

(3) Topographic and Bathymetric Conditions

Site surveys were conducted during 10 to 13, August 2010 and results are shown in Figure-1.2(9) and Figure-1.2(10).

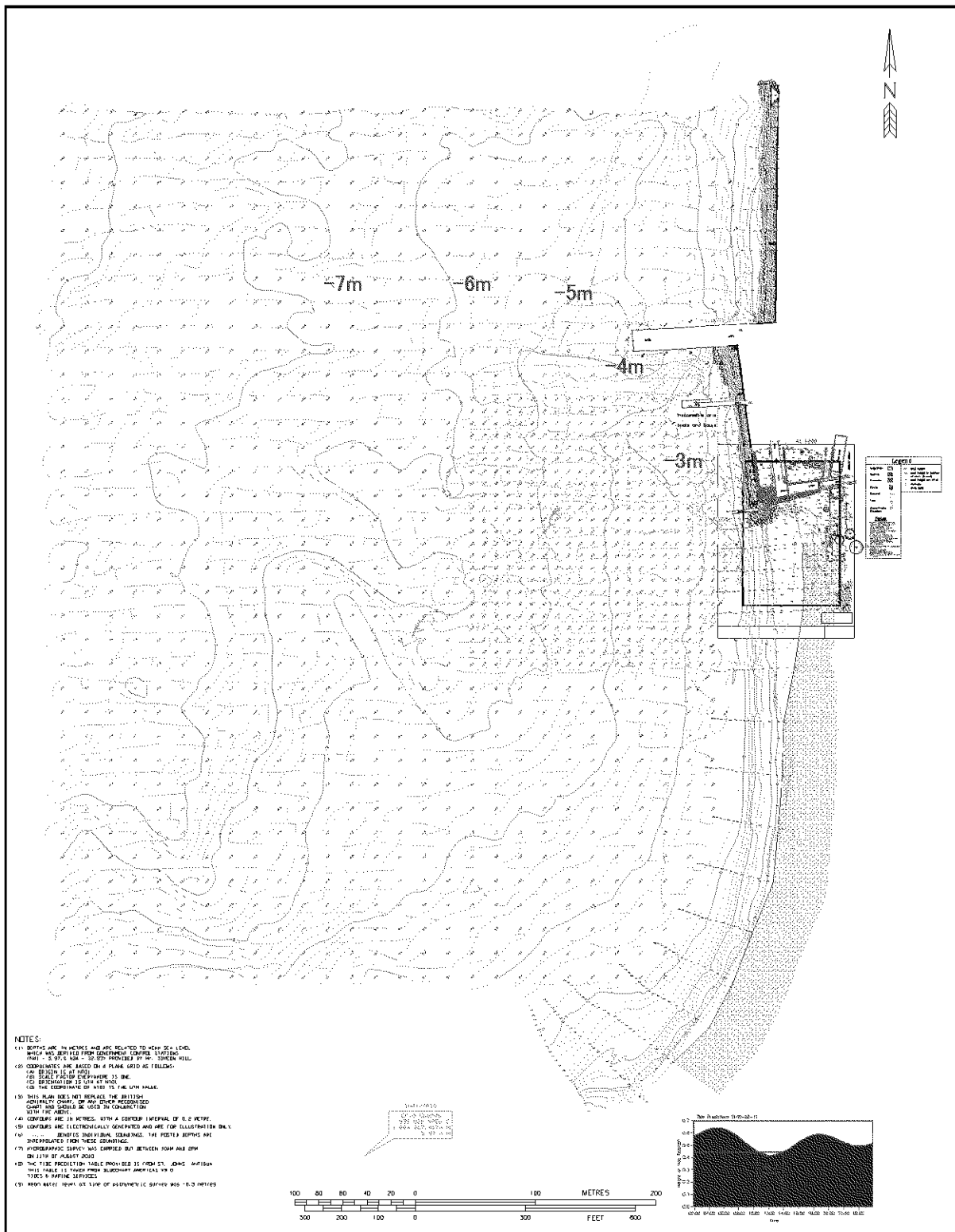


Figure-1.2(9) Composite Chart of Topographic and Bathymetric Survey Result

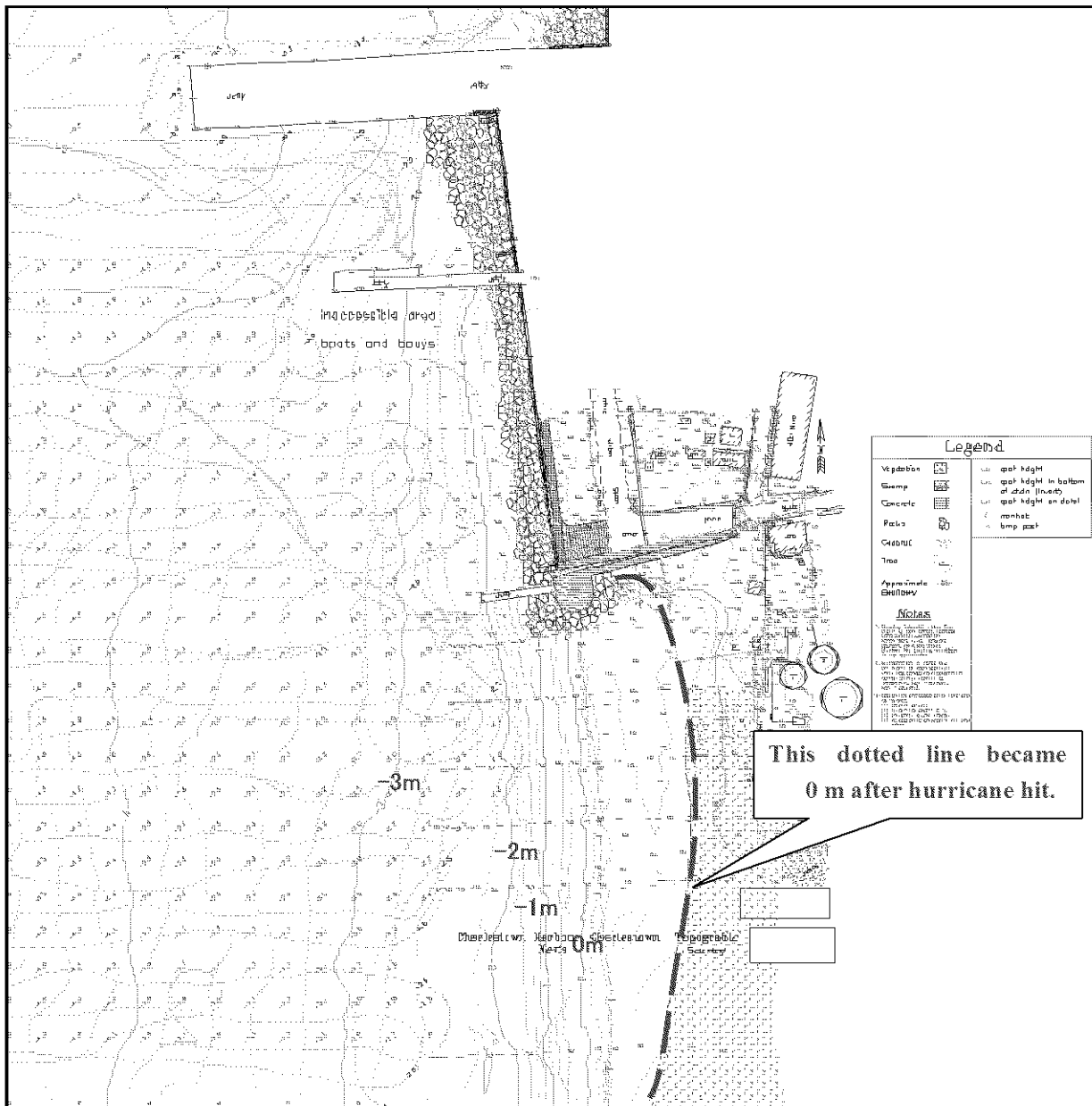


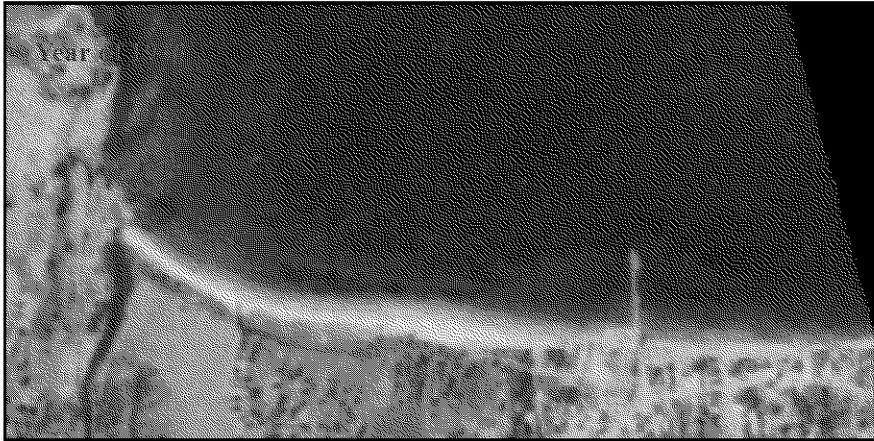
Figure-1.2(10) Result of Bathymetric and Topographic Survey around Project site

(4) Topographic Change

1) Secure Change on Beach Width

Judging from topographic change around project site seen on the aerial photos (years of 1946, 1982, 1991, 2003) obtained from Museum of Nevis History, the shoreline of Gallows Bay (project site) has been retreated by erosion generated at the time of hurricane but beach width has not been changed remarkably. Shore erosion from Penny Beach to Four Seasons Hotel became controversial after Ferry Dock has constructed in 1995. Therefore, the rubble mound revetment was constructed as the first one in Nevis Island and detached breakwaters have been constructed in front of Four Seasons Hotel.

In addition, it is seen that beach shape in Charlestown Ferry Dock constructed in 1995 land filling from Tourist Jetty to the backside of Fishery Jetty has not widely been changed.



Source: Museum of Nevis History

Photo-1.2(2) Aerial Photos of Gallows Bay

2) Seasonal Change on Beach Width

Beach width has become narrow to be about 20m by hit of Hurricane “EARL” in early September 2010, however it has recovered gradually after finish of hurricane season and returned back again in July 2011 as shown in Photo-1.2(3) and Photo-1.2(4). Since beach width has become narrow transiently after hurricanes and has recovered gradually, it is considered that seasonal change of beach width is continued after completion of the planed facilities.



Photo-1.2(3-1) Beach (August 2010)

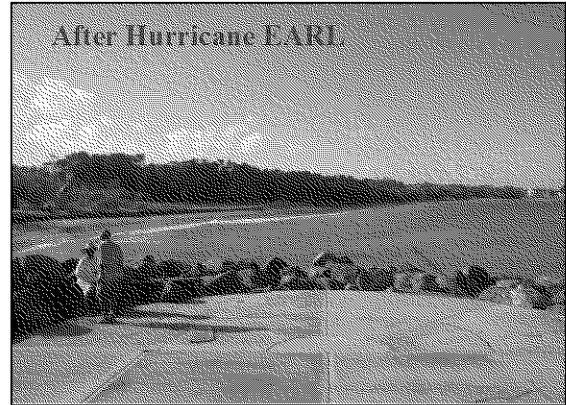


Photo-1.2 (3-2) Beach (September 2010)



Photo-1.2 (3-3) Beach (February 2011)



Photo-1.2(3-4) Beach (July 2011)

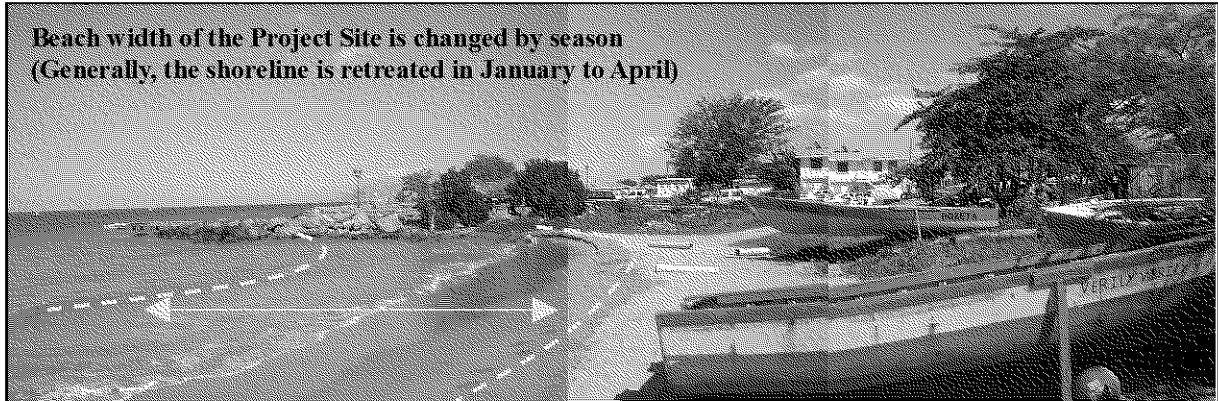


Photo-1.2 (4-1) Beach (February 2010)

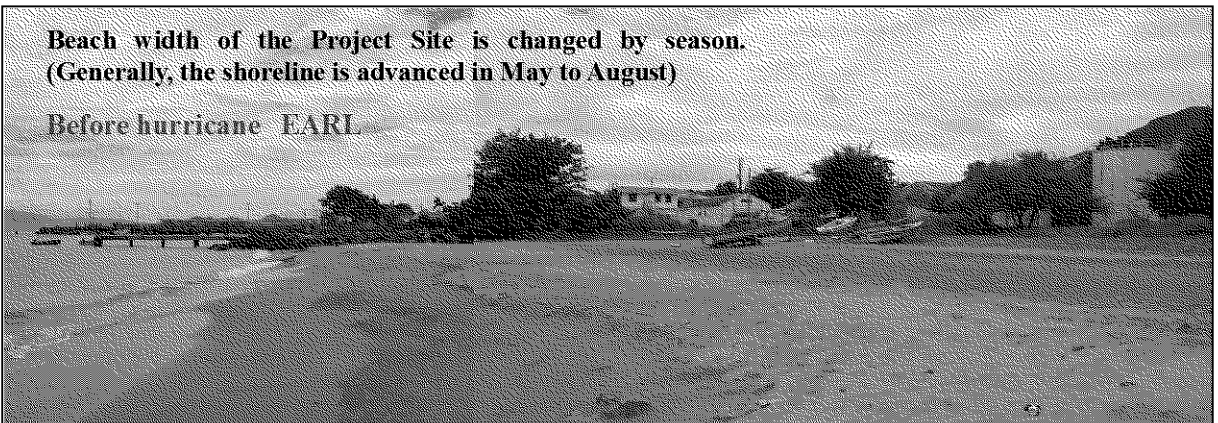


Photo-1.2(4-2) Beach (August 2010)



Photo-1.2(4-3) Beach (September 2010)



Photo-1.2(4-4) Beach (July 2011)

(5) Soil Investigation

Two land borings (BH-1 & BH-2) were executed during September 5 to 9, 2010. With the result, as soft peat layer was found, 5 Electric Corn Penetration Tests (CPT) and 4 Boring Investigations (land boring BH-4 & BH-5, marine boring BH-3 & BH-6) were executed in February, 2011. Location map is shown in Figure-1.2(11).

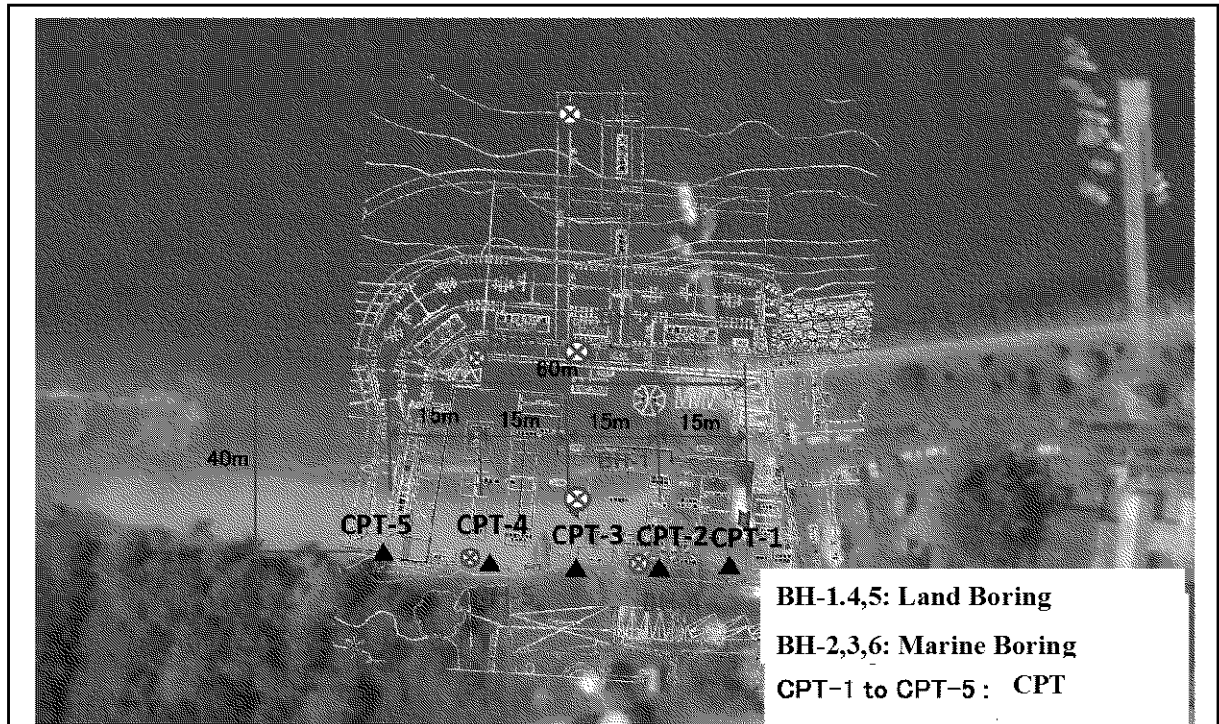


Figure-1.2(11) Location Map for CPT and Boring

1) Electric Corn Penetration Test (CPT)

CPT were executed at 5 places on 2 February, 2011. Figure-1.12 shows the results of CPT. Summary of investigation results are as follows,

- (a) The peat layer with the area of CPT-1 to CPT-3 in project site is about 3m in thickness.
- (b) The peat layer with the area of CPT-4 to CPT-5 is about 4m in thickness.
- (c) The surface layer with the depth of 1m of seashore is sand with boulder stones and peat layer does exist underneath.

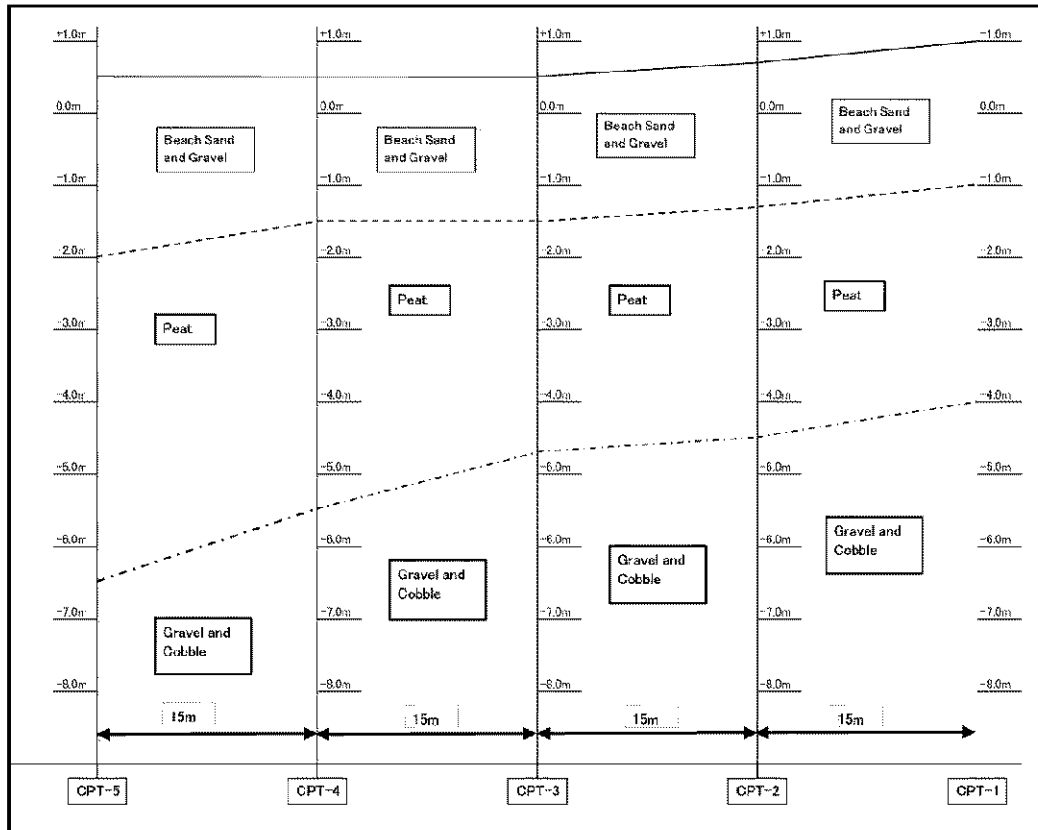


Figure-1.2(12) Results of CPT

2) Boring Investigation

Borehole logs are shown in Appendix 6-3. Summary of investigation results is as follows,

Soil structure of project site is consisted of 1 m thick sandy layer from surface and 3 m thick soft peat layer is existed underneath in the area from M.S.L.-1.0 m to -4 m. Way underneath up to M.S.L.-9.0m, there is sand layer with gravel of N value 20 to 40 and hard sand layer with boulder stones of N value 50 or more underneath.

(i) BH-1 : New Fisheries Center

- (a) Ground level is M.S.L. +0.5m (Land Boring)
- (b) M.S.L.+0.5m ~ -0.5m Sand
- (c) M.S.L.-0.5m ~ -4.5m Peat (N value = 0)
- (d) M.S.L.-4.5m ~ -5.0m Silt
- (e) M.S.L.-5.0m ~ -13.5m Sand with Gravels (N value = 16 to 22)
- (f) M.S.L.-13.5m ~ -17.5m Boulder Stones, Sand with Gravels (N value = 50 or more)

(ii) BH-2 : Base of Fishery Jetty and Revetment

- (a) Bottom Water depth is M.S.L.-1.0m (Marine Boring)
- (b) M.S.L.-1.0m ~ +0.0m Sand
- (c) M.S.L.+0.0m ~ -4.0m Peat (N value = 7)
- (d) M.S.L.-4.0m ~ -12.0m Sand Layer with Gravels (N value = 9 to 29)
- (e) M.S.L.-12.0m ~ -15.0m Boulder Stones, Sand with Gravels (N value = 50 or more)

(iii) BH-3 : Head of Fishery Jetty

- (a) Bottom water depth is M.S.L.-2.0m (Marine boring)
- (b)M.S.L.-2.0m~-3.0m Sand
- (c)M.S.L.-3.0m~-5.5m Peat (N value =0 to 1)
- (d)M.S.L.-5.5m~-6.0m Silt
- (e)M.S.L.-6.0m~-12.5m Sand with Gravels (N value = 20 to 27)
- (f)M.S.L.-12.5m~-17.0m Boulder Stones, Sand with Gravels (N value = 50 or more)

(iv) BH-4 : North side of project site (Ferry Dock side)

- (a)Ground level is M.S.L. +0.5m (Land boring)
- (b)M.S.L.+0.5m~-1.0m Sand (with Boulder Stones)
- (c)M.S.L.-1.0m~-4.5m Peat (N value = 1)
- (d)M.S.L.-4.5m~-5.0m Silt
- (e)M.S.L.-5.0m~-7.5m Sand with Gravels (N value = 19 to 33)
- (f)M.S.L.-7.5m~-9.5m Boulder Stones, Sand with Gravels (N value = 50 or more)

(v) BH-5 : South side of project site (Bath Bogs side)

- (a)Ground level is M.S.L. +0.5m (Land boring)
- (b)M.S.L.+0.5m~-1.0m Sand (with Boulder Stones)
- (c)M.S.L.-1.0m~-4.0m Peat (N value = 1)
- (d)M.S.L.-4.0m~-4.5m Silt
- (e)M.S.L.-4.5m~-9.5m Sand with Gravels (N value = 29 to 40)
- (f)M.S.L.-9.5m~-11.5m Boulder Stones, Sand with Gravels (N value = 50 or more)

(vi) BH-6 : South end of Revetment of project site

- (a)Ground level is M.S.L.-1.0m (Marine Boring)
- (b)M.S.L.-1.0m~-2.0m Sand (With Boulder Stone)
- (c)M.S.L.-2.0m~-5.0m Peat (N value = 0 to 1)
- (d)M.S.L.-5.0m~-5.5m Silt
- (e)M.S.L.-5.5m~-13.0m Sand with Gravels (N value = 15 to 49)

Total 10 thin-wall samples (undisturbed samples) were taken from BH-4, BH-5 and BH-6 and the laboratory test was conducted. Comparison table for physical and mechanical features of peat and soft clay is shown in Table-1.2(6). As peat has big consolidation settlement and the settlement time is long, the study and the countermeasure are necessary for ground subsidence of reclaimed land when the facilities are designed.

Table-1.2(6) Comparison for physical and mechanical features of peat and soft clay

	Peat (Nevis)	Soft Clay (generally)
Unit Weight γ_t (kN/m ³)	10.6~13.2	15~17
Dry Unit Weight γ_d (kN/m ³)	2~5.8	8~14
Moisture Content W (%)	111~435	30~60
Ignition Loss Li (%)	12~57	<20
Soil Particle Density ρ_s (g/cm ³)	1.7~2.4	2.6~2.8
Void Ratio e	2.9~6.9	0.8~2.8
Vane Shear τ_v (kN/m ²)	20~40	20~40
Coefficient of Consolidation C_v (cm ² /s)	10^{-4}	$10^{-3} \sim 10^{-4}$

Peat sample is high in organic fiber and black color and smell rotten of plant. The ratio of sand in the upper layer of peat and clay in its lower layer becomes major.

3) Results of Environmental Chemistry Analysis (Oil, Metals etc)

As the results of Environmental Chemistry Analysis of peat samples and underwater vein as shown in Table-1.2(7), the value more than the water quality standard was undetectable as to the oil and metals and soil and water contamination has not been generated with the oil effluence from neighboring oil tanks.

Table-1.2(7) Results of Environmental Chemistry Analysis

Parameter	Peat Soil	Soil Standard	Underwater	Water Standard
Arsenic	U mg/kg	15 mg/kg	U μ g/L	10 μ g/L
Cadmium	U mg/kg	0.4 mg/kg	U μ g/L	10 μ g/L
Copper	6.59 mg/kg	125 mg/kg	15.9 μ g/L	100 μ g/L
Lead	U mg/kg	0.01 mg/L	U μ g/L	10 μ g/L
Selenium	U mg/kg	0.01 mg/L	U μ g/L	10 μ g/L
Simazine	U μ g/kg	0.003 mg/L	U μ g/L	3 μ g/L
Cyanide Total	U mg/kg	Not detected	U mg/L	0.01 mg/L
FL-PRO	U mg/kg	—	U mg/L	—
Chromium, Hexavalent	U mg/kg	0.05 mg/L	U mg/L	0.05 mg/L

Remarks:

- 1) Soil standard quotes standard by Ministry of Environment in Japan.
- 2) Water standard quotes standard by Ministry of Health, Labor and Welfare in Japan.
- 3) mg (micro-gram) = 1000 μ g (mu-gram)
- 4) U: Criteria U indicates that the compound was analyzed for but not detected. This symbol shall be used to indicate that the specified component was not detected. The value associated with the qualifier shall be the laboratory method detection limit.
- 5) Parameter FL-PRO indicates to be oil content.

(6) Sediment Quality

5 sediment samples were collected on 17 August, 2010. Laboratory test results (Moisture Content, Specific Gravity, Sieve Analysis) are shown in Table-1.2(8).



Figure-1.2(13) Sediment Sample Collection Location

Table-1.2(8) Laboratory Test Results of Sediment

	S1	S2	S3	S4	S5
Moisture Content (%)	24.0	28.2	30.5	30.7	32.4
Specific Gravity (t/m ³)	2.66	2.84	2.83	2.83	2.83
Sediment	Coral sand with gravel and shell	Sand with gravel and shell	Sand with gravel and shell	Sand with gravel and shell	Sand with gravel and shell

(7) Water Quality

7 water samples were taken on 4 September in order to confirm the present situation of water quality in seashore and fresh water area around project site. 2 samples were taken at 40 cm below the water surface in flood tide and ebb tide. Concerning city water, tap water which is highly possible to induce to project site was taken. Especially as clean water is from volcanic underground water which is used as the island city water (80%) is said to be hard water with high in calcium. According to the hearing survey, the ice making companies in Nevis Island use rain water because of it.

W1 : Water area in front of project site

W2 : Open sea

W3 : Drain from urban area near project site

W4 : Small river at south end of Bath Bogs Protected Area

W5 : Small river at center of Bath Bogs Protected Area

W6 :City water at project site

W7 : Well water of Mineral Water Company

Collection location of water samples are shown in Figure-1.2(14) and laboratory test results are shown in Table-1.2(9).



Figure-1.2(14) Water Sample Collection Location

Table-1.2(8-1) Water Quality Analysis Results (1)

Parameter	Site W1		Site W2	
	Ebb	Flood	Ebb	Flood
Sampling depth (m)	0.4	0.4	0.4	0.4
Sampling date	05/09/10	05/09/10	05/09/10	05/09/10
Sampling time	9:00	12:15	9:10	12:25
Temperature (°C)	29.4	31.1	29.5	30.0
Salinity	34.0	33.1	34.0	33.9
pH	8.08	8.0	8.19	8.03
Suspended Solids (mg/L)	15.1	15.7	12.9	13.6
Chemical Oxygen Demand (mg/L)	816	481	618	1330
Dissolved oxygen (%saturation)	97.6	102.0	99.2	102.6
Dissolved oxygen (mg/L)	7.46	7.7	7.58	7.78
Coliform Bacilli (MPN/100 ml)	681	110	302	38
n-Hexane Extraction Substance (mg/L)	8	4	9	<1
Total Nitrogen (mg/L)	0.12	0.16	0.15	0.14
Total Phosphorus (mg/L)	<0.005	<0.005	<0.005	<0.005

Table-1.2(8-2) Water Quality Analysis Results (2)

Parameter	W3	W4
Sampling date	05/09/10	05/09/10
Sampling time	9:35	10:30
Temperature (°C)	29.6	37.7
Salinity	0.4	4.1
pH	8.41	6.96
Suspended Solids (mg/L)	348.3	6.0
Biochemical Oxygen Demand (mg/L)	5.39	0
Dissolved oxygen (%saturation)	89.3	22.6
Dissolved oxygen (mg/L)	6.89	1.47
Coliform Bacilli (MPN/100 ml)	>2420	22890
n-Hexane Extraction Substance (mg/L)	10	<1
Total Nitrogen (mg/L)	3.9	1.15
Total Phosphorus (mg/L)	1.01	0.249

Table-1.2(8-3) Water Quality Analysis Results (3)

Parameter	W5	W6	W7
Sampling date	05/09/10	05/09/10	05/09/10
Sampling time	10:50	9:50	11:10
Temperature (°C)	29.4	33.2	36.9
Salinity	1.5	0.4	0.5
pH	7.47	6.82	6.95
Suspended Solids (mg/L)	5.0	0.6	8.0
Biochemical Oxygen Demand (mg/L)	0	Bottle broken*	Bottle broken*
Coliform Bacilli (MPN/100 ml)	12910	300	98
Total Nitrogen (mg/l)	0.2	0.77	1.53
Total Phosphorus (mg/l)	0.263	0.104	0.112
Faecal Coliforms (MPN/100 ml)	2794	27	<1
Nitrate (mg/l)	0.1	0.6	0.5
Sulphate (mg/l)	71.5	29.0	40.0
Total Hardness (mg/l)	614	246	306
Calcium Hardness (µg/l)	122000	44000	55900
Chloride Ion (mg/L)	680	70	96
Silica ionic status (mg/l)	132	98	119

* Glass sample containers cracked during transportation and sample was not retrievable

(8) Material Survey

Samples of sand and stones were taken from the largest and the second quarries shown below selecting from 7 quarries in the island according to the hearing survey from Public Works Department and laboratory tests were executed. They were considered to be no problem as construction materials.

- 1) Lefco Quarry (Largest in Nevis) located at New River
- 2) Benjamin Joseph Quarry (Second in Nevis) located at Hicks Estate

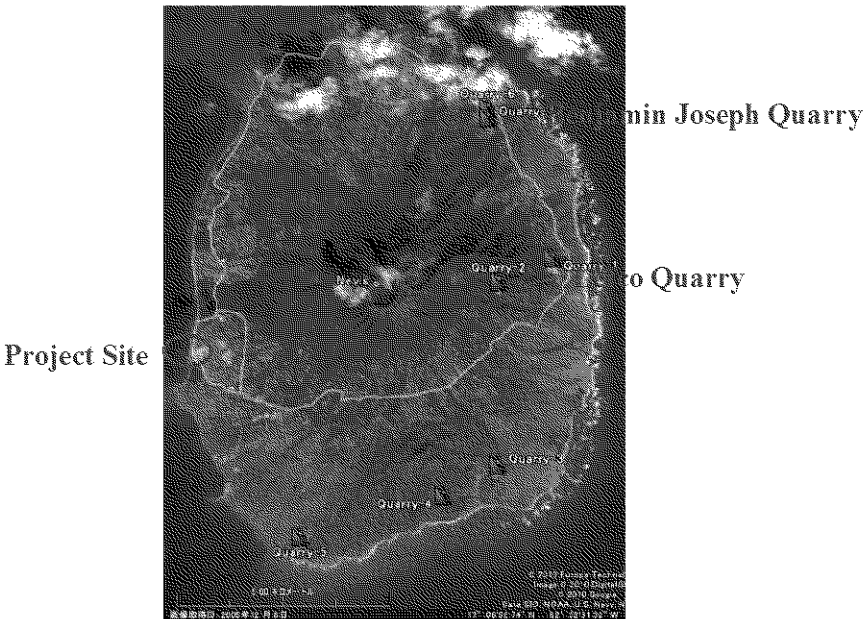


Figure-1.2(15) Location of Quarry

Table-1.2(9) Results of Material Test

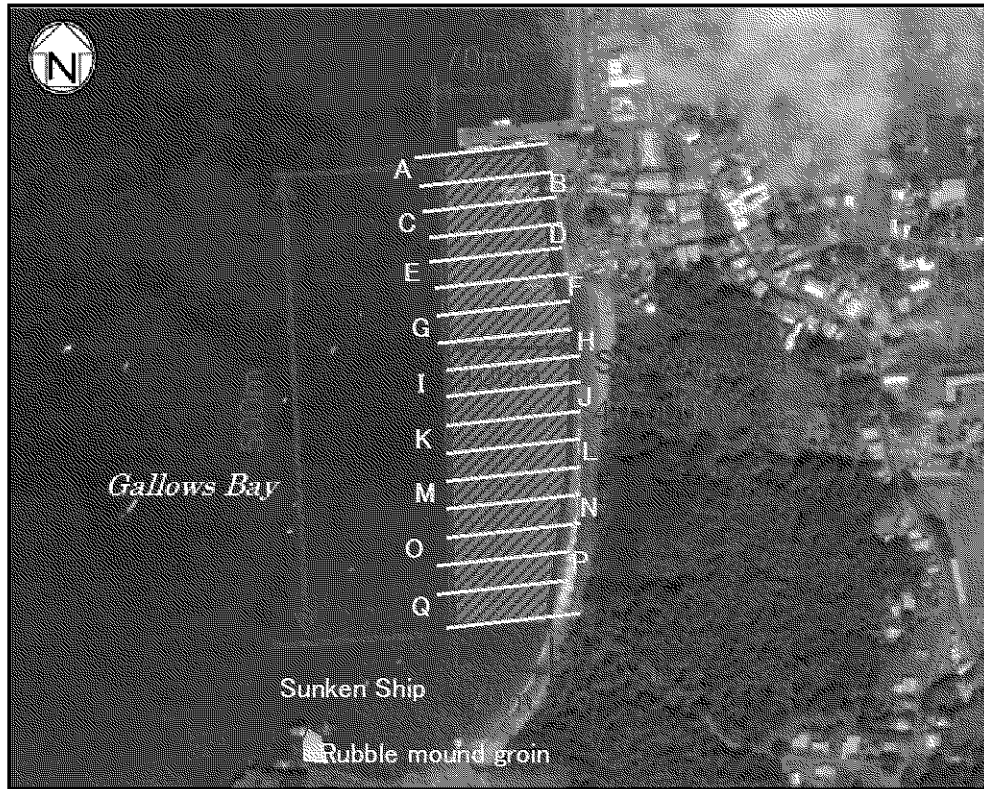
Test	Lefco Quarry		Benjamin Joseph Quarry	
	Sand	Stone	Sand	Stone
Mositure Content (%)	10.6	N/a	12.3	N/a
Specific Gravity (tm/m ³)	2.72	2.30	2.77	2.71
Strength (Mpa)	N/a	23.0	N/a	43.8

(9) Marine Spices and Biodiversity Survey

Submersible survey by diver was executed on 25 August, 2010. Submersible survey was done sorted out with area A to Q. Typical seabed photos are as shown in Photo-1.2(5) and most of the sea beds are covered by mud, sand, stone and a bit of rocks. Rubbish (bottles of beer, canned food, tires and etc.) is seen mixed with mud. The cause of above is considered that mud and stone were used to construct rubble mound groin for the purpose of demolish of sunken ship when hurricane hit in 2008 and this groin was swept away by hurricane in 2009 and ran through to Gallows Bay.

Marine spices are made habitant a little although few seaweed was confirmed among rocks. And several starfishs and sea urchins were confirmed. Juvenile mullets and snappers were confirmed with 20 to 30 fishes. No soft coral which is considered to be weak for turbidity was found.

Turtle habitat was shown in the past record though it was not confirmed during the site survey. And, according to an expert (the local NGO Representative of Nevis Turtule Group), turtle is not presently habitat in the project seawater nor be egg-laying site.



Remark: Sunken ship has been demolished.

Figure-1.2(16) Marine Spices and Biodiversity Survey Location