

No.

Ministry of International Trade, Industry, Commerce, Agriculture,
Marine Resources, Consumer Affairs and Constituency Empowerment,
Saint Christopher and Nevis
Ministry of Agriculture, Lands, Housing, Co-operatives and Fisheries,
Nevis Island Administration

**PREPARATORY SURVEY REPORT
ON
THE PROJECT FOR DEVELOPMENT
OF
A COMMUNITY FISHERIES CENTRE
IN
CHARLESTOWN, NEVIS
SAINT CHRISTOPHER AND NEVIS**

AUGUST 2011

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

ECOH CORPORATION

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PREFACE

Japan International Cooperation Agency (JICA) decided to conduct the preparatory survey and entrusted the survey to ECOH CORPORATION.

The survey team held a series of discussions with the officials concerned of the Government of Saint Christopher and Nevis, and conducted a field investigations. As a result of further studies in Japan, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Saint Christopher and Nevis for their close cooperation extended to the survey team.

August, 2011

Teruyoshi Kumashiro
Director General
Rural Development Department
Japan International Cooperation Agency

Summary

SUMMARY

(1) Background of the Project

The main industry of Saint Christopher and Nevis is tourism however, under the recent strategy of economic diversification, the government is trying to promote agricultural products like citrus fruits and etc., tourism, fisheries industry and offshore financing. The contribution ratio of fisheries industry is 1.0% for GDP though it occupies employment ratio (14%) next to tourism industries. In addition, the Government of Saint Christopher and Nevis aims the promotion of fisheries industry in view of increase of supply volume of animal protein, promotion of food self-sufficiency and the economic diversification.

The most of fishermen working in fishing industry of Nevis Island (located about 3 km south east of St. Kitts Island) are in artisanal fishing. There are only 7 small landing sites in Nevis island without modern facilities like ice making machine therefore, the deterioration of freshness of caught fishes and the after harvest loss come up. Furthermore, it comes into an issue that fishermen are exposed to danger at the time of landing due to no proper jetty.

Therefore, the improvement of production and distribution system is required for the development of fisheries. And, Saint Christopher and Nevis imports about 600 ton marine products from overseas countries while annual fish landing volume is 540 ton and it is not stably satisfied with the demand of marine products.

Under such circumstances, Saint Christopher and Nevis has drawn up “The Project for Development of A Community Fisheries Centre in Charlestown” aiming for the improvement of the above mentioned issues by constructing modern fisheries infrastructures in Charlestown where is one of landing site in Nevis Island and has requested Grant Aid Cooperation consisted of 1) Construction of New Fisheries Center, 2) Construction of Jetty and Revetment, 3) Procurement of relevant equipment to the Government of Japan.

Responding to this, Japan International Cooperation Agency (JICA) has dispatched a preparatory survey team in February, 2010 before this study. As the result, it has been confirmed that operation efficiency of fishermen, the sales and distribution status of marine products shall be improved with the construction of the New Fisheries Center in Charlestown and the consumers in Nevis Island can purchase healthy fresh fishes easily.

(2) Summary of Survey Results and Contents of the Project

Responding to the request from the Government of Saint Christopher and Nevis, the Government of Japan has decided to implement a Preparatory Study and JICA has dispatched a preparatory survey team from February 18 to March 6, August 1 to September 16, 2010, January 29 to March 5 and March 28 to March 31, 2011 to Saint Christopher and Nevis. Based on the results of above surveys, the outline of design contents and the obligations by the recipient country has been discussed and agreed between a study team visiting from July 17 to July 23, 2011 and the Government of Saint Christopher and Nevis after execution of careful examination of component, study on facilities scale, specifications and the construction schedule, project cost estimation and related design in Japan. As

the result, in order to supply stable fresh marine products to the Nevis people, it has reached the conclusion which the construction of New Fisheries Center and the procurement of equipment along with the request are necessary shown below.

- 1) Construction of Fishery Jetty and Revetment
- 2) Construction of New Fisheries Center and Fishing Gear Lockers
- 3) Procurement of Equipment
- 4) Execution of Soft Component (Technical Assistance) concerning operation and maintenance of New Fisheries Center

Facilities to be constructed and equipment to be procured in this project have been planned as below with proper scale and contents as Grant Aid Cooperation considering background of plan, contents, natural conditions, system for operation and maintenance, construction circumstances and etc.

Planned Scale and Contents

[Civil Facilities]

Name of Facilities	Scale, Contents of Planning
Land Reclamation	Reclamation Area: approx. 2,000m ² Filling soil volume : approx. 6,000m ³
Revetment	Crown height : M.S.L+3.0m Stone Gravity Type
Fishery Jetty	Steel pipe pile type jetty Berth Part: L=25m, B=8.0m Access Bridge Part: L=25m, B=4.0m Lighting: 2 poles, Water Tap: 2 nos.

[Architectural Facilities]

Name of facilities	Scale, Contents of planning
New Fisheries Center	Total Floor Area : 973.82 m ² Structure : Reinforced concrete ² stories with pile foundation Roof : Galvalume sheet roof Exterior Wall : Stone on concrete wall (Ground Floor) Sprayed texture paint concrete block (Second Floor) Equipment : Water reservoir tank for rain water 30m ³ Water reservoir tank for city water 10m ³ Emergency generator : 45 KVA Ice making plant : Ice making machine 1.5ton/day, Ice storage 3.0ton Freezer 3.0ton, Insulated storage 0.5ton
Work Shop	Total Floor Area : 20.00 m ² Structure : Reinforced concrete with pile foundation Roof : Reinforced concrete slab with polyurethane water-proof Exterior wall : Concrete block, Cement mortar with emulsion paint Equipment : Manual chain hoist lifting capacity of 500kg
Fishing Gear Lockers	Total Floor Area : 88.00 m ² Number of locker : 22 Structure : Reinforced concrete with pile foundation Roof : Galvalume sheet roof Exterior wall : Concrete block, Cement mortar with emulsion paint
Storage for large Fishing gears and Toilet	Total Floor Area : 33.90 m ² Structure : Reinforced concrete with pile foundation Roof : Reinforced concrete slab with polyurethane water-proof Exterior wall : Concrete block, Cement mortar with emulsion paint Equipment : Shower, Air compressor for scuba tank
Gazebo	Total Floor Area : 29.82 m ² Structure : Wood structure with reinforced concrete foundation (mat foundation) Roof : Shingle roofing
Septic Tank	Total Floor Area : 52.50 m ² Material : FRP (installed in reinforced concrete box) Treatment Capacity : Approx. 5.0t/day BOD density in disposal water : 20mg/l
Exterior Works	Mechanically stabilized crushed stone finish : approx 1,090m ² Lawn finish : approx. 435m ² Concrete blocks finish for vehicles : approx. 110m ² Fencing for anti-falling Equipment : Exterior lighting fixtures : 9 poles

[Equipment]

Equipment name	Q'ty	Specification	Usage
Ice Box	30	Approx. 100 liters Plastic made (urethane foam inside)	Transportation of ice and fish
Scale for weighing 330 lbs (for 150 kg) 60 lbs (for 30 kg)	2 2	Platform Scale Platform Scale	Weighing of *Receiving fish *Sales fish
Engine flushing tank	1	Approx. 300 liters Plastic made	Cleaning outboard engine
Fish processing table Sink	2	Approx. L1,800 x D750 x H800 mm, stainless made	*Fresh fish processing
Table	2	Approx. L1,800 x D750 x H800 mm, stainless made	*Auxiliary table
Showcase for display	2	Approx. L1,800 x D750 x H1200 mm, Stainless made	Processed fish sales by center
Fish selling table Fish display table	7	Approx. L1,200 x D600 x H900 mm, Stainless made	*Ice cooling fresh fish display in direct sales booth by fishermen
Table	7	Approx. L900 x D750 x H500 mm, Stainless made	*For placing ice box
Vacuum Packaging Machine	1	Interior desktop type Length of seal: approx. 300mm Vacuum pump: about 15 m ³ /h	Vacuum packaging for processed fish
Air Compressor for scuba tank	1	Movable type for scuba tank Cooling method: Air cooling type Discharge rate: approx. 150L/min. Maximum air pressure: approx. 20 Mpa	Air filling to scuba tank
Boat Trailer	1	Maximum 30ft for fishing boat Aluminum made (Salt resistance specification)	Beach landing for fishing boat

(3) Project Schedule and Cost Estimation

The cost estimation to be necessary for the implementation of this project shall be about 27 million yen for the Recipient Country side. Total construction period shall be 25 months with 5.5 months for detailed design and 19.5 months for facilities construction and procurement of equipment.

(4) Project Evaluation

Following quantitative and qualitative effects can be expected by the implementation of this project. And, the coverage of beneficiaries can be considered to be about 300 fishermen in Nevis Island directly and about 12 thousand residents in Nevis Island and about 38 thousand residents in St. Kitts Island indirectly.

[Quantitative Effects]

Index of Quantitative Effects

Index	Reference Value (2010)	Target Value (2016) [3 years after completion]
Annual fresh fish handling volume at New Fisheries Center	5.5 ton	102 ton
Annual ice sales volume at New Fisheries Center	3 ton	315 ton

[Qualitative Effects]

- (a) Stable supply of fresh fish shall be possible by the construction of New Fisheries Center.
- (b) Safe landing of fish catch shall be possible and the efficiency of fishing preparation shall be improved by the construction of Fishery Jetty.
- (c) Freshness of fish catch at the time of distribution shall be improved by the installation of ice making machine and storage facility.
- (d) Fishes caught can be sold by fishermen under the hygienic circumstances by the provision of Direct Sales Booth by Fishermen.
- (e) With the mutually complementary relationship between the New Fisheries Center and Basseterre Fisheries Center, more stable and hygienic supply of fishes shall be possible than now and it leads to the decrease of import volume of marine products in total Saint Christopher and Nevis.
- (f) Stable and safe supply of fresh fishes shall be possible for the annual 121 thousand tourists (as of 2008) to visit Saint Christopher and Nevis which main industry is tourism and hotels and restaurants.

Safe landing facility and hygienic Fisheries Center shall be constructed and the work environment of fishermen shall be improved as well as promotion of sales and distribution status of marine products in Nevis Island by this project. As the result, it shall be expected that more fresh marine products are stably supplied to residents in Nevis Island and tourism industry. Therefore, this project is considered to be significant to implement under the scheme of Grant Aid Cooperation of Japan.

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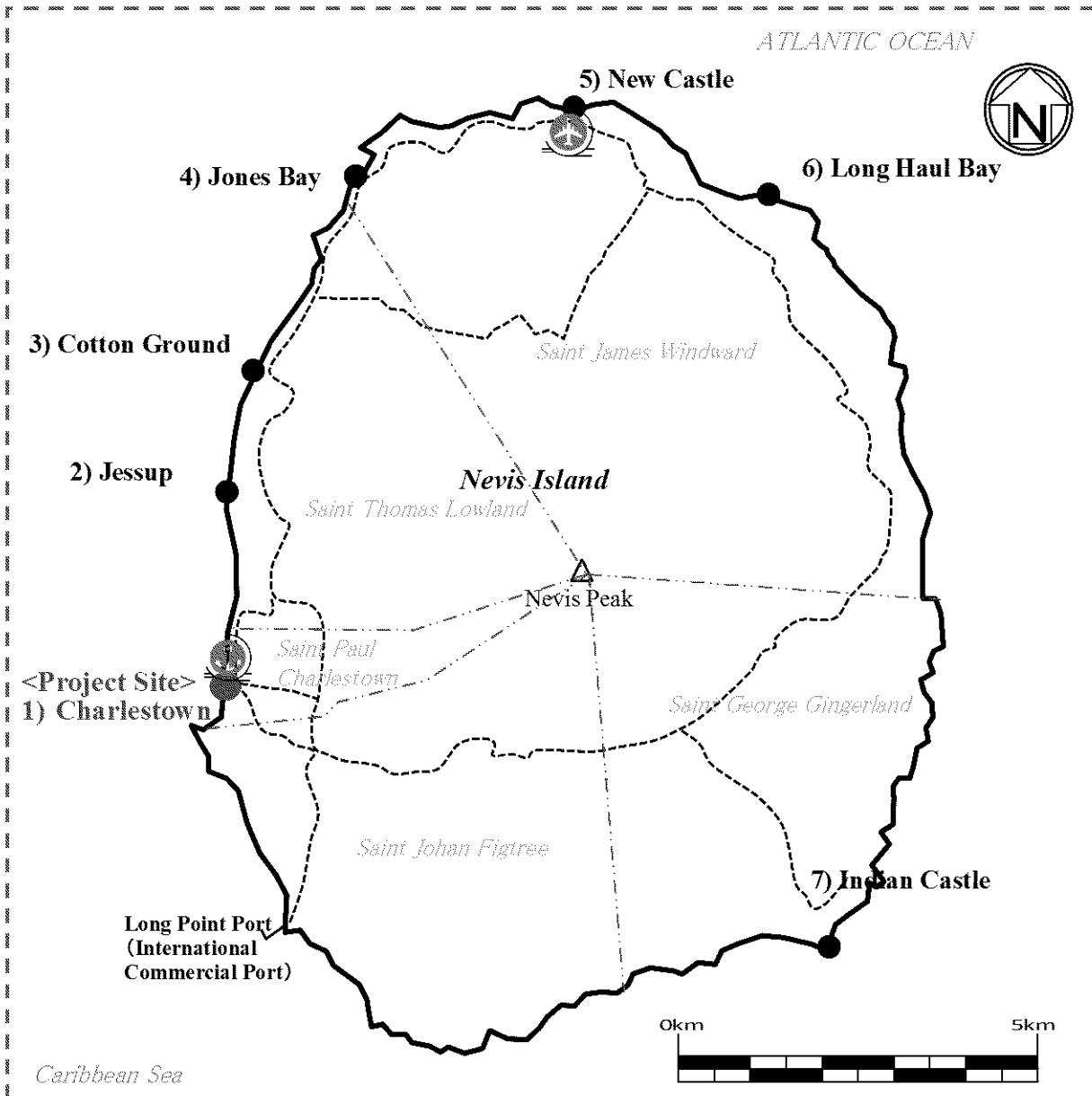
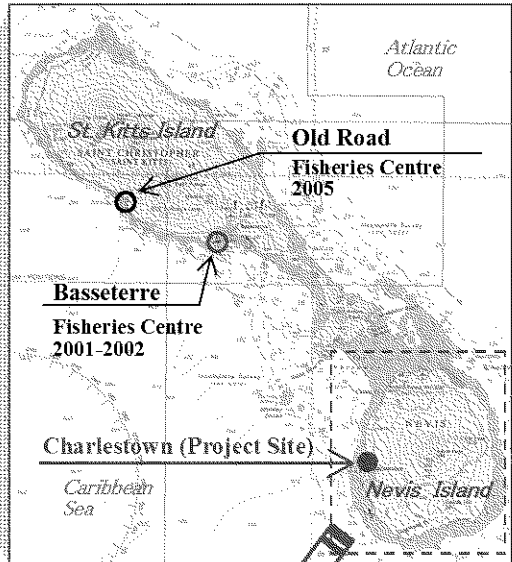
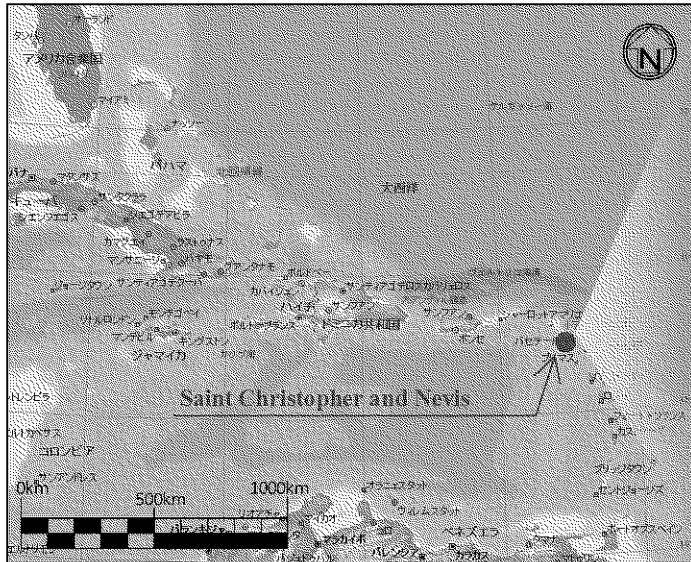
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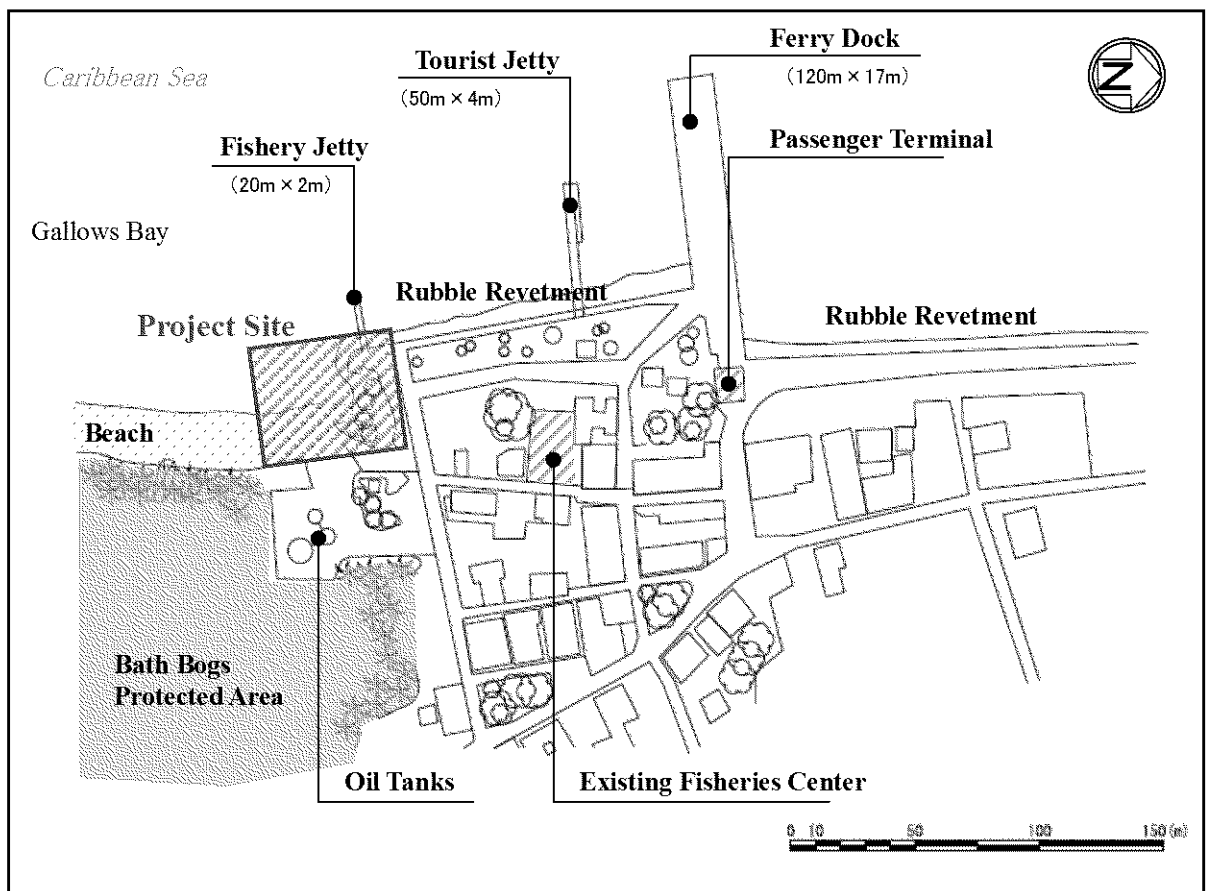
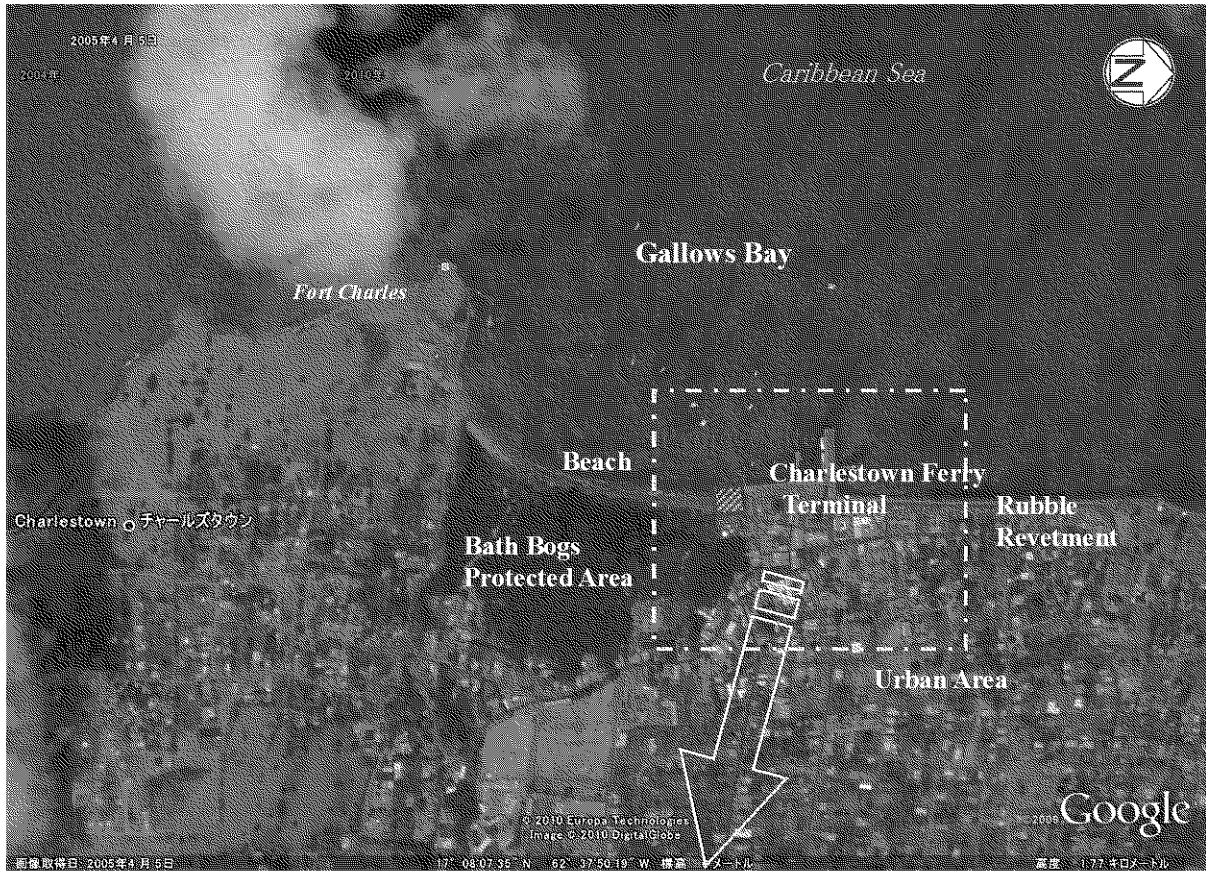
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Location of Saint Christopher and Nevis



Location of Project Site



Perspective

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Ablibliations

AEP	Acrylic Emulsion Paint
BFC	Basseterre Fisheries Centre
BOD	Biological Oxygen Demand
CIDA	Canadian International Development Agency
COD	Chemical Oxygen Demand
CPT	Cone Penetration Test
CUBIC	Caribbean Uniform Building Code
ECS	East Caribbean Dollar
EIA	Environmental Impact Assessment
E/N	Exchange of Notes
FAC	Fisheries Advisory Committee
FAO	Food and Agriculture Organization of the United Nations
FDB	Fisheries Development Board
FL	Floor Level
FRP	Fiver Reinforced Plastic
G/A	Grant Agreement
GCE	G.C. Enterprise
GDP	Gross Domestic Product
GNI	Gross National Income
GL	Grand Level
HIV	Human Immunodeficiency Virus
HWL	High Water Level
IEE	Initial Environmental Examination
JASS	Japan Architectural Standard Specification
JICA	Japan International Cooperation Agency
JIS	Japan Industry Standard
Lbs	Pounds
LWL	Low Water Level
MD	Minutes of Discussions
MSL	Mean Sea Level
NASPA	Nevis Air & Sea Ports Authority
NGO	Nongovernmental Organization
NHCS	Nevis Historical and Conservation Society
NIA	Nevis Island Administration
NOAA	National Oceanographic and Atmospheric Administration
OECS	Organization of Eastern Caribbean States
pH	Parameter Hydrogen
RC	Reinforced Concrete
SUS	Stainless Steel
TOR	Terms of Reference
TSS	Total Suspended Solids
UNDP	United Nations Development Programme

Chapter 1

Background of the Project

Chapter 1 Background of the Project

1-1 Background of the Project

The main industry of Saint Christopher and Nevis is tourism however, under the recent strategy of economic diversification, the government is trying to promote agricultural products like citrus fruits and etc., tourism, fisheries industry and offshore financing. The contribution ratio of fisheries industry is 1.0% for GDP though it occupies employment ratio (14%) next to tourism industries. In addition, the Government of Saint Christopher and Nevis aims the promotion of fisheries industry in view of increase of supply of animal protein, promotion of food self-sufficiency and the economic diversification.

The most of fishermen in Nevis Island (located about 3 km south east of St. Kitts Island) are in artisanal fishing. There are 7 small landing sites in Nevis Island without modern facilities like ice making machine therefore, the deterioration of freshness of caught fishes and the after harvest loss come up. Furthermore, it comes into an issue that fishermen are exposed to danger at the time of landing due to no proper jetty.

Therefore, the improvement of production and distribution system is required for development of fisheries. And, Saint Christopher and Nevis imports about 600 ton marine products from overseas countries while annual fish landing volume is 540 ton and it is not stably satisfied with the demand of marine products.

Under such circumstances, Saint Christopher and Nevis has drawn up “The Project for Development of A Community Fisheries Centre in Charlestown” aiming for the improvement of the above mentioned issues by constructing modern fisheries infrastructures in Charlestown where is one of landing site in Nevis Island and has requested Grant Aid Cooperation consisted of 1) Construction of New Fisheries Center, 2) Construction of Jetty and Revetment, 3) Procurement of relevant equipment to the Government of Japan.

Responding to this, Japan International Cooperation Agency (JICA) has dispatched a preparatory survey team in February, 2010 before this study. As the result, it has been confirmed that operation efficiency of fishermen, the sales and distribution status of marine products shall be improved with the construction of New Fisheries Center in Charlestown and the consumers in Nevis Island can purchase healthy fresh fishes easily.

1-2 Natural Conditions

(1) Metrological Conditions

Saint Christopher and Nevis is located in an equatorial convergence zone, and east wind is dominant at the summit of Nevis Peak at 3,232 feet elevation affected by trade wind however, south-west wind (9 to 12 knots) is dominant at the observatory of Nevis International Airport which is located at north side of Nevis Island. The average precipitation is about 1,150 mm and it becomes heavy in September to January. The humidity remains relatively constant through a year with about 75%.

It is said that hurricane season is from August to November however according to local people, it mostly concentrates in September and October. The data related with hurricane was obtained from

Nevis Disaster Management Department and in recent years, hurricane “LENNY” in November, 1999 and “OMAR” in October, 2008 which severely damaged to Antilles Islands altering its anomalous course from west to east in Caribbean Sea.

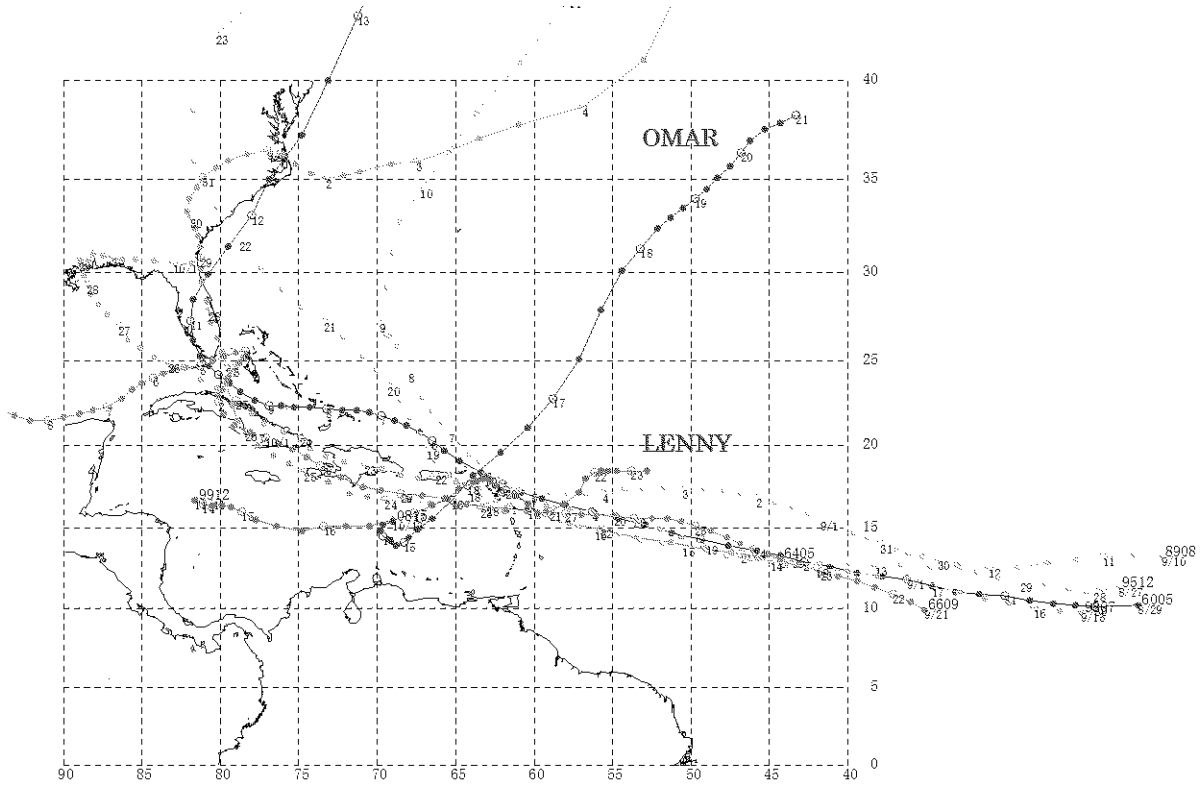


Figure-1.2(1) Path Diagram of Hurricanes damaged Nevis

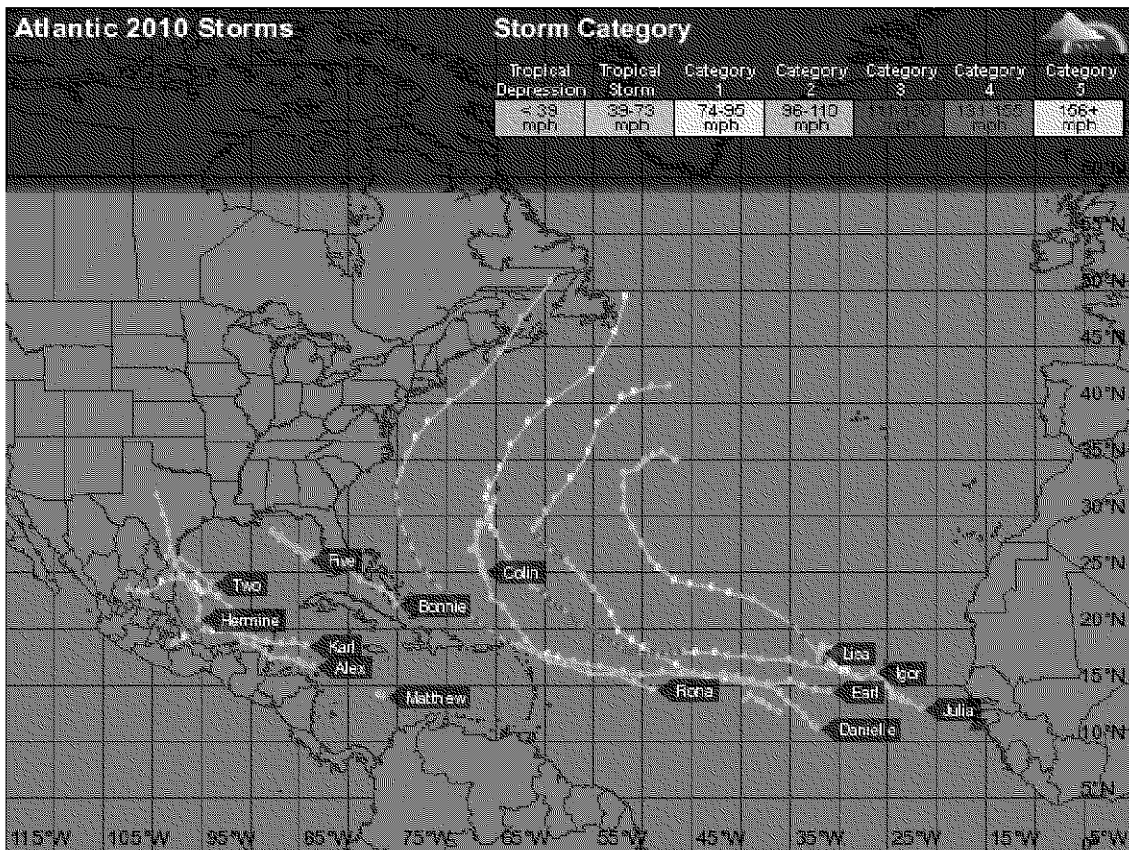


Figure-1.2(2) Path Diagram of Hurricane coming closer to Nevis Island (January to September)

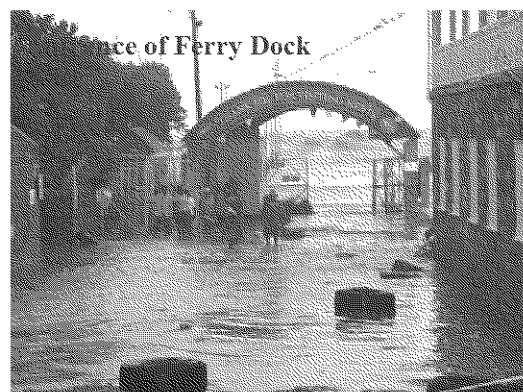
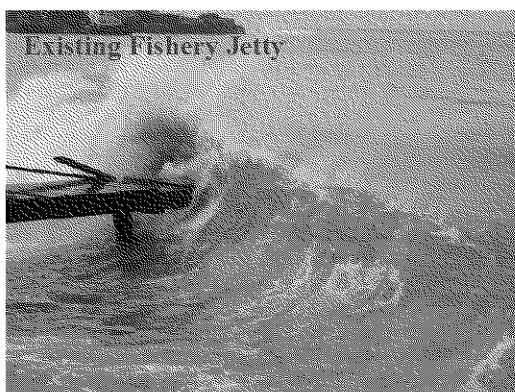
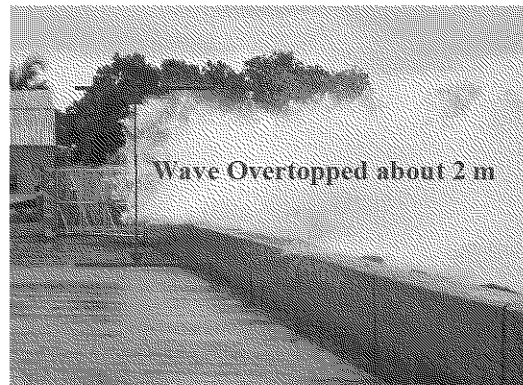


Photo-1.2(1) Documentary photography when hurricane “OMAR”

(2) Hydrographic Conditions

The survey was done during 19 days from 15 August to 3 September, 2010 at the water area with the depth of 11.5m where is the offshore of Gallows Bay located between project site and Fort Charles installing Wave Height Measurement Machine. This measurement machine can record both tide level and tidal current at the same time.

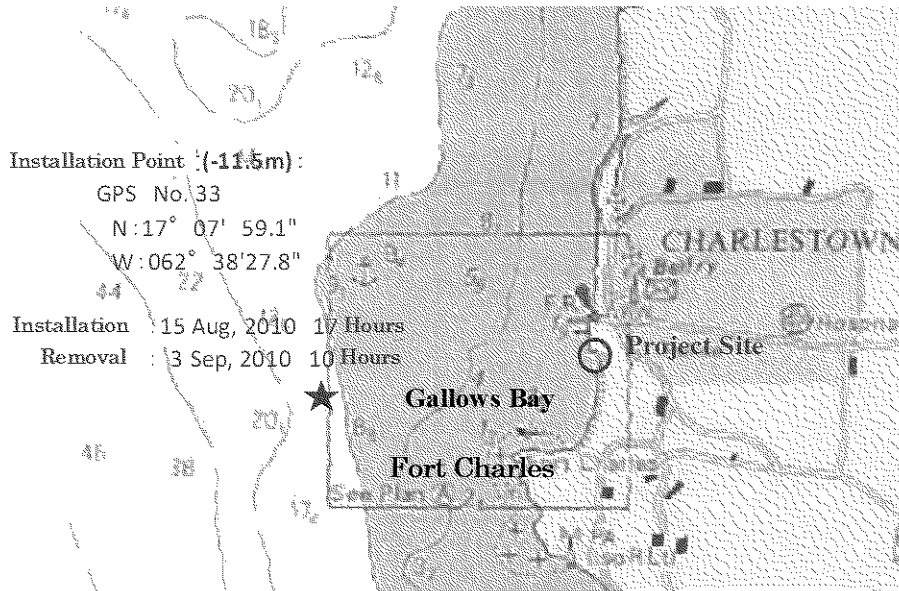


Figure-1.2(3) Installation location of Wave Height Measurement Machine

1) Wave Survey (Wave Height Measurement Machine)

In this survey, Wave Height Measurement Machine surveyed abnormal wave by hurricane “EARL” hit during 29 to 31, August, 2010 in addition to surveying normal waves. As the result, the wave height and period are as follows and its maximum significant wave height was 3.0m and the period was 6sec. It was found that the maximum wave height at that time exceeded 5m.

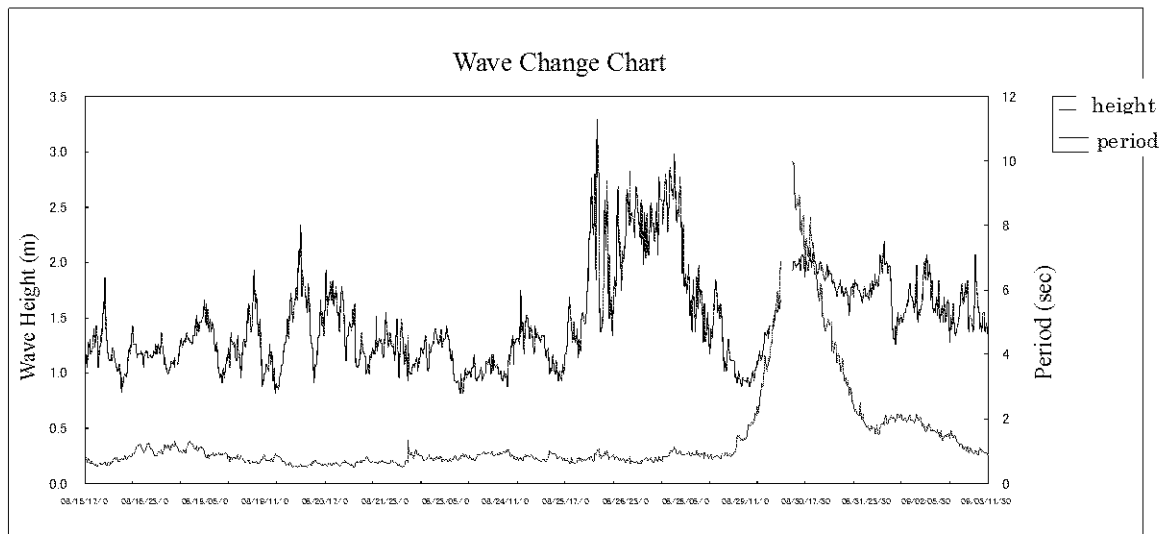


Figure-1.2(4) Observation record of significant wave height by Wave Height Measurement Machine

2) Tide Level (Wave Height Measurement Machine)

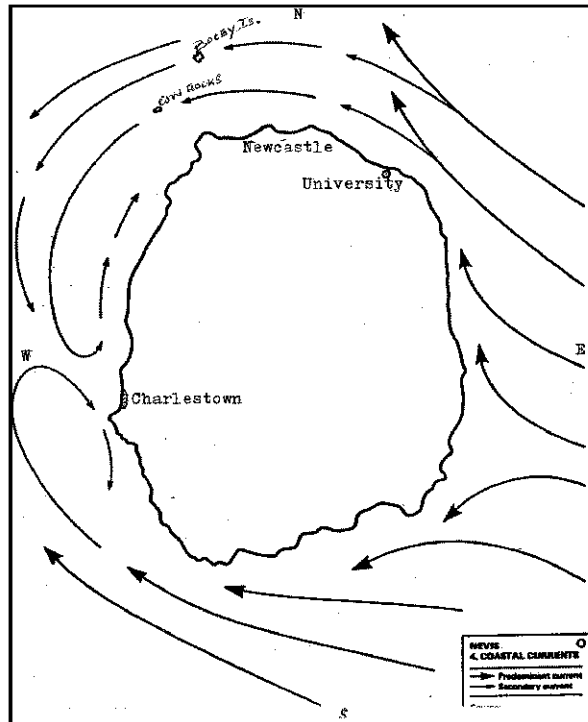
At Zante Commercial Port in capital city Basseterre in St. Kitts Island and Charlestown Ferry Dock and Long Point Port in Nevis Island, as the tidal level difference in each port is about 30 cm which is small, tide table is not produced. Therefore, the design tide level have been set as follows.

High Water Level (H.W.L.)	Mean Sea Level (M.S.L.)	+0.27m
Mean Sea Level (M.S.L.)	Mean Sea Level (M.S.L.)	0.00m
Low Water Level (L.W.L.)	Mean Sea Level (M.S.L.)	+0.27m

3) Current

(a) Ocean current

The ocean current of total Nevis Island is shown in “Eastern Caribbean Natural Management Program” and as shown in Figure-1.2(5), it runs into Nevis Island from eastern side of the Atlantic Ocean and the current turns around from the direction of north and south and it crosses at offshore of Charlestown near project site.



Source: Eastern Caribbean Natural Management Program

Figure-1.2(5) Current around Nevis Island

(b) Tidal current

In addition to the observation by previously described Wave Height Measurement Machine, float observation at the time of flood tide and ebb tide on 22 August, 2010 was conducted. It was confirmed that the current in Gallows Bay showed southwest direction at the both flood and ebb tide.

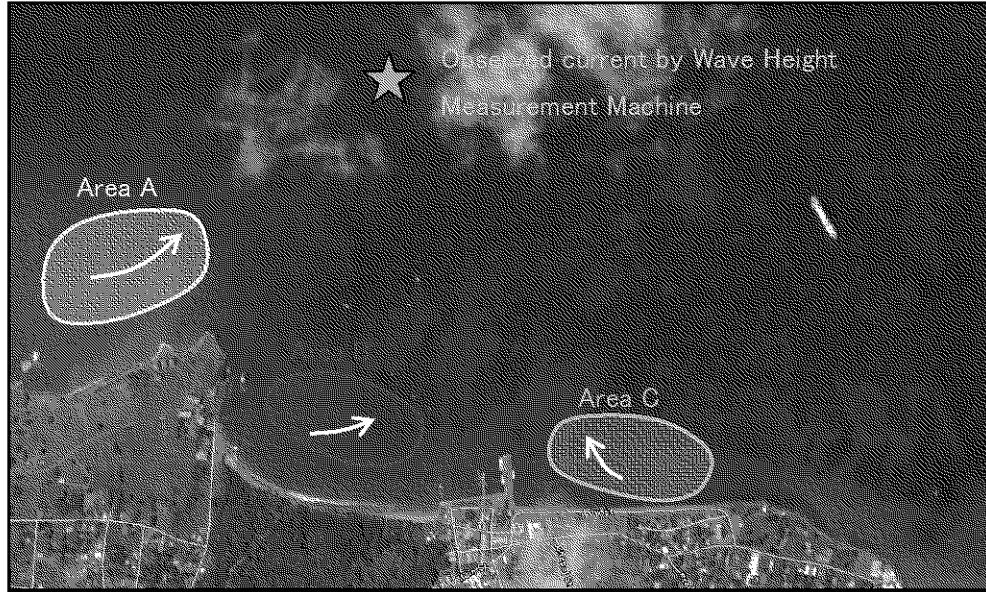
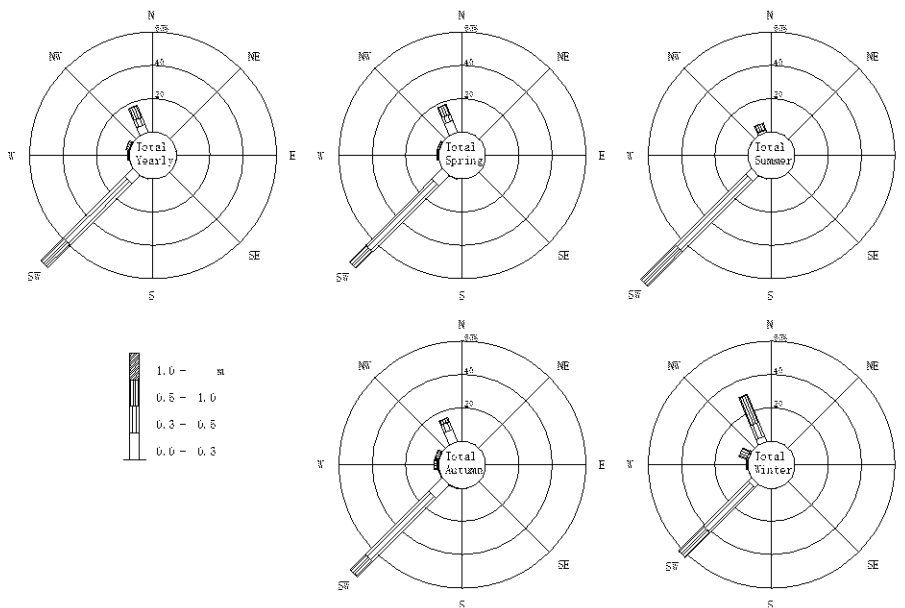


Figure-1.2(6) Location of Float Observation

4) Design Wave

(a) Normal Wave

Referring average wind rose (2002 to 2006) based on the data from Meteorological Office. The wave direction distribution chart and wave frequency table have been produced from the results of wave hind-casting and wave deformation calculation adopting “One Point Spectral Method” for the waves generating in the Atlantic Ocean and Caribbean Sea. The results are as shown in Figure-1.2(7) and Table-1.2(1); SW wave direction is dominant at front water area of project site (at water depth -10 m) and the wave height below 0.5 m occupies about 70% of the total. While, concerning wave height more than 0.5m (about 30% of the total), NNW direction exists as well as SW direction.



**Figure-1.2(7) Wave Height Distribution Chart
(In front of project site: Presumption 2002 to 2006)**

**Table-1.2(1) Frequency Table per Wave Direction and Height
(In front of project site: Presumption 2002 to 2006)**

WAVE DIRECTION WAVE HEIGHT (M)	U. K.	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
CALM	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0
0.00 - 0.25	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	50 .1	3024 6.9	1 .0	151 .3	17 .0	0 .0	2238 5.1	5461 12.5
0.25 - 0.50	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	38 .1	22780 52.0	19 .0	182 .4	159 .4	0 .0	2029 4.6	25207 57.5
0.50 - 0.75	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	4 .0	8235 18.8	36 .1	222 .5	718 1.6	0 .0	3035 6.9	12250 28.0
0.75 - 1.00	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	17 .0	230 .5	12 .0	85 .2	167 .4	0 .0	317 .7	828 1.9
1.00 - 1.25	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	3 .0	0 .0	6 .0	0 .0	42 .1	51 .1
1.25 - 1.50	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0
1.50 - 1.75	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0
1.75 - 2.00	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0
2.00 - 2.25	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0
2.25 - 2.50	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0
2.50 - 2.75	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0
2.75 - 3.00	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0
3.00 -	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0
TOTAL	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	0 .0	109 .2	34269 78.2	71 .2	640 1.5	1067 2.4	0 .0	7661 17.5	43817 100.0

(b) Extreme Storm Waves (Setting up Design Wave)

a) Offshore Wave (Design Wave)

Estimation of offshore wave is as shown in Table-1.2(2) from the wave hind-casting adopting “One Point Spectral Method” based on the data of 8 hurricanes which severely damaged around Saint Christopher and Nevis. While, as the result of statistical work for the estimated calculation of all hurricanes, the wave height with a return period of 50 years becomes 10.3m.

And, this figure is highly credible in comparison with its 9.6m (estimation from NOAA historical database from 1950 to 2000) by Management Plan for the North West Shoreline of Nevis Island. However, the two hurricanes, “LENNY” and “OMAR” which took abnormal route in recent 10 years, can not be ignored as recent tendency to damage the project site. Therefore, the wave brought by “LENNY” which is more risky than the wave with a return period of 50 years is adopted as the design wave. It considers to set Wave Height (H_0) 12.44m and Period (T) 14sec for this project design.

Table-1.2(2) Result of Wave Hind-Casting (Maximum Offshore Wave)

Hurricane					Offshore wave		
No.	Name	year	month	day*	Wave height (H _o) m	Period (T) sec	Wave Direction
6005	DONNA	1960	9	5	5.49	9.27	SSW
6405	CLEO	1964	8	23	5.06	11.33	SSE
6609	INEZ	1966	9	28	5.70	11.88	SSE
8908	HUGO	1989	9	18	8.47	12.43	SSE
9512	LUIS	1995	9	16	6.79	10.29	SW
9807	GEORGES	1998	9	21	5.48	10.21	SSE
9912	LENNY	1999	11	18	12.44	13.82	WSW
0815	OMAR	2008	10	16	11.34	13.68	SW

Remark : The day hurricane hit shows the appearance date of the maximum wave height

Table-1.2(3) Design wave (Offshore wave condition)

Offshore wave	
Wave Height (H _o)	12.44m
Period (T)	14 sec
Wave Direction	WSW

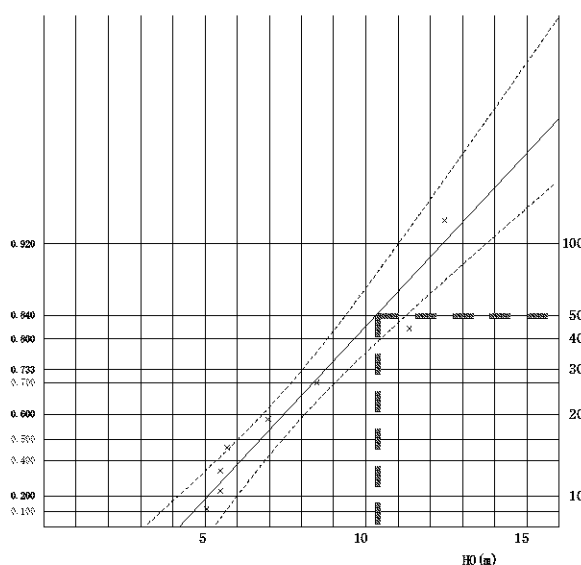


Figure-1.2(8) Result of Wave Statistical Analysis

b) Water area in front of Project site (Design Wave)

In order to estimate design wave around the project site with the previous result, the study was made by wave deformation calculation (refraction deformation calculation), shoaling calculation and wave breaking calculation. The result of wave deformation calculation is as shown in Table -1.2(4) and it has been calculated same area with the deformation calculation at normal waves.

Waves in front of the project site which are used for structures design is based on wave breaking deformation calculation and the result is shown in Table-1.2(5). The significant wave height is estimated as about 2.5m to 4.5m at around the water depth -2.0m (2.9 m included tide level) to -5.0 m (5.9m included tide level).

Table-1.2(4) Equivalent Offshore Wave

Offshore Waves			Wave around project site		
Wave direction	Wave height (m)	Period (sec)	Refraction coefficient	Equivalent offshore wave height (m)	Incident wave direction
S	12.44	14.0	0.99	12.32	N93.4° W

Table-1.2(5) Wave Tabulation

Water Depth(incl. tide level)	Period	Equivalent offshore wave height	Bottom slope	Wave steepness	Water depth/Wave height ratio	Significant wave height ratio	Significant wave height
D(m)	T(s)	Ho'(m)	1/slope	Ho'/Lo	h/Ho'	H _{1/3} /Ho'	H _{1/3} (m)
-2.9	14	12.32	50	0.040	0.235	0.203	2.501
-3.4	14	12.32	50	0.040	0.276	0.230	2.836
-3.9	14	12.32	50	0.040	0.317	0.257	3.172
-4.4	14	12.32	50	0.040	0.357	0.285	3.507
-4.9	14	12.32	50	0.040	0.398	0.312	3.843
-5.4	14	12.32	50	0.040	0.438	0.339	4.178
-5.9	14	12.32	50	0.040	0.479	0.366	4.514
6.4	14	12.32	50	0.040	0.519	0.394	4.850
6.9	14	12.32	50	0.040	0.560	0.421	5.185

Remarks: Tide level: +0.9m (astronomical tide 0.3m + meteorological tide 0.6m)
 Installation water depth(h) : -2m (Revetment), -5m (Jetty head) excluding tide level,
 calculated every 0.5m at the depth from -2m to -6m.