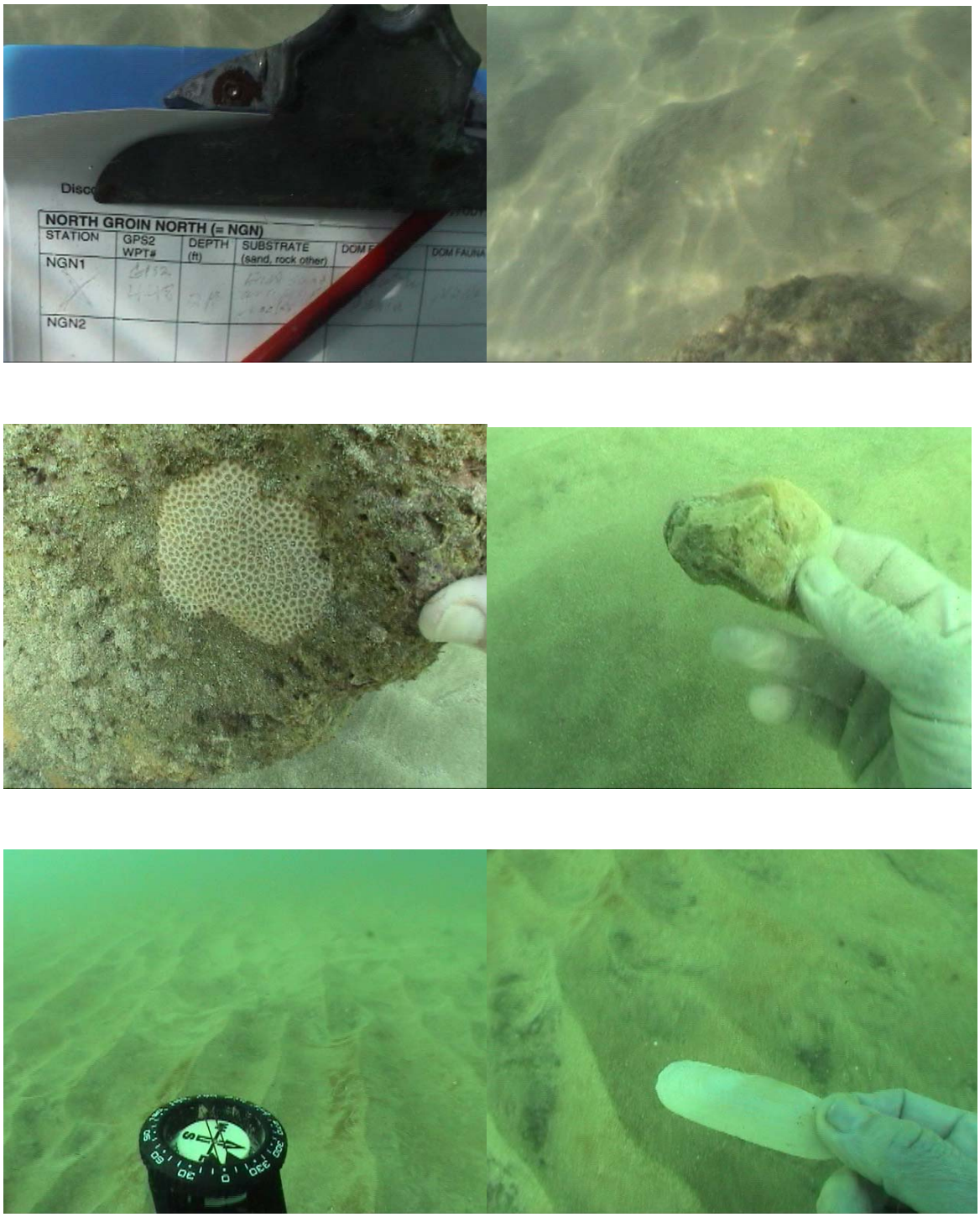


FIGURE 5 (continued). Representative underwater photos taken between stations (TR NGN1-NGN2…TR NGN9-NGN10) along the northern section off the northern groin.

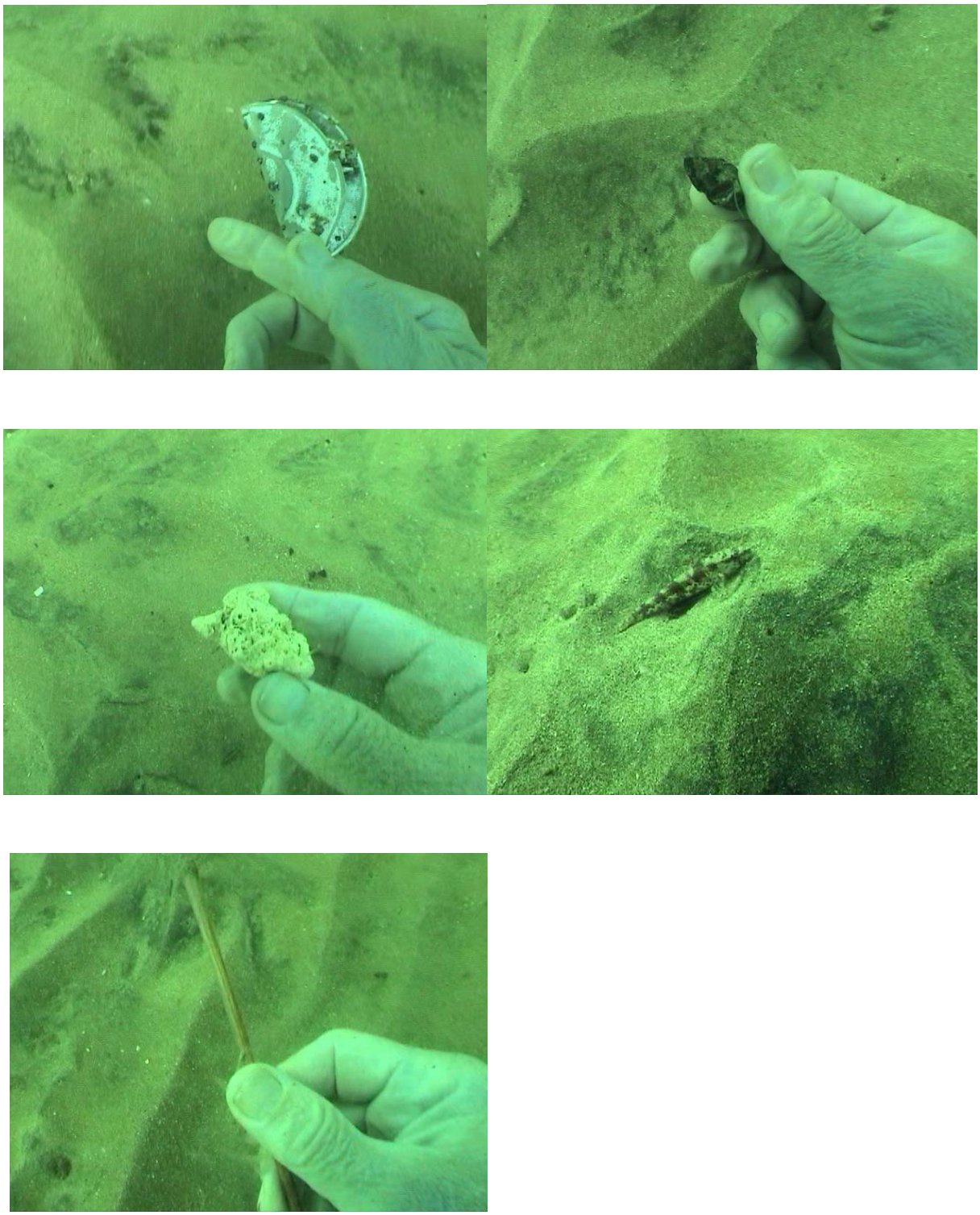


FIGURE 6. Northern panoramic view of the southern side of the existing north groin. The dry subaerial limestone boulders provide roosting grounds for shore birds while the submerged portion of the boulders provide habitats for macrophytic algae and invertebrates. The photo was taken in January 26, 2007 by V&A, Inc, from Station NGS1, latitude 18°24.823' N, longitude 67°09.756' W.

FIGURE 7. Representative underwater photographs of the substrate and epibenthos within the sublittoral zone of the <u>southern side</u> of the north groin (photographs by V&A Inc., January 26, 2007). Sandy bottom and rocky bottom with the brown algae *Dictyopteris* sp. (TR), The articulated coralline red alga *Amphiroa* (MRL) and the sea urchin *Echinometra lucunter* (MRR). Fine sand with an apparent rich magnetite deposit (BRR).

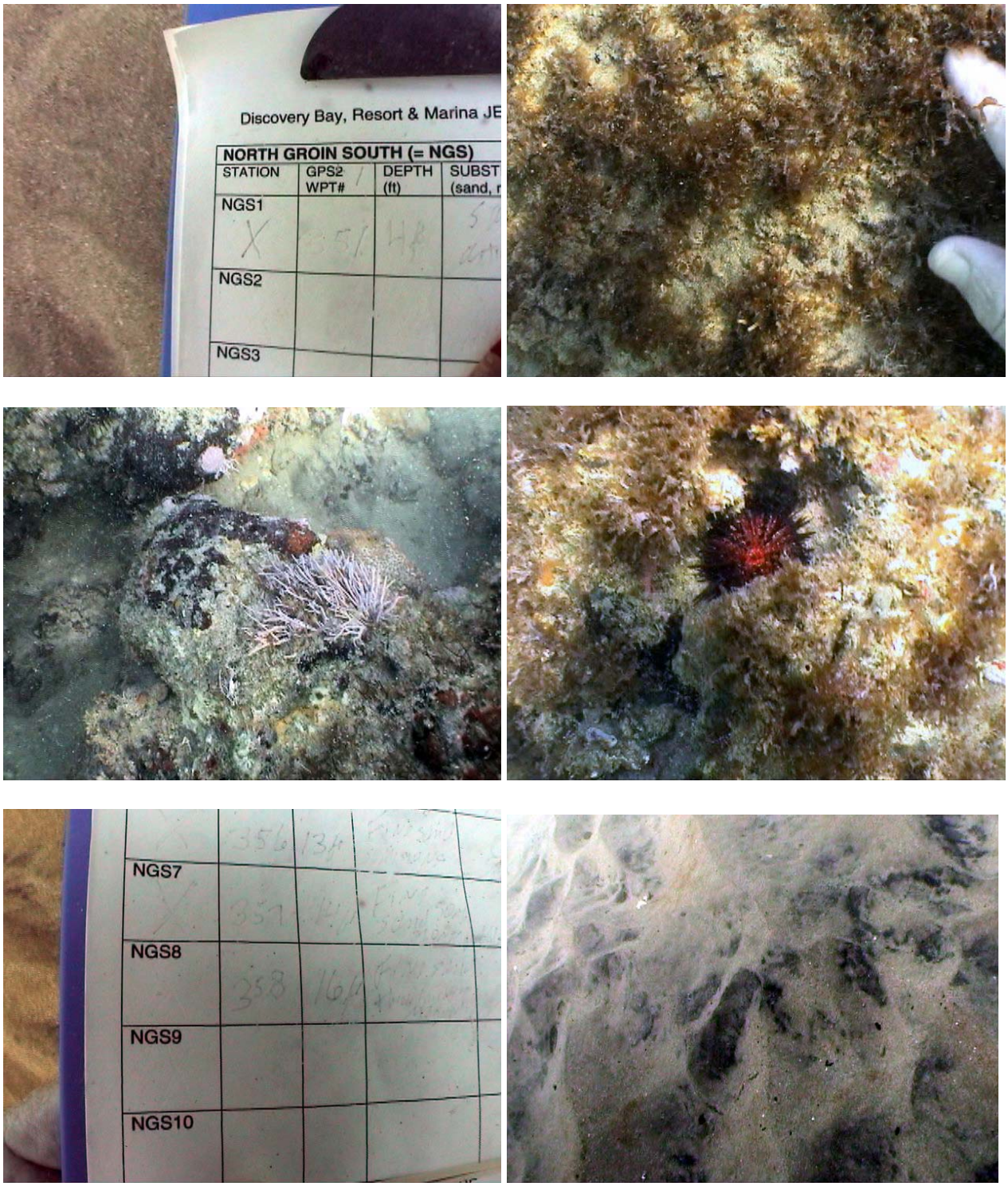


FIGURE 8. Representative underwater photos taken between stations (TR NGS1-NGN2…TR NGS9-NGS10) along the southern section of the north groin and along the proposed extension of the same.

FIGURE 8 (continued). Representative underwater photos taken between stations (TR NGS1-NGN2…TR NGS9-NGS10) along the southern section of the north groin and along the proposed extension of the same.

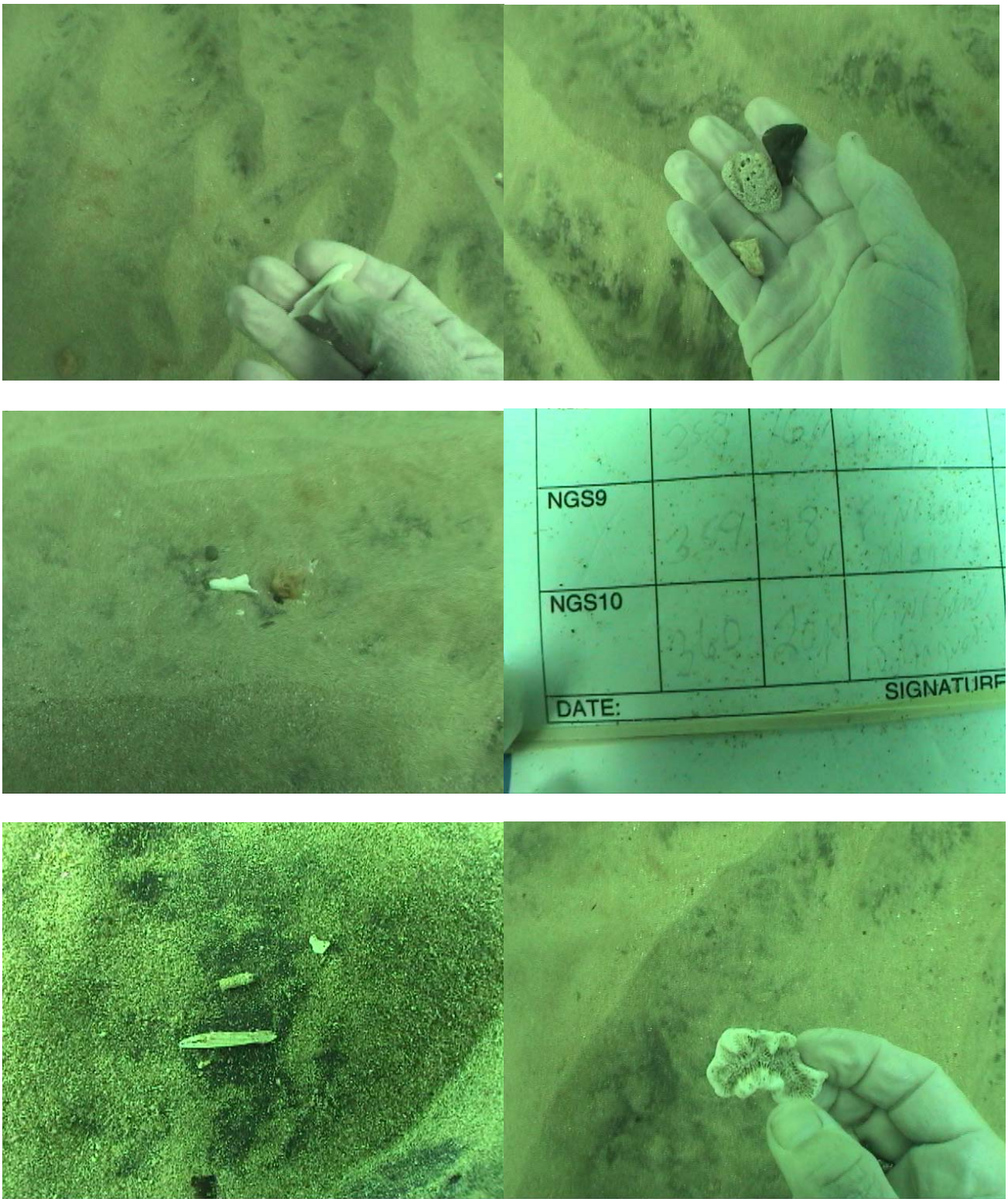


FIGURE 9. Selected representative underwater photos taken off the northern side of the SOUTH GROIN, (SGN1 – SGN10) in April 13, 2007 and along the proposed extension of the same.

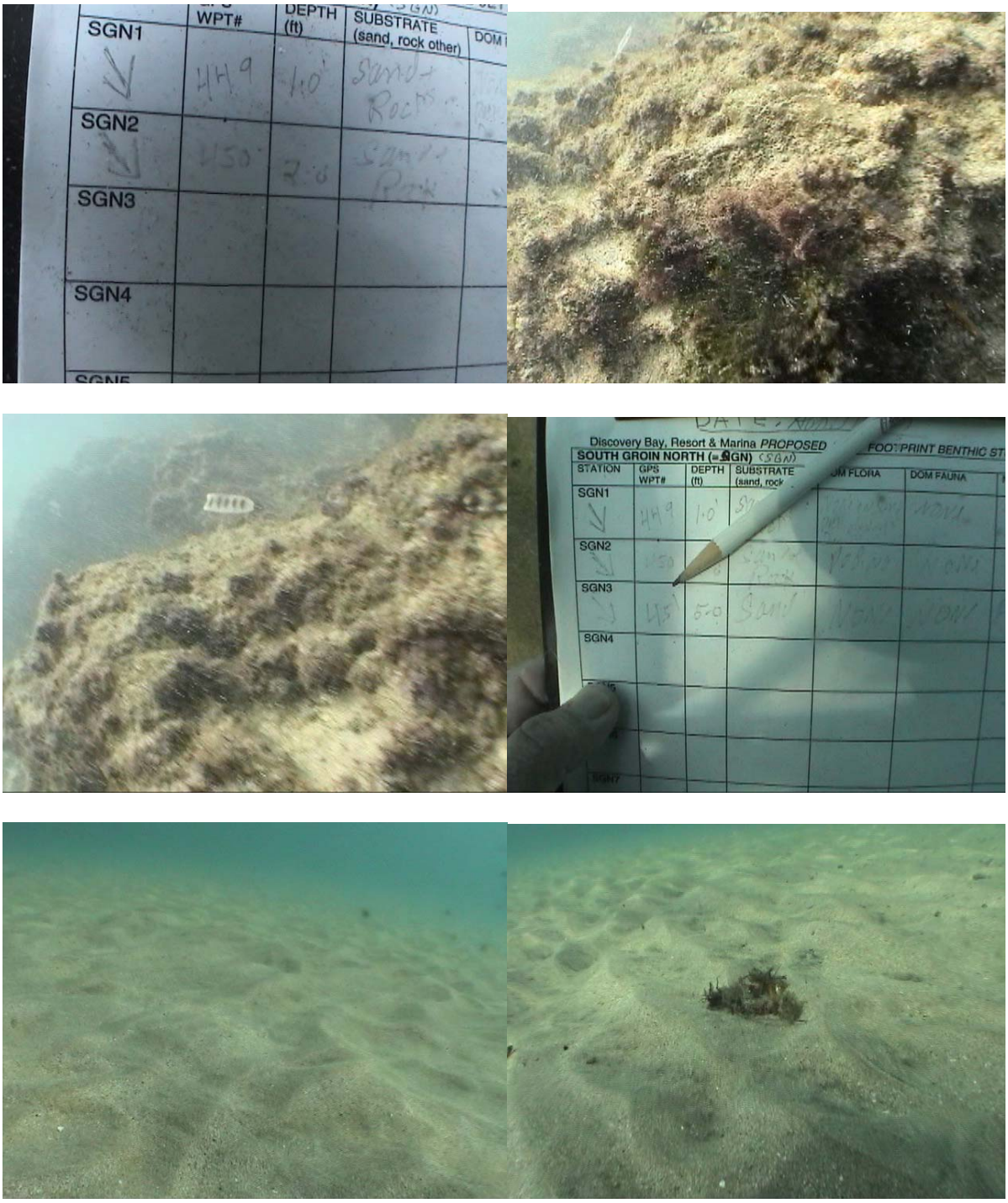


FIGURE 9 (continued). Selected representative underwater photos taken off the northern side of the SOUTH GROIN, (SGN1 – SGN10) in April 13, 2007 and along the proposed extension of the same.

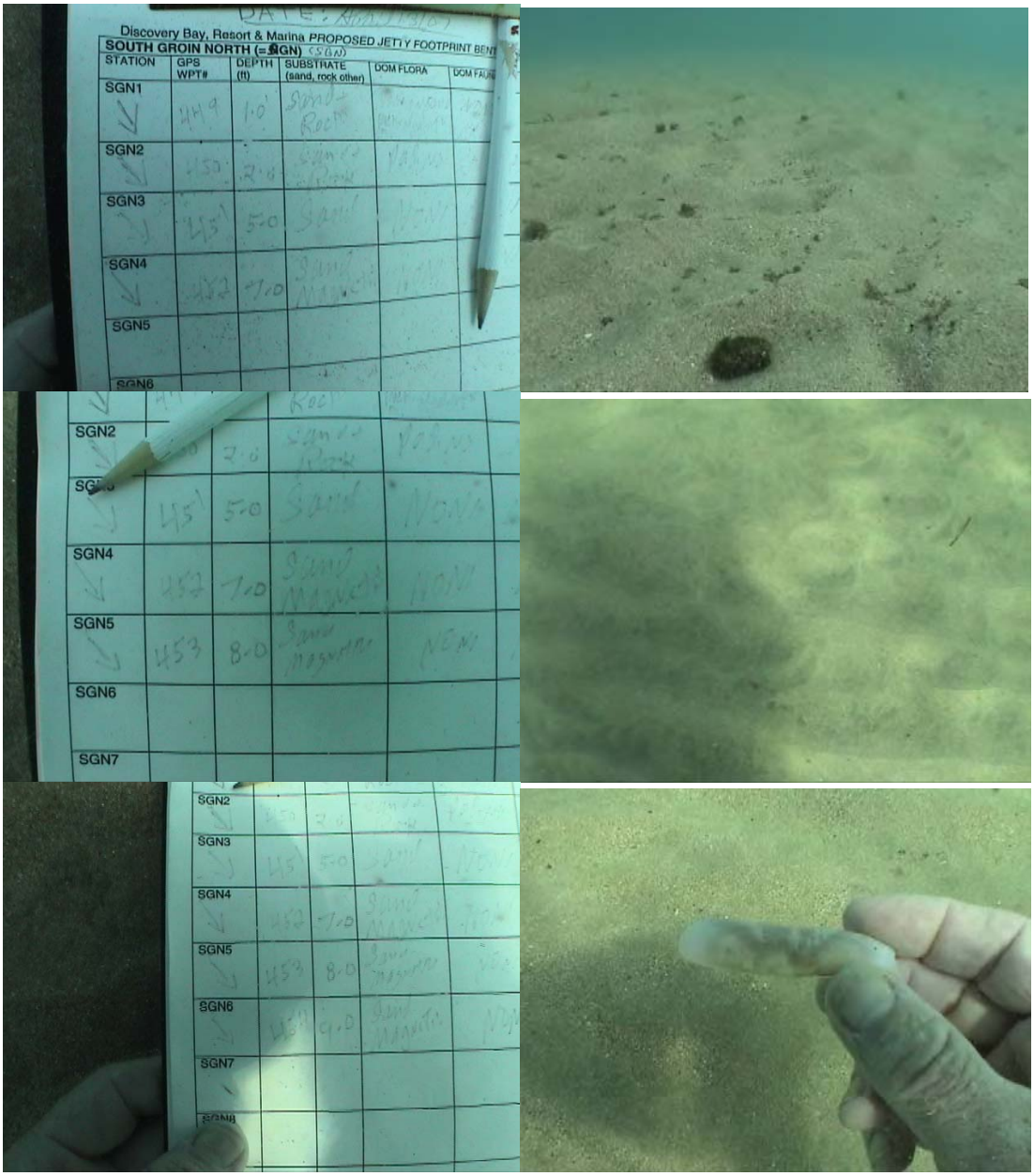


FIGURE 9 (continued). Selected representative underwater photos taken off the northern side of the SOUTH GROIN, (SGN1 – SGN10) in April 13, 2007 and along the proposed extension of the same.

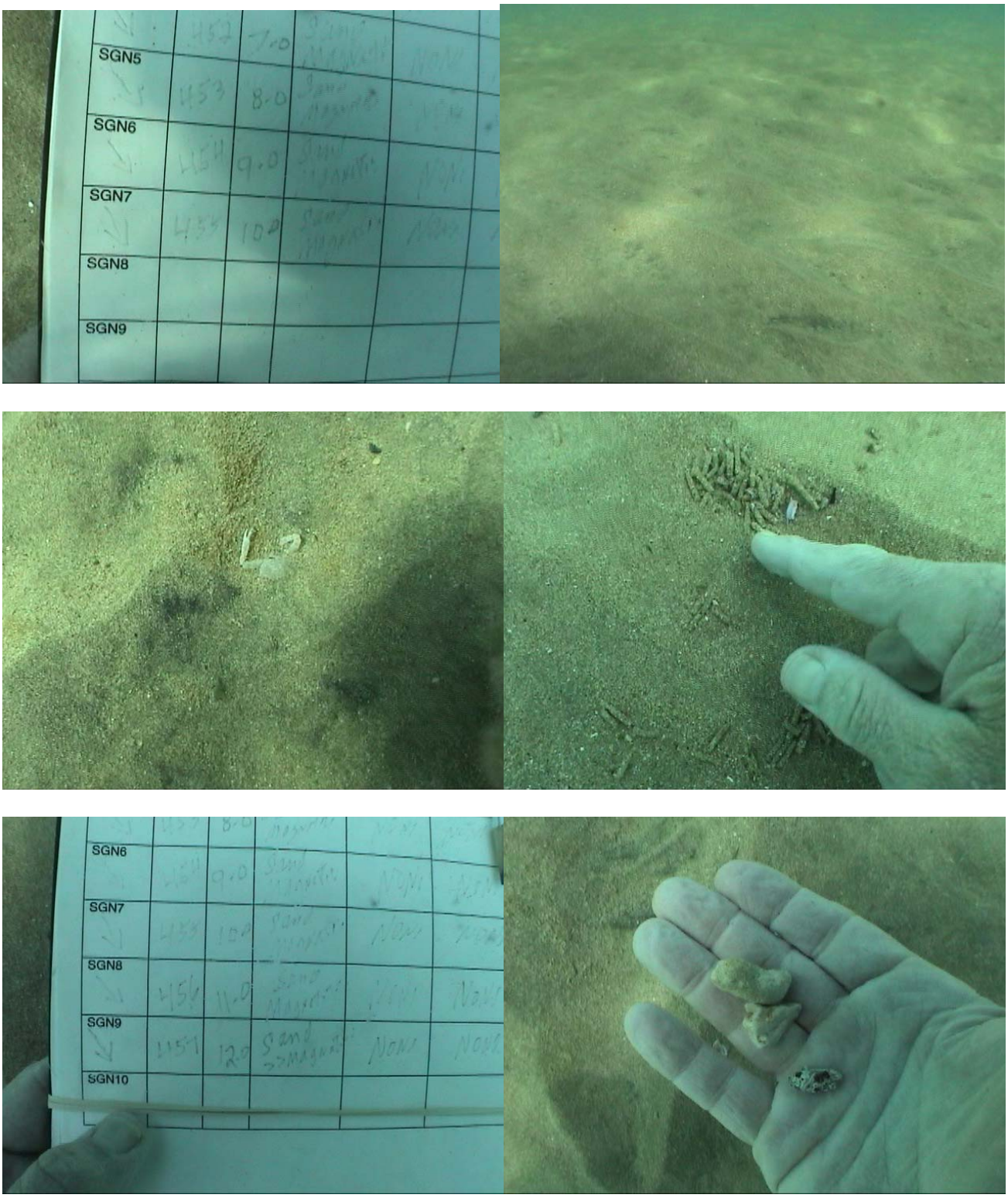


FIGURE 10. Selected representative underwater photos taken off the southern side of the SOUTH GROIN, (SGS1 – SGS10) in April 13, 2007 and along the proposed extension of the same.

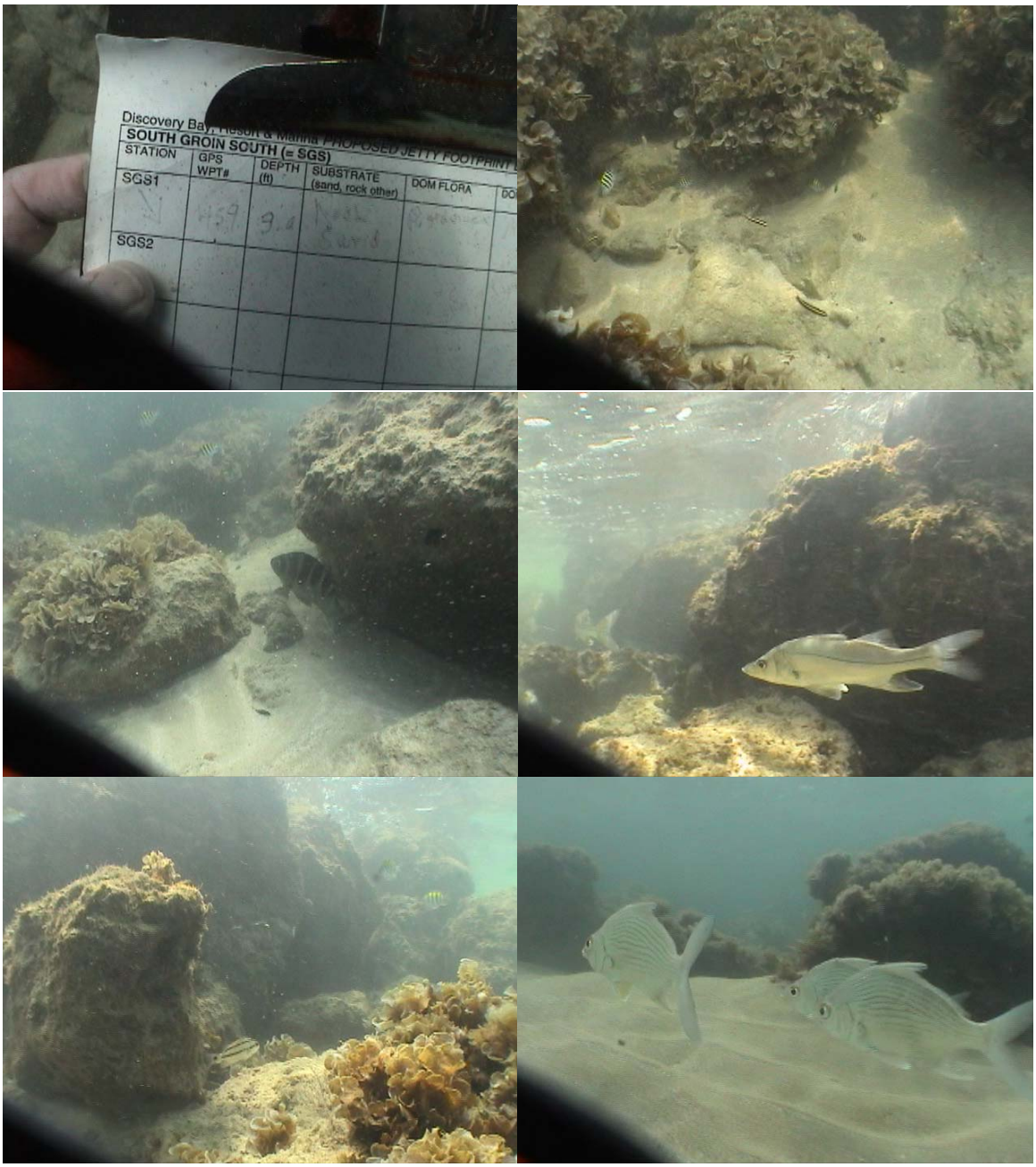


FIGURE 10 (continued). Selected representative underwater photos taken off the southern side of the SOUTH GROIN, (SGS1 – SGS10) in April 13, 2007.

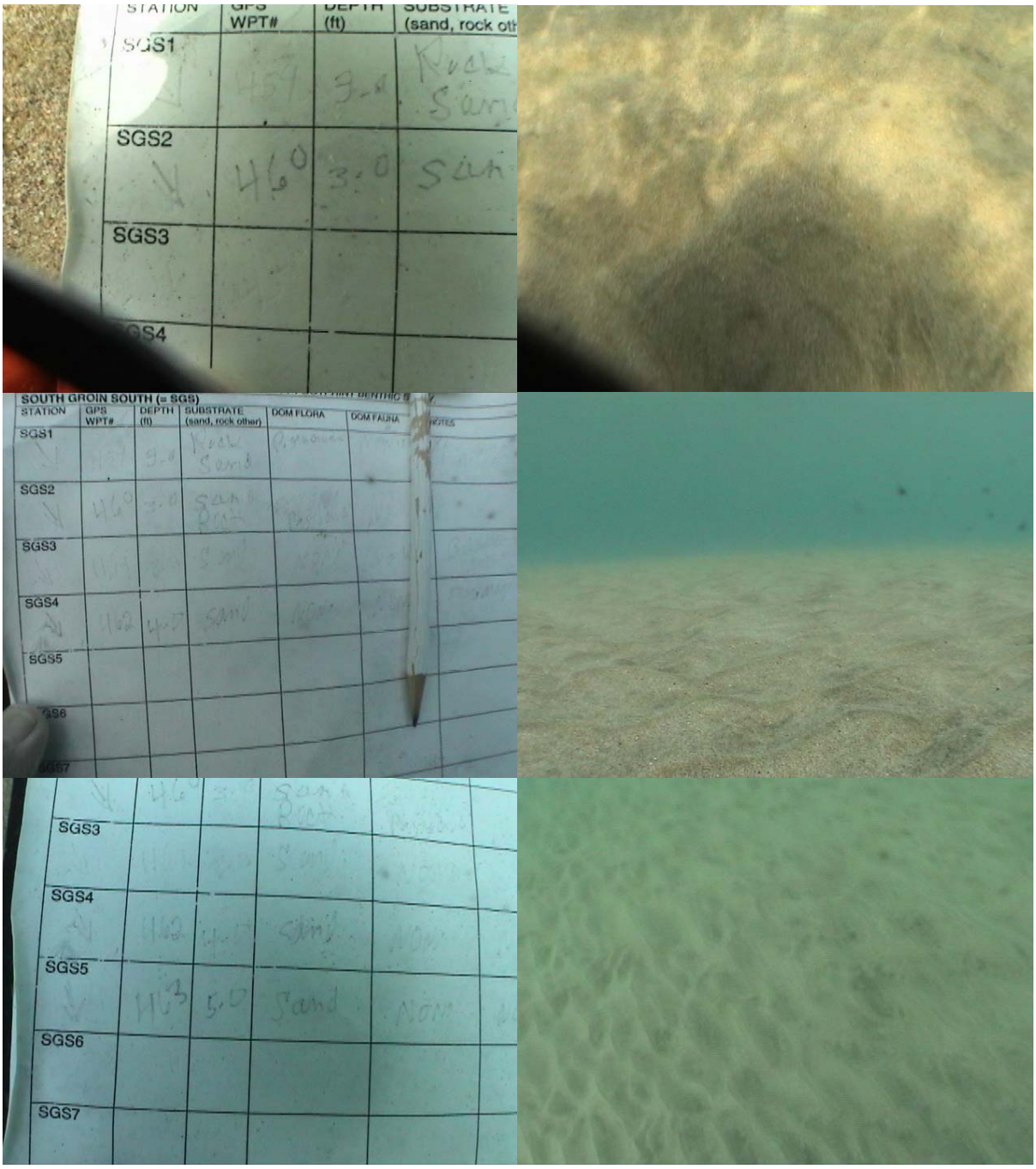


FIGURE 10 (continued). Selected representative underwater photos taken off the southern side of the SOUTH GROIN, (SGS1 – SGS10) in April 13, 2007.

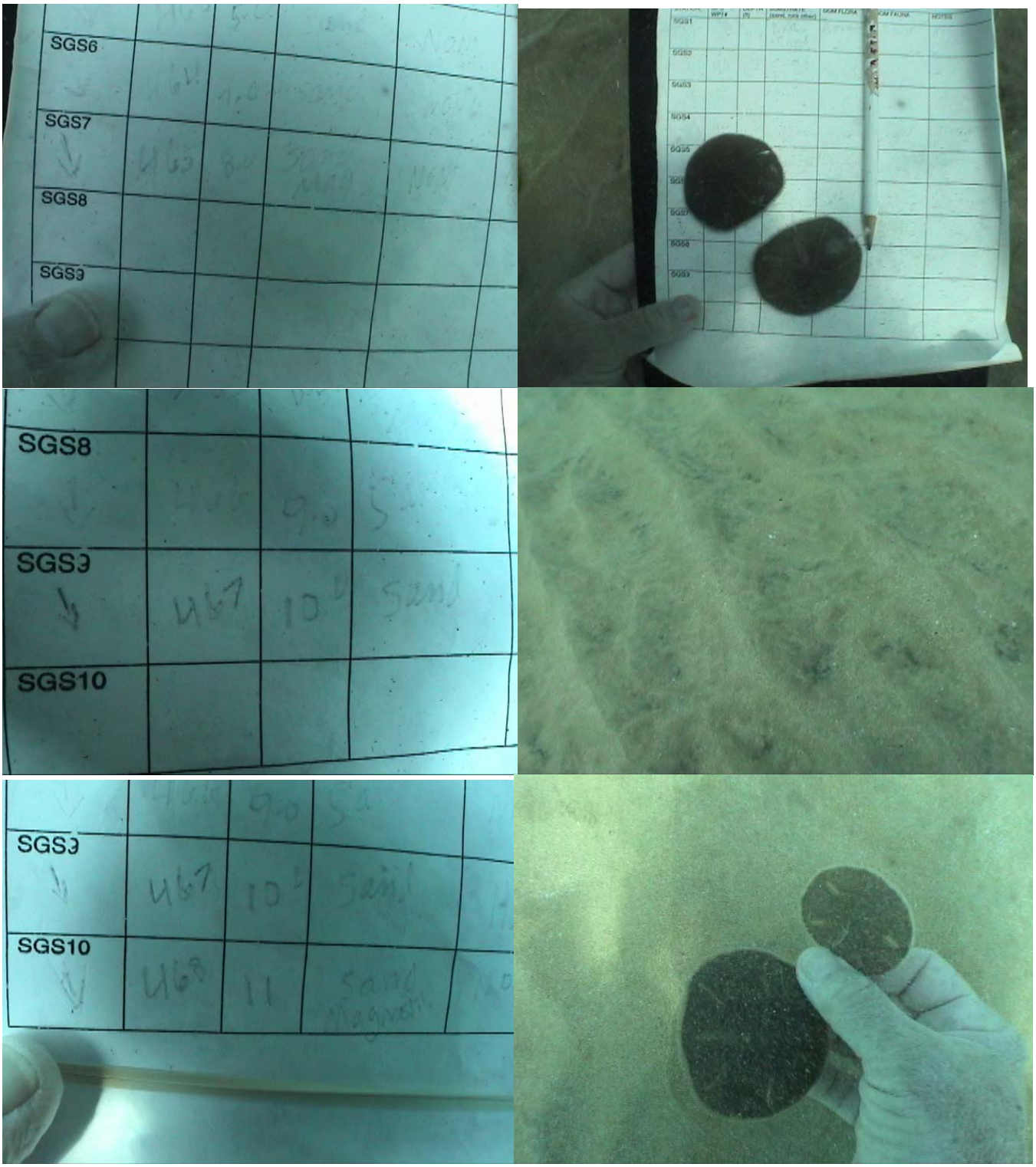


FIGURE 11. Selected representative underwater photos taken along the proposed navigation channel (CHAN1 – CHAN11) in April 13, 2007.

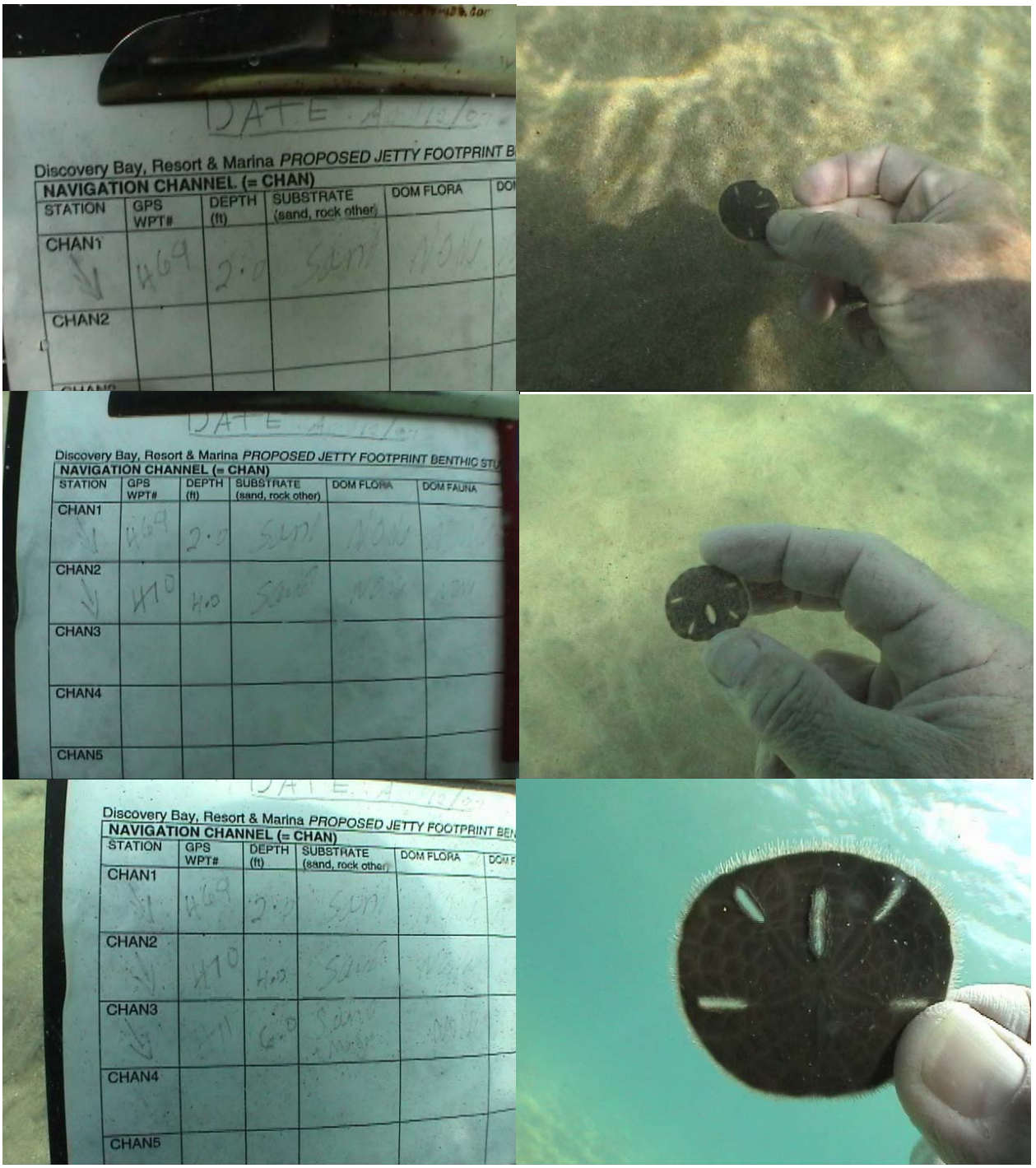


FIGURE 11 (continued). Selected representative underwater photos taken along the proposed navigation channel (CHAN1 – CHAN11) in April 13, 2007.

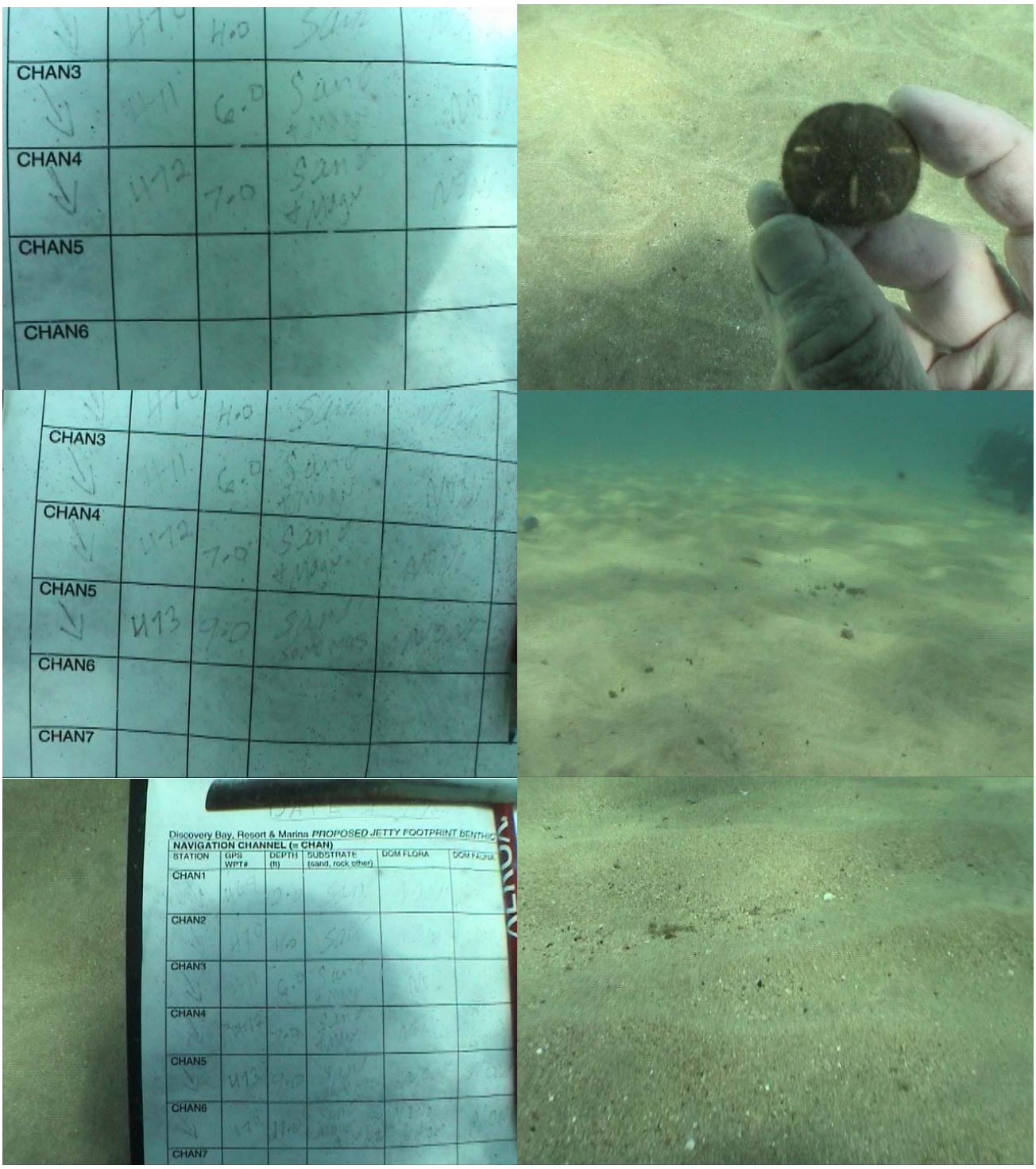


FIGURE 11 (continued). Selected representative underwater photos taken along the proposed navigation channel (CHAN1 – CHAN11) in April 13, 2007.

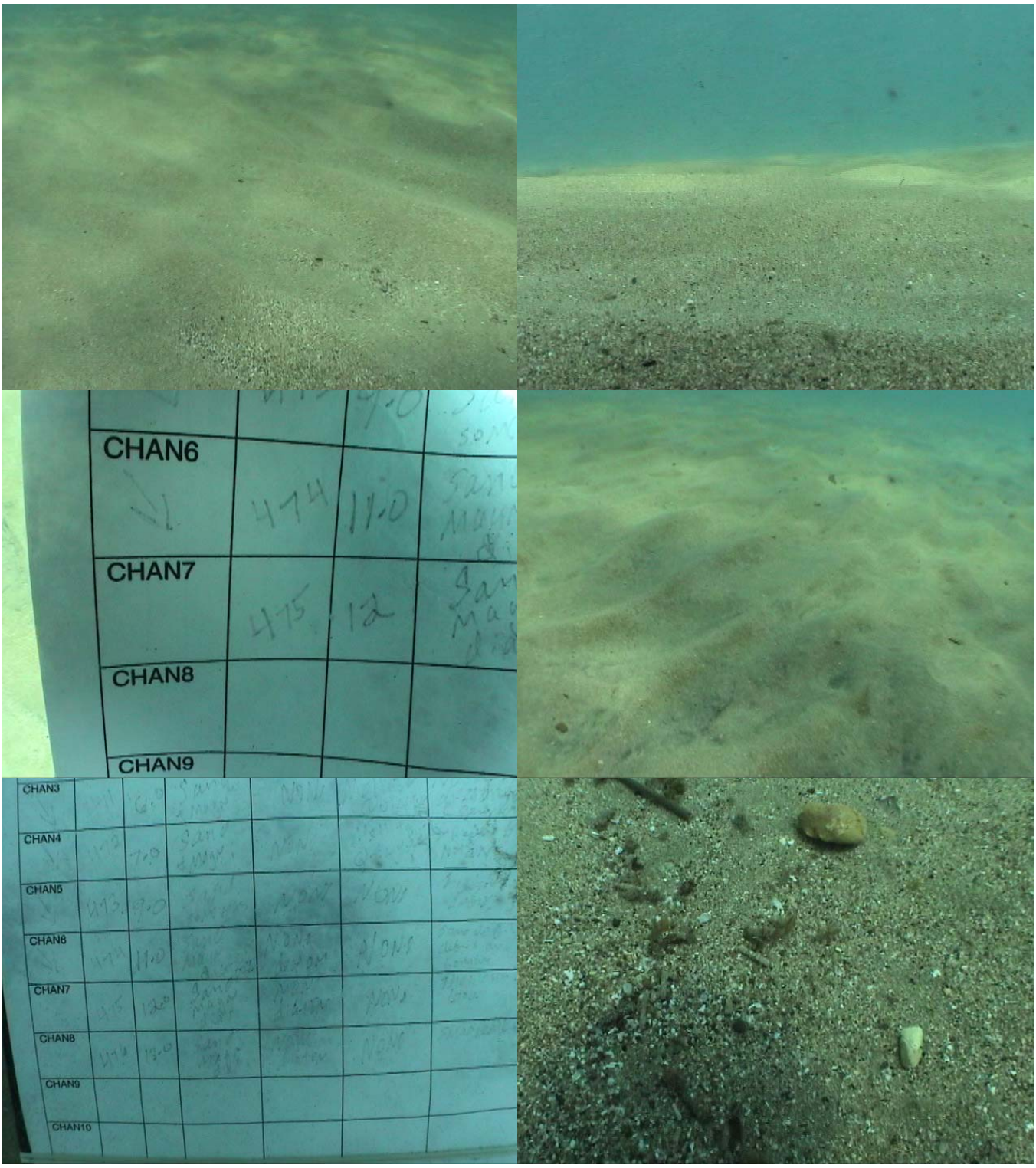
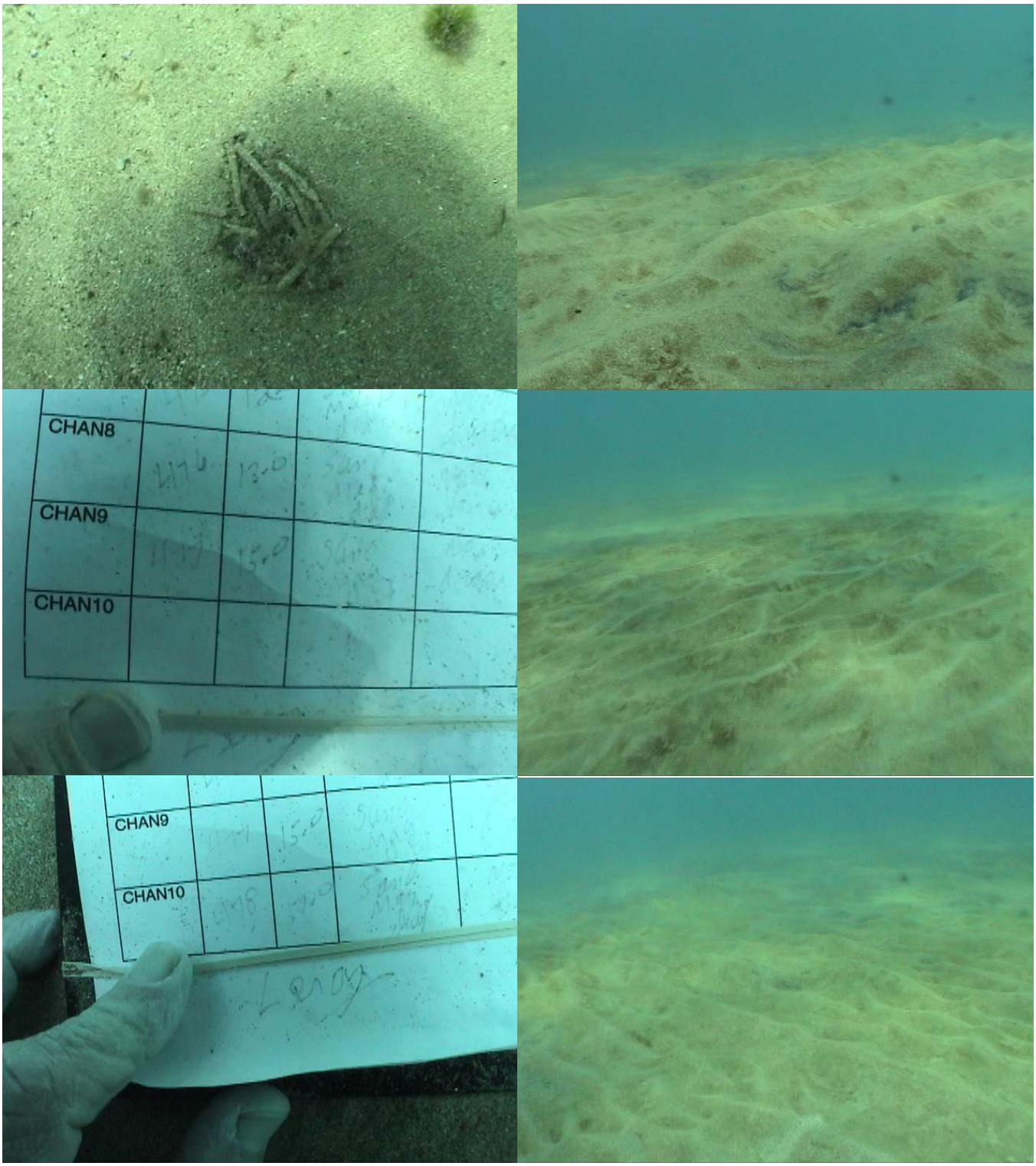


FIGURE 11 (continued). Selected representative underwater photos taken along the proposed navigation channel (CHAN1 – CHAN11) in April 13, 2007.



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