Yolanda M. Chin

Commissioned by the Ministry of
Economy, Trade and Industry

The Feasibility Study for the Construction of an Artificial Island at the Pacific Entrance to the Panama Canal

Final Report

March 31, 2004

Japan External Trade Organization (JETRO)

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Letter of Transmittal

To Whom It May Concern:

We are pleased to submit herewith the final report for the "Feasibility Study for the Construction of an Artificial Island at the Pacific Entrance to the Panama Canal", which is prepared under the program named "The International Atmospheric and Environmental Research Development Program 2003", organized by Japan External Trade Organization (JETRO).

This program, established in 1997 by Government of Japan, is a financial support facility to fund the feasibility studies of projects, which have contribution to the improvement and conservation of global environment. After conducting such feasibility studies, the project would be a prospective candidate to be financed under Yen Loan Package, which provides the project cost with quite low interest.

In response to the request from Autoridad del Canal de Panama (ACP), JETRO has decided to carry out the feasibility study for the Construction of Artificial Island at the Pacific Entrance to the Panama Canal.

It is concluded that the proposed artificial island construction project is effective for the beneficial usage of excavated materials coming from the Panama Canal Expansion Plan activities, and also feasible from technical, financial, economic and environmental points of view.

I would like to express my sincere appreciation to the officials concerned of ACP for the precious information, close cooperation, and warm assistance they extended to the study team at every step throughout the course of the study.

I am also greatly indebted to the Embassy of Japan and JETRO in Panama for giving us valuable advice and assistance throughout the study period.

Very Truly Yours,

Takeshi Kokado

Team Leader for the Feasibility Study
(Nippon Steel Corporation)

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2. Study Team

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SUMMARY

1. Backgrounds of the Feasibility Study

Autoridad del Canal de Panama (ACP) is evaluating the possibility to expand the Canal to accommodate ships larger than Panamax vessels. The proposed construction of new locks and the related work for the expansion of the Panama Canal are expected to generate significant quantities of excavated materials, amounting to some 50-70 million m^3. As part of its activities, the Panama Canal Master Plan for the expansion of the waterway is considering land reclamation at the Pacific entrance to the Panama Canal, as an alternative to give excavated material a beneficial use.

In order to assess the technical and environmental aspects of the land reclamation alternatives, JETRO's Preliminary Study on "Land Reclamation Alternatives for the Pacific Entrance to the Panama Canal" was carried out in cooperation with ACP from December 2002 to March 2003. In this preliminary study, with a view to the beneficial usage of excavated materials coming from Panama Canal Expansion Plan activities, land reclamation alternatives were proposed in consideration of Japanese technologies and experiences. Due to time constraints and lack of data, some bold assumptions were adopted in evaluating land reclamation alternatives.

In response to the request for a subsequent study from ACP, Japan External Trade Organization (JETRO) has decided to carry out the "Feasibility study for the Construction of Artificial Island at the Pacific Entrance to the Panama Canal" in 2003. The Feasibility Study is executed by the study team organized by Nippon Steel Corporation, in cooperation with Nippon Koei Co., Ltd.

2. Objectives of the Feasibility Study

This Feasibility Study of JETRO (hereinafter called as JETRO F/S) aims to propose constructing an artificial island using the excavated materials resulting from the proposed construction of new Pacific locks and analyze the feasibility of the project.

3. Executing Agency of the Project

The executing agency is Autoridad del Canal de Panama (ACP).

4. Study Area

The Study area is at the Pacific entrance to the Panama Canal (see **Figure 4.1**).

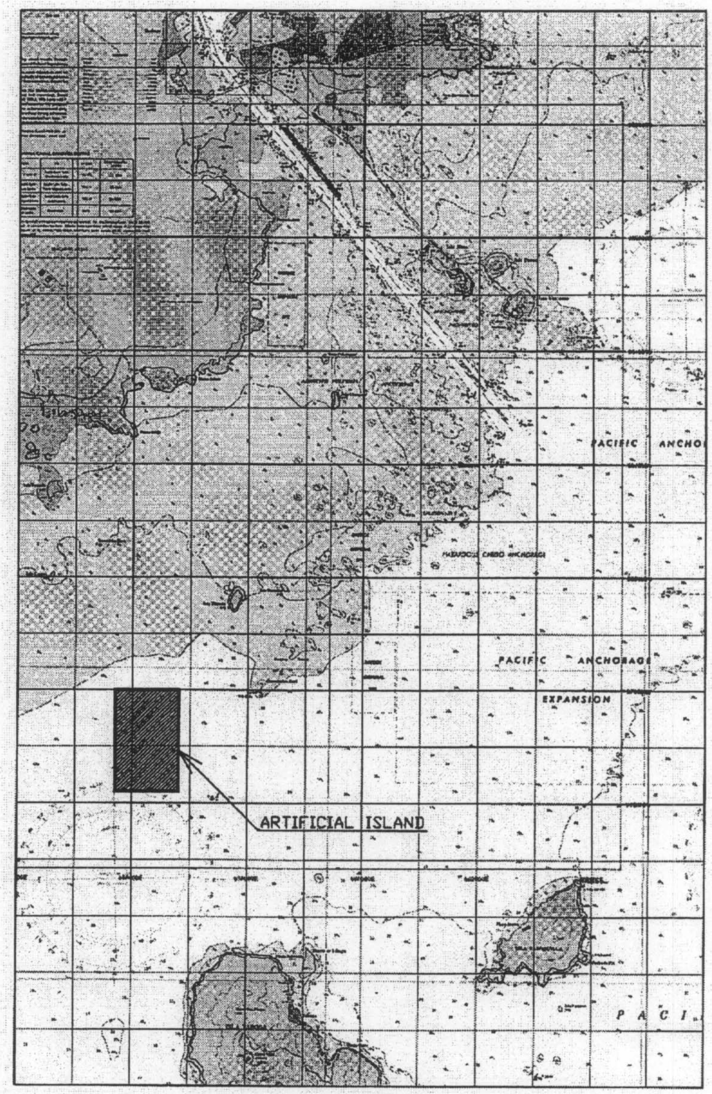
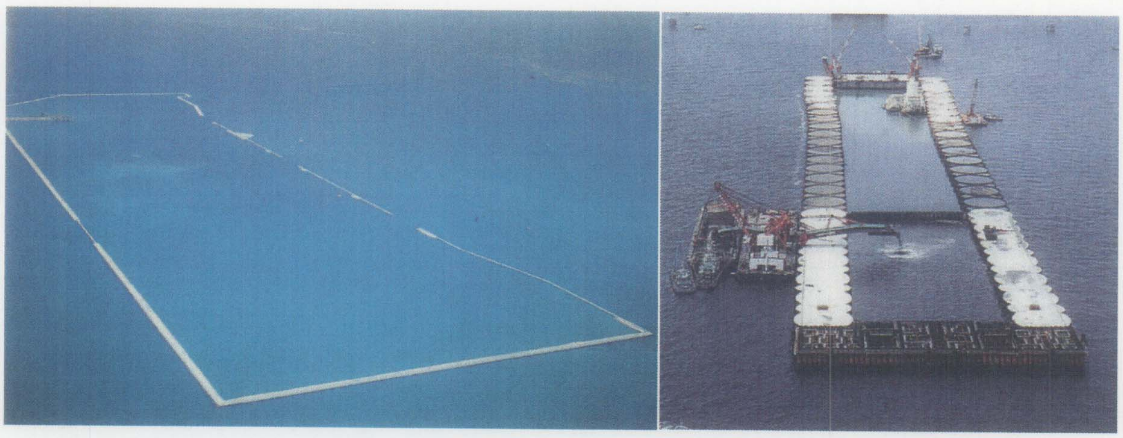


Figure 4.1 Location Map

5. Artificial Island Construction Method

During and after construction of Artificial Island, one of the most principal concerns is to achieve the minimum impact on environment. Particularly, the seawater pollution must be avoided carefully.

As shown in **Figure 5.1**, when constructing an artificial island in Japan, the reclamation is implemented after all construction of surrounding revetment. Therefore, environmental impact can be minimized because the reclamation area is separately enclosed perfectly in the sea.



(a) Kansai International Airport

(b) Tokyo-wan Aqua Line (Umihotaru Island)

Figure 5.1 Construction Examples of Reclaimed Islands in Japan

Among popular structural types in Japan is steel sheet pile cellular-bulkhead quaywall or concrete caisson. In this situation, there are two differences between them, in terms of installation site environment and construction period. In the construction (installation) of sheet pile cellular-bulkhead quaywall, driving sheet piles and then inside filling can keep the seawater clean from contamination. On the other hand, in the construction of concrete caisson, rubble replacing may cause seawater pollution. Furthermore, casting, hauling and emplacement of concrete caisson need generally longer time than driving sheet piles. Additionally, it needs wide area for casting work and setting of concrete plant near the construction site. Consequently, steel sheet pile cellular-bulkhead quaywall is recommended in this Study.

6. Container Terminal Planning for Artificial Island Size

There is a plan to use the artificial island for a container terminal in the future. Artificial island size is studied based on container port operation activities.

6.1 Target Vessel

In this Feasibility Study, the dimensions of the target vessel are in accordance with those of the Third Locks Project as mentioned below.

Length Overall (LOA)	:	385.7m
Breadth	:	54.9m
Draft	:	15.2m
DWT	:	105,000
TEU	:	10,500

Considering above dimensions, it can be assumed that target vessels are able to carry 21 rows of containers on the deck.

6.2 Container Demand Forecast

Balboa Port is at present playing an important role as the transshipment port in the Pacific Ocean side of Panama and Panama Port Company has a vision to expand Balboa Port to receive a growing number of containers in the future although the available onshore area seems narrow to handle staking containers. The number of containers to be handled in Panama at the year 2025 has been projected to be approximately 5,690,000 TEUs as a medium transshipment scenario by the ACP

Study. Under such circumstance, it can be assumed that the Artificial Island will receive approximately 1,000,000 TEUs for the year 2025 in consideration of the allocation each other.

6.3 Berth Dimensions

The container terminal should be designed to accommodate the target vessel, with a draft of 15.2m fully loaded. The length of the container berth is determined from the design vessel length and bow and stern mooring space. Suppose the mooring angle of vessels is 45 degrees considering that the berth line is continuous and straight, the length of the berth can be calculated to be 450m by the following formula.

Length of Container Berth = 385.7 m + 2 x (54.9/2 + 2.0) = 444.6 m → 450 m

6.4 Number of Container Berths Required

Using the container traffic forecast by ACP, the number of container berths required at the year 2025 should be determined by the following formula.

Nb = My / (Ec x Nc x (1+Rf) / (Dy x Hd) / Br

Where;

Nb	:	Required number of container berths	
My	:	Container throughput (in TEUs) at the year 2025	1,000,000 TEUs
Rf	:	Ratio of 40 foot containers	80%
Ec	:	Container handling productivity per hour	25 Boxes
Nc	:	Number of gantry crane to be allocated	2 Nos.
Dy	:	Annual operational days	356 Days
Hd	:	Working hours per day	20 Hours
Br	:	Berth occupancy rate	0.40

Nb = 1,000,000 / (25 x 2 x 1.8) / (20 x 356) / 0.40 = 3.90 → 4 berths in 2025

The required number of container berths (Nb) has been calculated to be 3.90. Therefore, four (4) container berths, each of which is equipped with two (2) gantry cranes should be planned to accommodate the prospected number of containers at the year 2025. Two (2) berths are to be planned additionally at the year 2035 provided that the container cargoes increase with a growth rate of five (5) percent.

6.5 Depth of Container Terminal

The depth of a container terminal should be sufficient to cope with a growing number of container cargoes taking into account the stacking method in the yard and necessary facilities in the container terminal. Considering the future increase of container cargoes to be triggered by the increase of containerization ratio and future deployment of larger size container vessels, a depth of 500 m for the container terminal should be planned.

6.6 Phase-wise Development

(1) Phase I

As the transshipment study by ACP is targeted the year 2025, the Phase I development of the Artificial Island Project can be set as the same year as well. Based on the required number of container berths, the Phase I development has been formulated. Also, dredging plan has been determined phase-wisely to achieve cost-effective development.

(2) Phase II

The Phase II development is targeted at the year 2035, which is 10 years later of the Phase I. Two (2) additional container berths would be provided to meet the container demand in 2035 and additional work for dredging and the construction of onshore facilities is required.

6.7 Reserved Area for Future Commercial Activity

Two (2) liquid cargo berths are provided to receive bunker oil for container vessels.

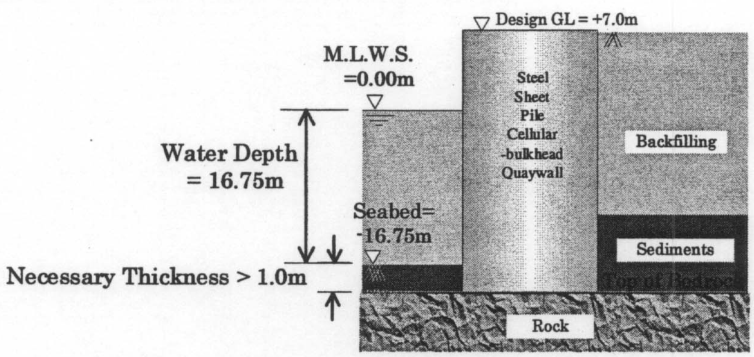
The existing water depth at the liquid cargo berths is sufficient to accommodate 30,000 class tankers and it is possible to apply tidal operation. Some tank storages are also to be provided on land to stock oil. Bunker oil can be transported from the storages to the container berth through pipeline connection.

Once the Artificial Island is constructed using the material generated from the Third Locks Project, various distribution facilities would be located near the container terminal. Also, various commercial activities on the Island are expected to generate.

7. Artificial Island Location

7.1 Location on North-South Direction

Necessary depth for the berth facility is planned as MLWS –16.75m. Roughly estimating the unevenness of existing seabed level at 1 m, the shallowest level of installment of steel sheet pile cellular-bulkhead quaywall should be set to MLWS –18m. This minimum depth is illustrated in **Figure 7.1.1**.



Minimum depth of bedrock
< M.L.W.S. –16.75m - 1.0m = -17.75m ⇨ -18.0m

Figure 7.1.1 Minimum Depth for Installment of Cellular-bulkhead Quaywall

If Artificial Island is constructed on the shallower rock layer than MLWS –18 m, the construction cost can increase considerably due to huge excavation volume of stiff rock layer.

On the other hand, the farther away from landside to offshore (southbound) the construction site is located, the larger the infrastructures becomes, such as the sectional size of cellular-bulkhead quaywall and the total length of Accessway. Consequently, the construction cost will be much more expensive.

In this study, the following alternative cases are compared in terms of construction cost to decide the best location of Artificial Island on north-south direction.

a) Location I (see **Figure 7.1.2**)

Artificial Island is located to correspond the north edge of Island with the contour line of rock layer level of MLWS -18 m. There is no need to excavate stiff rock layer in this case. The length of accessway is 5,525m, and the distance between the coast and south edge of the island is 7,325m (= 5,525m + 1,800m).

b) Location Alternative II -a (see **Figure 7.1.3**)

Artificial Island is located to correspond the south edge of Island with the south edge of Location P1 defined in ACP Report "Preliminary Study of Island Development at the Pacific Entrance of the Panama Canal". The length of accessway is 4,645m. The distance between the coast and south edge of the island is 6,445m (= 4,645m + 1,800m), which is almost equivalent to P1. In this case, rock excavation is needed to construct two berths in north side of island, but not in the construction of four berths in south side.

c) Location Alternative III (see **Figure 7.1.4**)

Artificial Island is located to correspond the north edge of Island with the north edge of Location P1 defined in ACP Report as well. The length of accessway is 3,820m, which is almost equivalent to P1. The distance between the coast and south edge of the island is 5,620m (= 3,820m + 1,800m). Though there is merit in this case of reducing the total length of Accessway, huge quantities of stiff rock have to be excavated for all six berths unfortunately.

d) Location Alternative II -b

The location of Artificial Island is the same as Location Alternative II -a. However, the necessary depth of berth is changed to MLWS -13.5 m for the first northern berth and MLWS -14.5 m for the second northern berth. This case allows intentionally the

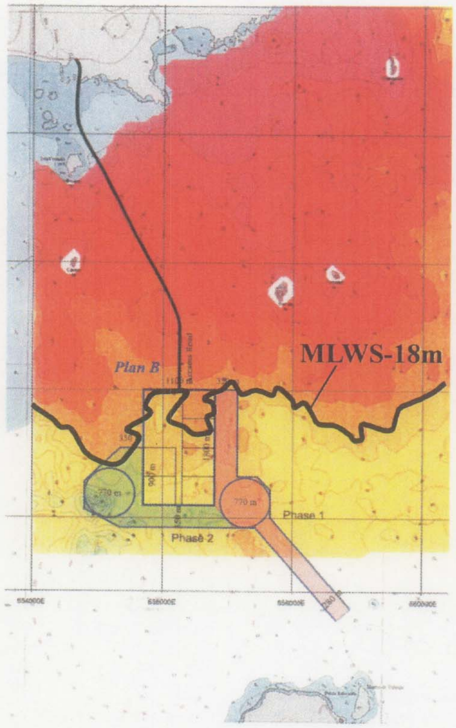


Figure 7.1.2 Location Ⅰ

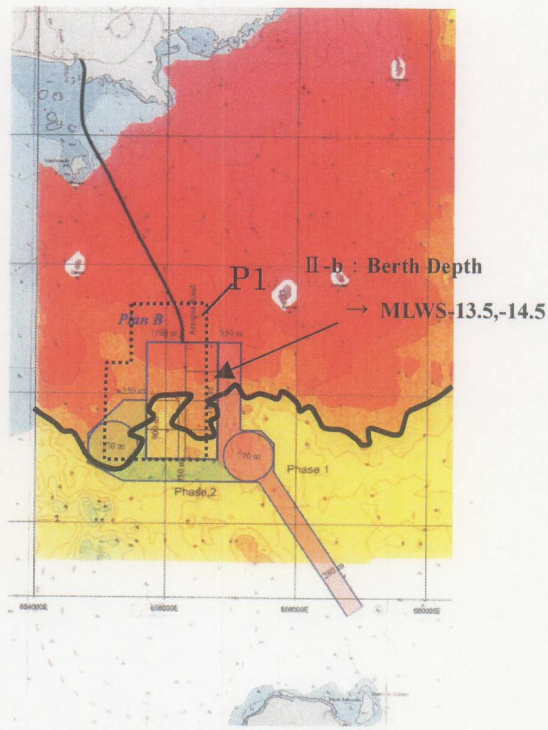


Figure 7.1.3 Location Ⅱ-a and Ⅱ-b

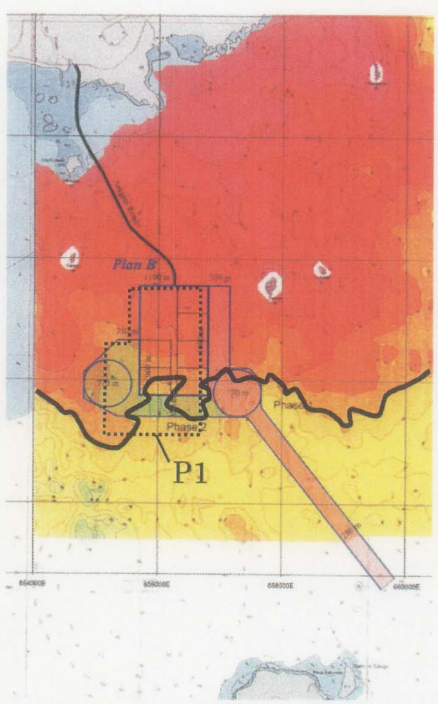


Figure 7.1.4 Location Ⅲ

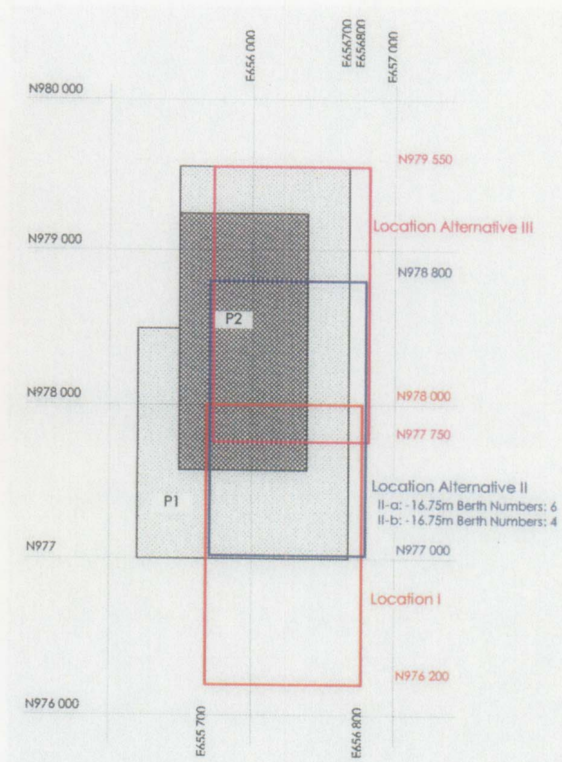


Figure 7.1.5 Comparison of Location

Table 7.1.1 Comparison of Location Alternatives

	Location I	Location Alternative II-a	Location Alternative III	Location Alternative II-b
1. POV				
1.1 Artificial Island Location	On the northern limit without rock dredging [Latitude] North end: N978 000 South end: N976 200	South end latitude is equal to the one of ACP-P1 [Latitude] North end: N978 800 South end: N977 000	North end latitude is equal to the one of ACP-P1 [Latitude] North end: N979 550 South end: N977 750	= Location Alternative II-a [Latitude] North end: N978 800 South end: N977 000
1.2 Number of -16.75m berth	-16.75m berth: 4+2 = 6			-16.75m berth: 4 -14.5m berth: 1 -13.5m berth: 1
2. Features				
2.1 Length of accessway	5,525m [Base]	4,645m [-880m]	3,820m (same as ACP-P1) [-1,705m]	= Location Alternative II-a
2.2 Reclamation Volume	39 Mm3	37 Mm3	34 Mm3	37 Mm3
2.3 Dredging volume	Soil: 9.0 Mm3 Total: 9.0 Mm3	Soil: 11.0 Mm3 Rock: 0.4 Mm3 Total: 11.4 Mm3	Soil: 12.3 Mm3 Rock: 2.0 Mm3 Total: 14.3 Mm3	Soil: 10.6 Mm3 Total: 10.6 Mm3
3.Construction Cost				
(1) Quaywall/Revetment	269 M US$	263 M US$	262 M US$	262 M US$
(2) Reclamation	96 M US$	93 M US$	88 M US$	93 M US$
(3) Accessway	99 M US$	85 M US$	72 M US$	85 M US$
(4) Dredging	65 M US$	139 M US$	371 M US$	76 M US$
Total Cost	529 M US$	580 M US$	793 M US$	516 M US$
4. Evaluation	AA	A	B	A

reduction of berthing ability of two northern berths, in which the berth depth should have been, MLWS -16.75 m originally. Other four (southern) berths can keep the sufficient depth of MLWS -16.75 m.

The result of comparison of these four Location Alternatives is shown in **Table 7.1.1** and **Figure 7.1.5**. The construction cost in **Table 7.1.1** includes that of Accessway.

In comparison of Location Alternatives I, II-a and III, it is obviously proved that the construction sites in northern side from the line of rock layer level of MLWS -18 m lead to be more expensive. This is because the cost-push for rock excavation is larger than the cost-down by shortening the total length of Accessway. Meanwhile, the construction cost becomes higher when the construction site is set farther to offshore in southern direction, as mentioned previously. Consequently, the cost can be minimized when the Artificial Island is located to correspond the north edge of Island with the contour line of rock layer level of MLWS -18 m.

Actually, Location Alternative II-b can be constructed with cheaper cost than Location I due to no rock excavation. However, Location Alternative II-b cannot maintain satisfactory berthing ability.

In this study, it is concluded that Location I is the best location for construction of Artificial Island on the north-south direction.

7.2 Recommended Location for Artificial Island

As a result of the above comparison study, the recommended location of Artificial Island is set to the followings (see **Figure 7.2.1**):

North Edge of Artificial Island: N978000
East Edge of Artificial Island: N656800

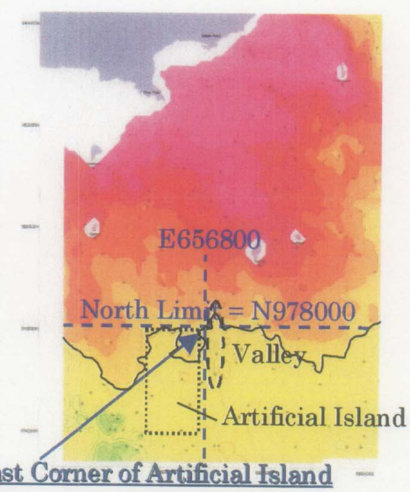


Figure 7.2.1 Best Location of Artificial Island

8. Analysis of Wharf Operation Efficiency

Based on the location of the artificial island recommended above, the effect of wave transformation and calmness of the existing basin condition due to the placement of the proposed artificial island were investigated. And then, wharf operation efficiency for cargo handling at each container berth was calculated.

The model results have concluded the following matters.

- The typical wave climate in the area of the proposed artificial island is relatively mild with the geometry of the Gulf of Panama and South America limiting the directions of waves entering the region. Additionally, the near-shore islands of ISLA TABOGA and TABOGUILLA will provide a relatively tranquil area behind, which in turn, a better position and suitable place for the proposed artificial island.
- If container berths are located on the east side and the west side of the artificial island, the standard level of wharf operation efficiency for cargo handling, 97.5%, can be achieved without a breakwater.
- The ratio of wave height is relatively large at the south of artificial island, because wave directions are almost southwardly at the project site. And the standard level of wharf operation efficiency for cargo handling, 97.5%, can not be achieved at the southern berths. Consequently, a breakwater is needed if the container berths are located on the south side of the artificial island.

9. CURRENT ANALYSIS

The current simulation was implemented to evaluate the potential impacts of the construction of the artificial island and the access way.

The following was concluded based on the mathematical modelling of the effects of the construction of the artificial island and the proposed accessway:

- The construction of the island will change current directions and speeds in some degrees, however such change does not significantly affect the natural current conditions of the bay as a whole.
- The impact of increase in the current velocities from the natural condition is mostly significant in the northern part of Taboga Island, however, such increase remains within around 10cm/s from the natural condition.
- The accessway design shall incorporate a bridge or intermittent trestle sections to avoid any impact on the shore area and to prevent negative effects especially due to the social and environmental value of Veracruz Beach.

10. Container Terminal Layout

Table 10.1 shows the comprehensive evaluation results of container terminal alternatives.

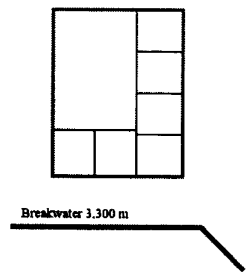
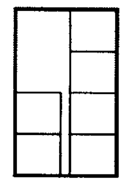
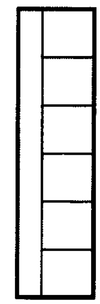
In view of the calmness, Plan-B and C will achieve the standard level of wharf operation efficiency for cargo handling, 97.5%, while Plan-A needs a breakwater to secure designated calmness in the port.
In terms of terminal operation, Plan-C is the best plan since quayside gantry cranes can be utilized to all the berths.

According to the results of current simulations, Plan-C will have a biggest influence on the speed of the current among the three alternatives. However, such change in the current is not so significant

The island construction cost for Plan-B is a base case and cost difference from the base case for Plan-A and Plan-C is shown in **Table 10.1**. Plan-A is most costly because a breakwater is needed to secure calmness in the port.
Hence, according to the overall evaluation, the recommended container terminal

layout is Plan-B.

Table 10.1 Evaluation of Container Terminal Layout

	Plan-A	Plan-B	Plan-C
Container Terminal Layout			
Island Area	1,400m * 1,800m = 252 ha	1,100m * 1,800m = 198ha	733m * 2,700m = 198ha
Reclamation Volume	49 M m^3	39 M m^3	40 M m^3
Evaluation Item 1. Port Operation			
1) Calmness (Chap 4 & 6)	AA (100% > 97.5%) (Breakwater is necessary)	A (98.4% > 97.5%)	A (98.0% > 97.5%)
2) Terminal Operation	A	A	AA (Gantry cranes can be utilized to all other berths)
2. Influence to Current	A	A	B
3. Island Construction Cost	B (US$ +135 M)	AA (Base)	A (US$ +54 M)
Comprehensive Evaluation	B	AA	A

11. Cost Estimate

11.1 Overall Project Cost Estimation (Plan B)

Estimated construction cost of the Panama Artificial Island and container terminal is summarized in **Table 11.1**.

Table 11.1 Summary of Construction Cost - Plan-B

(Million $)

Component	Phase 1	Phase 2	Total
Island Construction			
Quaywall / Revetment	269		269
Reclamation	96		96
Breakwater	0		0
Sub Total	**365**		365
Accessway	99	0	99
Infrastructures	74	39	113
Container Terminal Module	217	103	320
Total	755	142	**897**

11.2 Comparison of Construction Volume and Cost

Table 11.2 shows the comparison of construction volume and cost between two alternatives. As the proposed artificial island in this JETRO F/S is also advantageous to the total construction cost as the revetment can be used for the quaywall of the container terminal.

Table 11.2 Comparison of Construction Volume and Cost

Items	JETRO F/S Plan-B	ACP-P2-A*)
Size of Artificial Island	1,100m*1,800m = 198 ha (1.29)	900m*1,700m =153 ha
Reclamation Volume	39 M. m^3 (1.26)	31 M. m^3
Island Construction	$ 365 M.	$ 248 M.
Accessway	$ 99 M.	$ 103 M.
Infrastructures	$ 113 M.	$ 138 M.
Container Terminal Module **(Marine Structures for Container Terminal)**	$ 320 M. **($ 75 M.)**	$ 447 M. **($ 183 M.)**
Total Cost	$ 897 M. ($ 453/m2)	$ 936 M. ($ 612/m2)

*) ACP: PRELIMINARY STUDY OF ISLAND DEVELOPMENT AT THE PACIFIC ENTRANCE OF THE PANAMA CANAL, Final Report, Volume 1 of 2 Main Report, December 2001.

12. Environmental Evaluation

Environmentally, the proposed project location does not pose a significant threat to the environment for many reasons, such as:

1. No loss of inter-tidal habitat (depending on the structure of Accessway) and no loss of vegetative protected species;
2. Dumping of excavated materials will be done in a contained environment thus greatly minimizing environmental impact, which is normally associated with open sea dumping;
3. Location is nearby island formations, therefore environment is thus adapted to the existing velocity variations of the currents; and
4. Recommended access way structure provides a feasible and suitable solution since it minimizes the barrier effect.

It was identified that one of the few irreversible impacts of the implementation of the project, nevertheless mitigable, is the location of the access point of the access way. This point falls in the border of a naturally protected area, such area lost would have to be compensated by a re-vegetation measure as proposed in the Draft Environmental Management and Monitoring Plan.

It is implied that all other conditions regarding the operations, local regulations and international agreements would be fully complied with, therefore having a negligible impact as long as the regulation are met.

It is expected that a full fledge Environmental Impact Assessment will be carried out to obtain approval by the Autoridad Nacional de Ambiente (ANAM) once a decision is reach on the detail design of the infrastructure.

It was learned from an interview by a member of the JETRO Study Team that the project area is not visited by artisanal fishermen; therefore, little impact is expected by the project construction in such industry.

The alternative to dump the material from the works of the excavation of the third set of locks in a contained environment is definitely a better environmental option than reclamation near the shore since it implies loss of inter tidal habitat and the need for a larger area to accommodate the same volume of material.

The greatest impact of the proposed island construction comes from the construction of the access way and not the island construction itself. The proposed use of the island as a container terminal is the cleanest potential use of the development as manageable levels of waste a generated and can be treated as proposed in the EMMP.

13. Project Evaluation

13.1 Economic Evaluation

The economic internal rate of return (EIRR) of the Project based on a cost-benefit analysis is 12.4%.

13.2 Financial Evaluation

The financial internal rate of return (FIRR) of the Project is 9.6%, which is much higher than JBIC's interest rate (1.2 %) for preferential terms loan..

14. Conclusion

JETRO Feasibility Study for the Construction of an Artificial Island at the Pacific Entrance to the Panama Canal was carried out in cooperation with Autoridad del Canal de Panama (ACP) from August 2003 to January 2004. In this feasibility study, an artificial island construction plan was proposed with a view to the beneficial usage of excavated materials coming from Panama Canal Expansion Plan activities, and this proposed artificial island construction project was ascertained to be feasible from technical, economic, financial and environmental point of views.

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CHAPTER 1 INTRODUCTION

1.1 Backgrounds of the Feasibility Study

Autoridad del Canal de Panama (ACP) is evaluating the possibility to expand the Canal to accommodate ships larger than Panamax vessels. The proposed construction of new locks and the related work for the expansion of the Panama Canal are expected to generate significant quantities of excavated materials, amounting to some 50-70 million m^3. As part of its activities, the Panama Canal Master Plan for the expansion of the waterway is considering land reclamation at the Pacific entrance to the Panama Canal, as an alternative to give excavated material a beneficial use.

In order to assess the technical and environmental aspects of the land reclamation alternatives, JETRO's Preliminary Study on "Land Reclamation Alternatives for the Pacific Entrance to the Panama Canal" was carried out in cooperation with ACP from December 2002 to March 2003. In this preliminary study, with a view to the beneficial usage of excavated materials coming from Panama Canal Expansion Plan activities, land reclamation alternatives were proposed in consideration of Japanese technologies and experiences. Due to time constraints and lack of data, some bold assumptions were adopted in evaluating land reclamation alternatives.

In response to the request for a subsequent study from ACP, Japan External Trade Organization (JETRO) has decided to carry out the "Feasibility study for the Construction of Artificial Island at the Pacific Entrance to the Panama Canal" in 2003. The Feasibility Study is executed by the study team organized by Nippon Steel Corporation, in cooperation with Nippon Koei Co., Ltd.

1.2 Objectives of the Feasibility Study

This Feasibility Study of JETRO (hereinafter called as JETRO F/S) aims to propose constructing an artificial island using the excavated materials resulting from the proposed construction of new Pacific locks and analyze the feasibility of the project.

1.3 Scope of Study

To achieve the above-mentioned objectives, the Feasibility Study includes the following study items:

A. Data Collection:

a. Collection and review of data on traffic demand, including transshipment, to plan for the use of the artificial island as a container terminal.

b. Collection and review of the available data and information related to the operations of the existing container port(s) in Panama.

c. Collection of data on the natural condition of the Pacific Ocean-side of the Canal :

c-1. Observed data and/or hindcast data (direction, period and height) on waves and swells, including wave spectrum.

c-2. Typical weather maps describing high waves and seasonal pressure pattern.

c-3. Wind data at some spots.

d. Collection of data on the cost of labor, material and the equipment necessary for the cost estimation.

B. Assessment for the Construction of an Artificial Island:

a. Selection of artificial island location, from the viewpoint of wave and current conditions, bathymetric and seismological information, and environmental aspects including tidal current analysis.

This includes the study of the necessity of the breakwater, and its proposal of the specification (length, height, etc.).

This study also includes the proposal of the structural type of the access road.

b. Boring exploration at the sites. (See the "Technical Specification for Offshore Geotechnical Investigation for Artificial Island Construction at the Pacific Entrance to the Panama Canal.")

c. Structural design of quaywall, revetment, foundation of gantry crane, and breakwater.

   Conceptual design of access road.

d. Analysis of transportation and handling of excavated materials.

e. Construction method and program.

f. Review and update of the environmental aspects, Chapter 4 in the report of the preliminary study by JETRO Study Team, March 2003: 4.1 Present situation of the artificial island project, 4.2 Legal framework, 4.3 JBIC's Environmental guidelines, and 4.4 Review of existing environmental conditions.

   Proposal for environment management and monitoring plan for the artificial island.

g. Cost estimation for the construction of the artificial island.

h. Project evaluation.

1.4 Study Area

The Study area is at the Pacific entrance to the Panama Canal (see **Figure 1.4.1**).

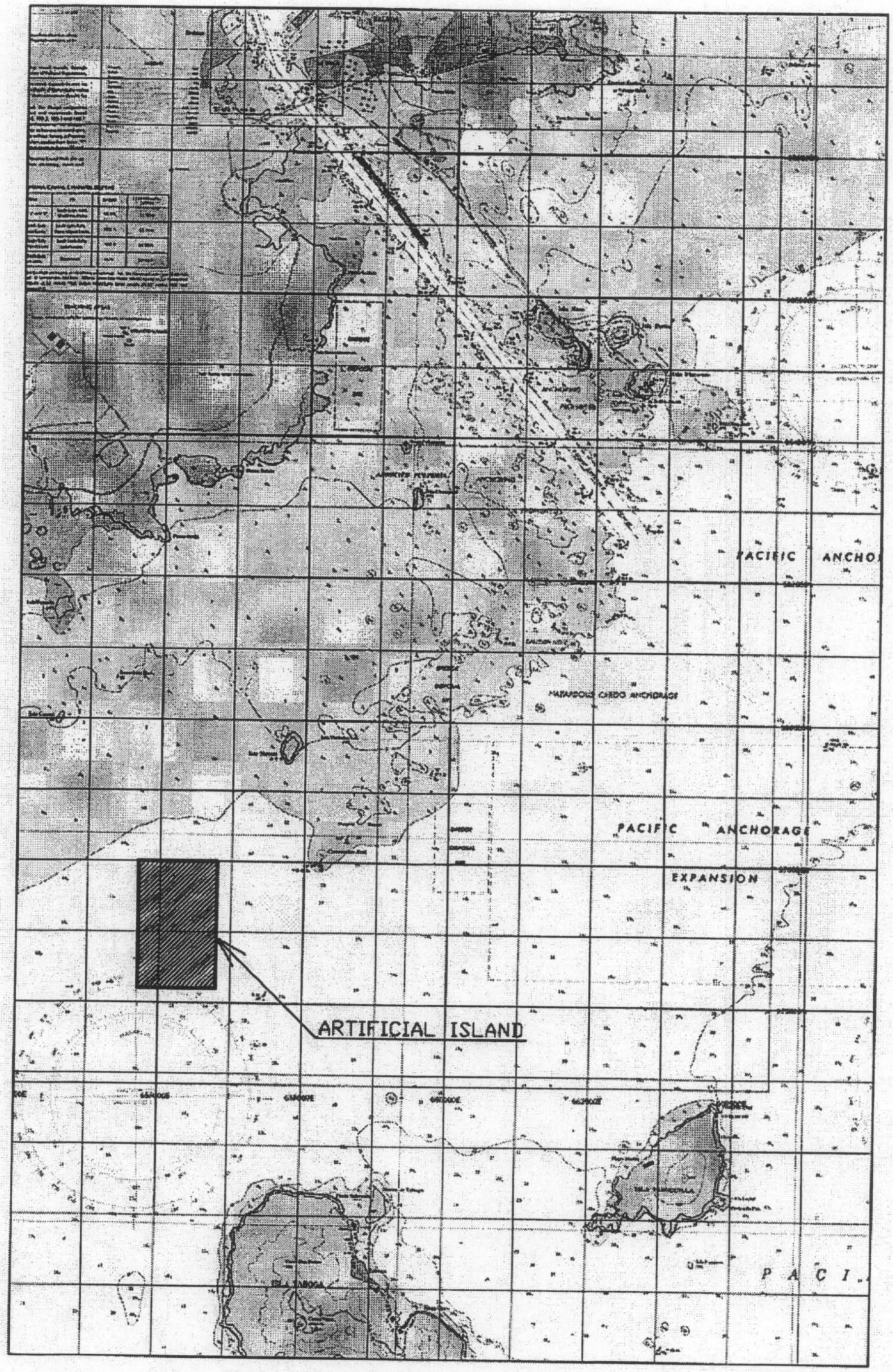


Figure 1.4.1 Location Map

1.5 Study Schedule

The JETRO F/S has started from August 2003 and will be finished at the end of March 2004.

Table 1.5.1 Study Schedule

year	2003					2004		
month	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
# Inception Meeting								
A. Data Collection								
B-a Selection of Island Location								
B-b Boring Exploration								
B-c Structural Design								
B-d Material Transportation and Handling Analyses								
B-e Construction Planning								
B-f Review of the Environmental Aspects								
B-g Cost Estimation								
Preparation of Interim Presentation								
# Interim Presentation								
B-h Project Evaluation								
Preparation of F/S Report								
# Submitting F/S Report							#	

Note: Study in Panama, Study in Japan

CHAPTER 2 NATURAL CONDITIONS

2.1 Meteorological Conditions

2.1.1 General

Two weather systems define the climate of Panama. One is the semi-permanent anticyclone of the Atlantic which produces east winds in the lower layers of the atmosphere. The other is the Intertropical Convergence Zone (ITCZ), a kind of meteorological interference associated with the anticyclone of the Eastern Pacific. The ITCZ moves following the displacement of the sun throughout the year. Consequently, the seasonal migration of the masses of tropical air from the Pacific and those of sub-tropical air from the Atlantic, in combination with the local physical geography of mountains, establishes the weather of each area.

2.1.2 Precipitation and Wind

There are two seasons in the Panama city area consisting of the rainy season from May to November and the dry season from December to April. The annual rainfall is about 1,700 mm, annual average temperature is 27℃, and the annual relative humidity is 83.3% During the dry season, the prevailing winds are mostly from the northwest (58%) with an average speed of 8.0 miles per hour (MPH) and the next prevailing one is from the north (36%) with an average speed of 11.0 MPH.

During the rainy season, the prevailing winds continue mostly from the northwest (50%) with an average speed of 6.0 MPH and the next prevailing one is again from the north (15%) with an average speed of 5.0 MPH. The winds from the south and the southeast are 12% with an average speed of 7.0 MPH and 5.5% with an average speed of 5.0 MPH respectively.

2.2 Oceanographic Conditions

2.2.1 Wave

The typical wave climate in the Gulf of Panama is relatively mild, because wave energy can only reach the entrance to the Gulf of Panama from a restricted directional window due to the geometric shape of the Gulf itself and the surrounding geography (as can be observed in **Figure 2.2.1**). That is, the only significant wave energy to the Gulf may be from south to west-southwest. And the islands within the Gulf and the geometric configuration of the Gulf itself further shelter the study region from offshore waves.

More details about wave condition in the Gulf of Panama were mentioned in Chapter 4 Analysis of Wharf Operation Efficiency.

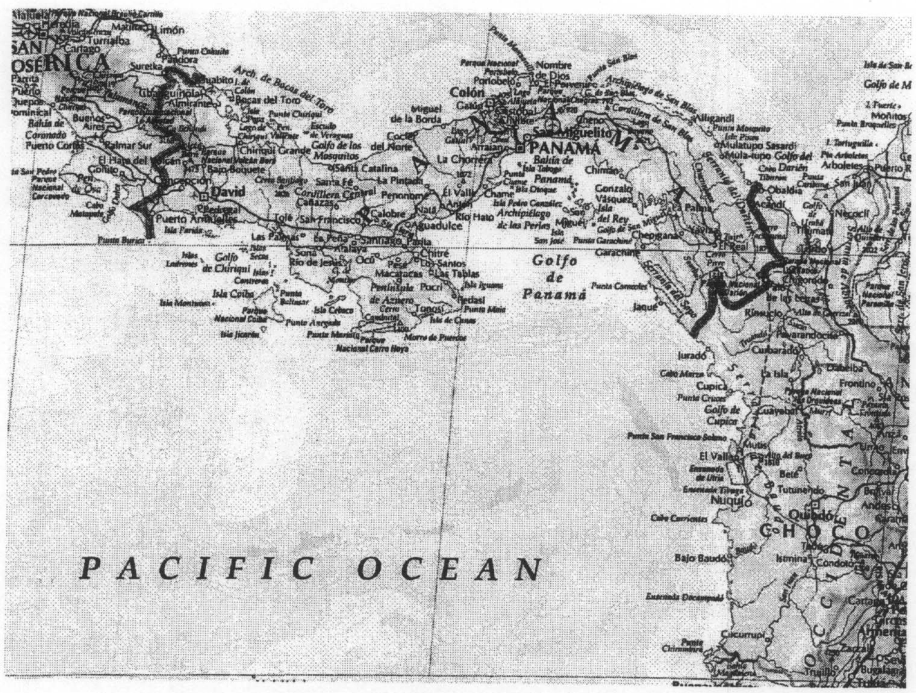


Figure 2.2.1 Overview Map of the Gulf of Panama

2.2.2 Current

The Oceanic currents in the Eastern Pacific are very complex. One of the main currents affecting the current of the Gulf of Panama is Equatorial counter-current. It disappear between 90° to 85° W where it is partially incorporated into the circulation of the Gulf of Panama. The typical current of the Gulf of Panama originated in Oceanic Current forms a cyclonic (counterclockwise) circulation known as Gulf of Panama Current or Colombia current (Bennett; 1965). The intensity of the current varies with the intensity of the trade winds, being the highest during the months of December to April, and the lowest from May to June.

More details about current condition in the Gulf of Panama were mentioned in Chapter 5 Current Analysis.

References

Bennett, B.E.. (1965) : Currents observed in Panama Bay during September-October 1958, Inter-American Tropical Tuna Comission. Bulletin Vol.10, No.7, pp.399-457.

2.2.3 Tides

Tidal level is assumed as shown in **Table 2.2.1** based on JICA Report (1997), : The Study on the Development of the Port of Balboa in the Republic of Panama. This study is based on M.L.W.S..

Table 2.2.1 Tide Level (JICA Report 1997)

JICA Report	P.L.D.=0.000	M.L.W.S=0.000
Highest Water (H.W.)	3.596	5.918
Mean Monthly Highest High Water (M.H.H.W.)	3.023	5.345
Mean High Water (M.H.W.)	2.140	4.462
Lowest High Water (L.H.W.)	0.676	2.998
Mean Sea Level (M.S.L.)	0.307	2.629
0.00 Precise Level Datum (P.L.D.)	0.000	2.322
Highest Low Water (H.L.W.)	-0.327	1.995
Mean Low Water (M.L.W.)	-1.696	0.626
Mean Low Water Spring (M.L.W.S.)	-2.322	0.000
Mean Monthly Lowest Low Water (M.L.L.W.)	-2.788	-0.466
Lowest Water (L.W.)	-3.445	-1.123

Means are from 1973 to 1991. Extremes are from 1909 to 1991

2.3 Geotechnical Conditions

2.3.1 Bathymetric Information

To understand the bathymetric conditions of construction site, the seismic surveying was executed by ACP. Seabed contour map obtained from the seismic surveying is shown in **Figure 2.3.1**, and top of bedrock contour map is shown in **Figure 2.3.2**. Seabed descends in a gradual slope to the offshore. Seabed level of the construction site is from MLWS-8m to -16m. Top of bedrock also declines gradually to the offshore. It is note that level undulation is larger in bedrock surface than in seabed. Top of bedrock level is from MLWS-14m to -30m.

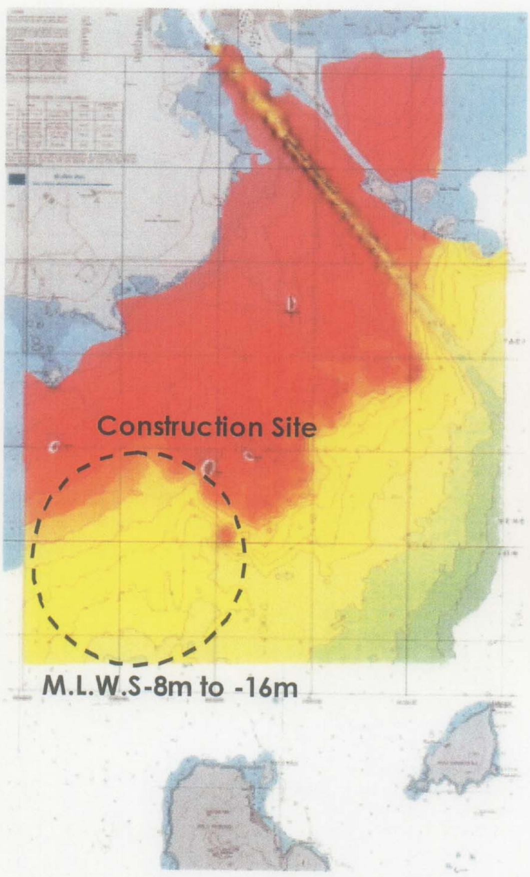


Figure 2.3.1 Seabed Contour Map

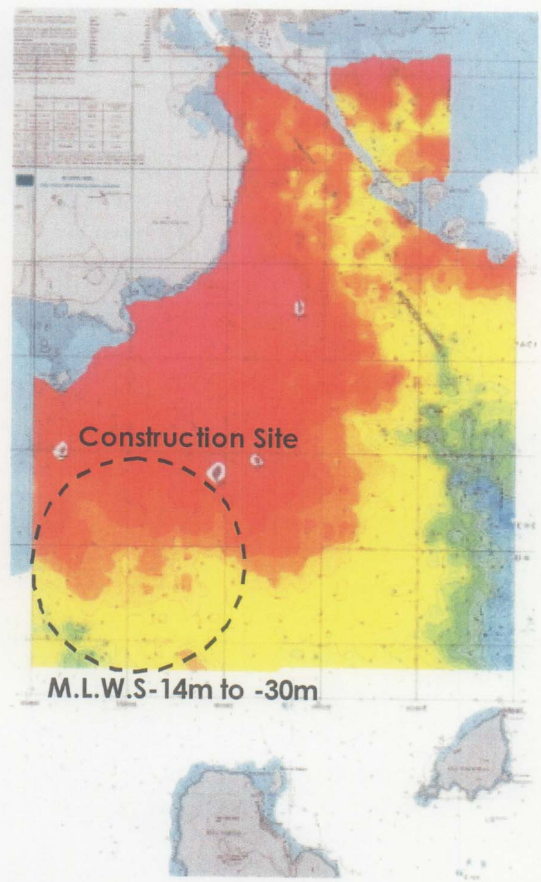


Figure 2.3.2 Bedrock Contour Map

2.3.2 Geological Information

Geological information of rock layer by ACP is shown in **Figure 2.3.3**. Rock layer of the construction site is supposed to consist mainly of two categories. They are PANAMA FORMATION and VOLCANIC ROCKS. PANAMA FORMATION is the sedimentary and volcanic rock composed by agglomerate and sandstone. PANAMA FORMATION was formed from 34 million years ago to 23 million years ago. VOLCANIC ROCKS is composed by andesite and basalt. It was formed about 23 million years ago.

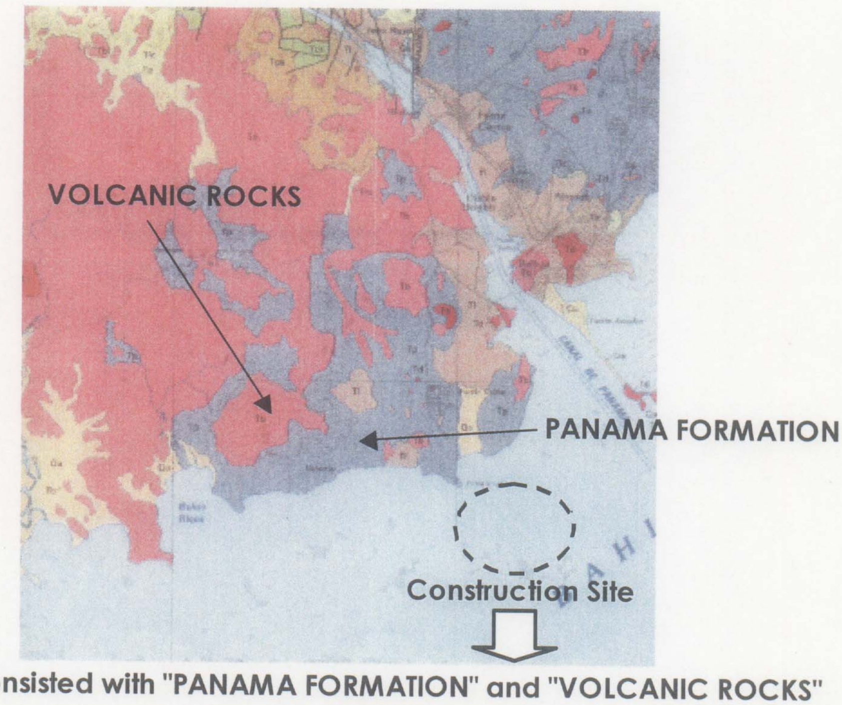


Figure 2.3.3 Geological Map

2.3.3 Geotechnical Information

To understand the geological and geotechnical condition of the construction site, three exploratory borings were executed newly. The boring points are shown in **Figure 2.3.4**. These new boring logs are indicated as IS-A, B and C. "RTP-7" is an existing boring point near the construction site. The location of Artificial Island in the Preliminary Study is enclosed by broken line in **Figure 2.3.4**. Boring point "IS-B" is located at the Southeast corner of Artificial Island. Point "IS-A" is 1km far away from Point IS-B and it is located on the extension line from Point RTP-7 to IS-B. Point "IS-C" is located at 1km northbound from Point IS-B on the same extension line.

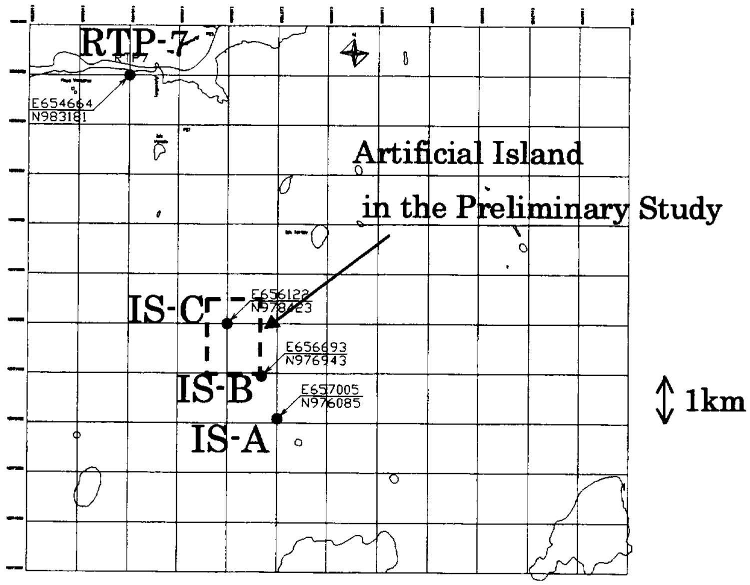


Figure 2.3.4 Exploratory Boring Points

The geologic section of three exploratory borings is shown in **Figure 2.3.5**. In **Figure 2.3.5**, the bathymetric level and top level of bedrock are drawn. The differences of these levels accounts for 1m approximately. Seismic surveying can find out the almost accurate level of seabed and surface of rock layer. Geological category of rock is also shown in **Figure 2.3.5**. Rock of "IS-B" is agglomerate of PANAMA FORMATION. Rock of "IS-A" and "IS-C" is andesite of VOLCANIC ROCKS.

The results of standard penetration tests and laboratory soil tests are shown in **Table 2.3.1**. The standard penetration tests were carried out at in 4.5～5.0m depth from seabed. N value varies from 7 to 40 in soil layer, and the average of them is calculated as 24.

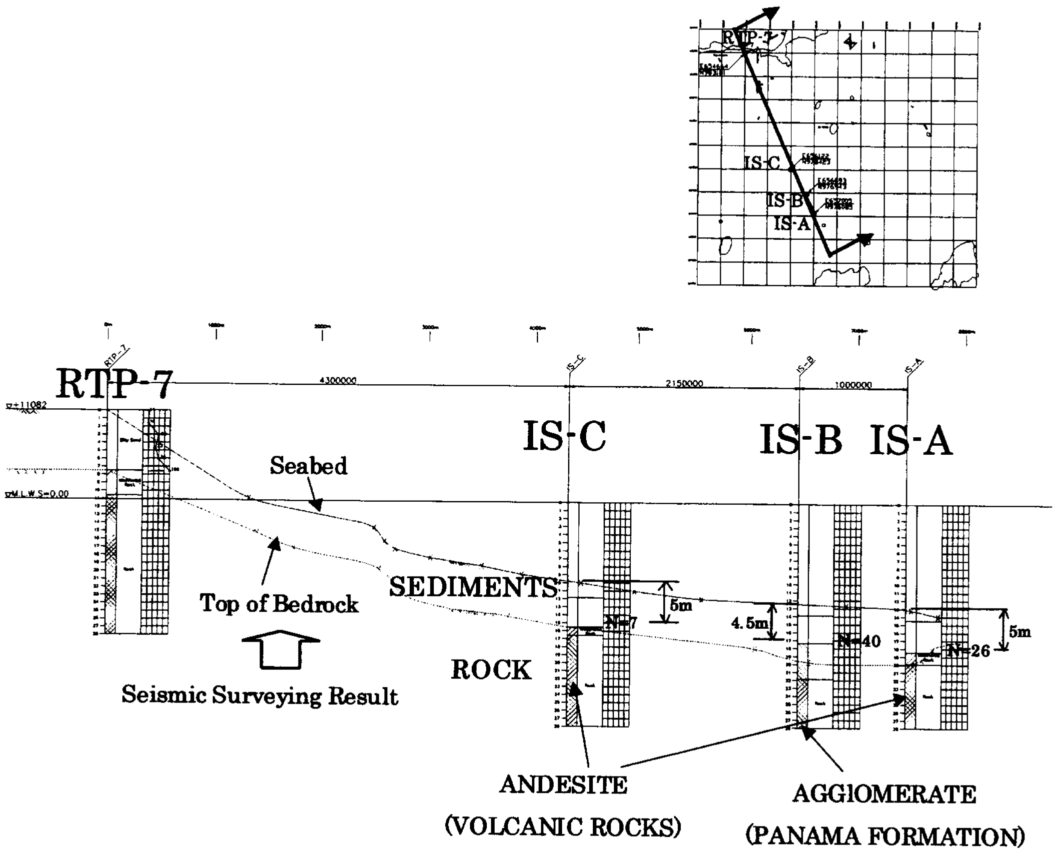


Figure 2.3.5 The Geologic Section of Three Exploratory Borings

Table 2.3.1 Soil Condition at Construction Site

Borehole	Elevation (m)	Depth From Seabed	N-value (N)	Liquid Limit LL	Plastic Limit PL	Plastic Index PI	Name
IS-A	-17.9～-18.4	-5.0	26	98	28	70	Fat clay
IS-B	-16.9～-17.1	-4.5	40	47	18	29	Clayey sand
	-17.1～-17.3			53	21	32	Clayey sand
	-17.4～-17.5	—	—	61	22	39	Sandy fat clay
	-18.9～-19.4	—	—	64	23	41	Sandy fat clay
IS-C	-14.1～-14.5	-5.0	7	62	28	34	Fat clay
	-14.5～14.6			55	20	35	Fat clay with sand

Classification of soil is regulated by ASTM D 2487. It is obtained by liquid limit (LL) and plastic index (PI). Plasticity chart is shown in **Figure 2.3.6**. When the relational point between the plasticity index and liquid limit falls on or above the "A" line, the soil is classified as a clay. When the relational point falls below the "A" line, the soil is classified as a silt. In this feasibility study, the results obtained from **Table 2.3.1** explains that clay is a main component of soil layer around the construction site.

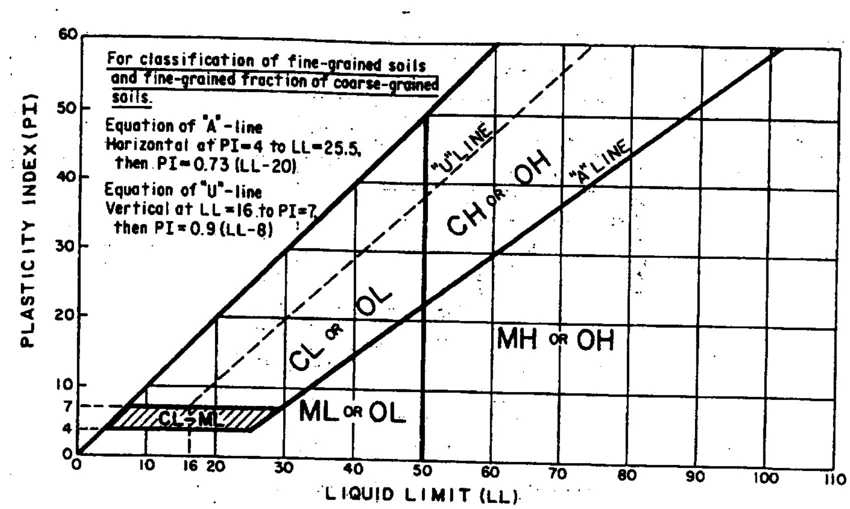


Figure 2.3.6 Plasticity Chart

2.4 Earthquake

2.4.1 Historical Seismic Records

Nowadays, US Oceanology & Meteorology Bureau stores historical earthquake records for whole world named as "Preliminary Determination of Epicenters (PDE)". The PDE includes the event date, the magnitude and the exact location of the epicenter (latitude, longitude and depth) from 1973 to 1999. In this study, the large area around Panama (Longitude of 65° to 95° W, Latitude of 10° S to 25° N) is selected as gathering area of historical earthquake events as shown in **Figure 2.4.1**.

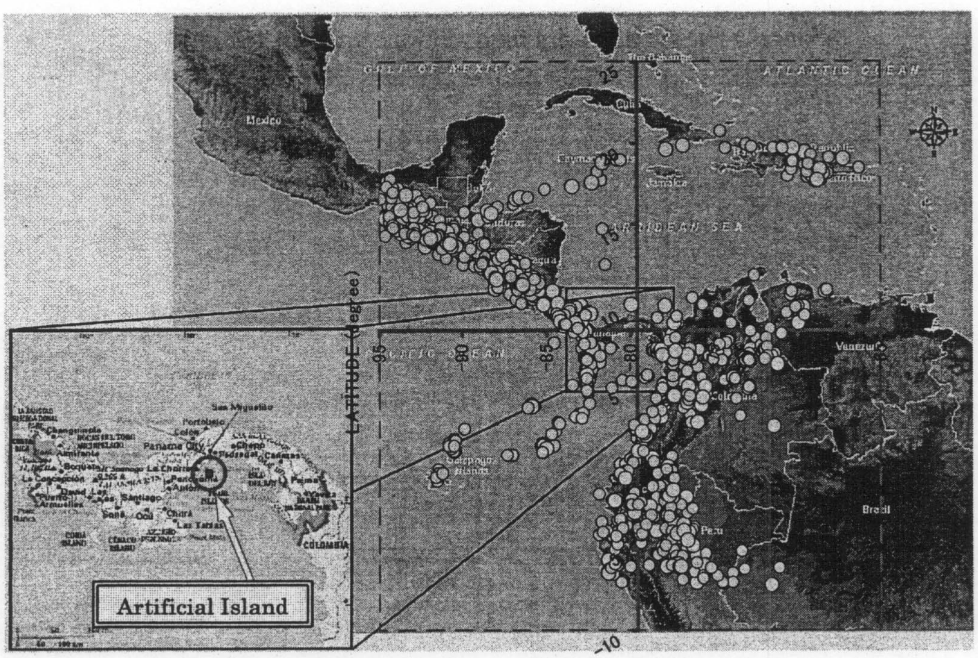


Figure 2.4.1 Historical Earthquake Events Map

The magnitude of earthquake events around Panama is shown in **Figure 2.4.2**. The seismic coefficient is directly related to peak ground acceleration. Therefore, the peak ground acceleration has to be calculated in terms of the location of Panama. The calculation of the peak ground acceleration Ag(G) is expressed as,

$$LogAg=0.53M-log(X+0.0062\times 10^{0.53M})-0.00169X+0.524 \qquad (2.4\text{-}1)$$

where M : Magnitude of Earthquake

X : Distance between Construction Site and Earthquake Source(km)

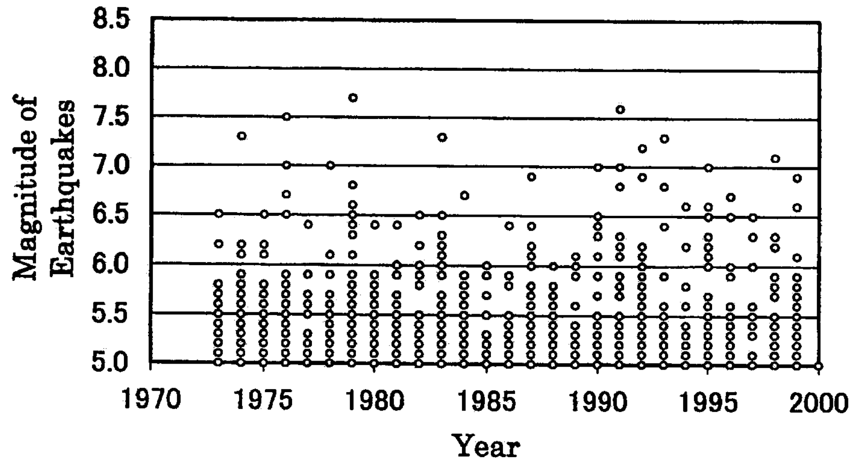


Figure 2.4.2 The Magnitude of Earthquake Events around Panama (Magunitude>5.0)

The resultant value of equation (2.4-1) is generally recognized as equivalence to the measurement of ERS accelerometer. The peak ground accelerations calculated by Equation (2.4-1) are shown in **Figure 2.4.3**. From **Figure 2.4.3**, the largest value accounts for only 62 gal. In other words, the seismic coefficient became 0.06.

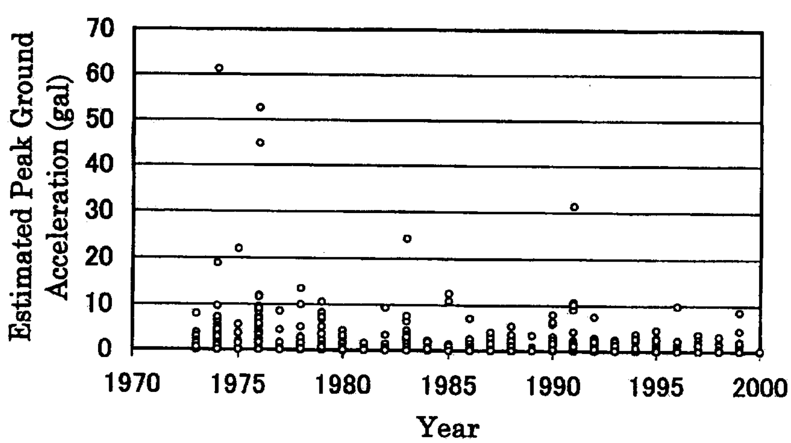


Figure 2.4.3 The Peak Ground Accelerations

2.4.2 Technical Standards for Buildings in Panama

Technical standards for buildings in Panama include the map of "Coefficient of Maximum Acceleration relative to Velocity for the Republic of Panama, REP-94, January 1994" as shown in **Figure 2.4.4**. According to this Figure, Maximum acceleration relative to velocity (Av) accounts for 0.10 at the construction site of Artificial Island.

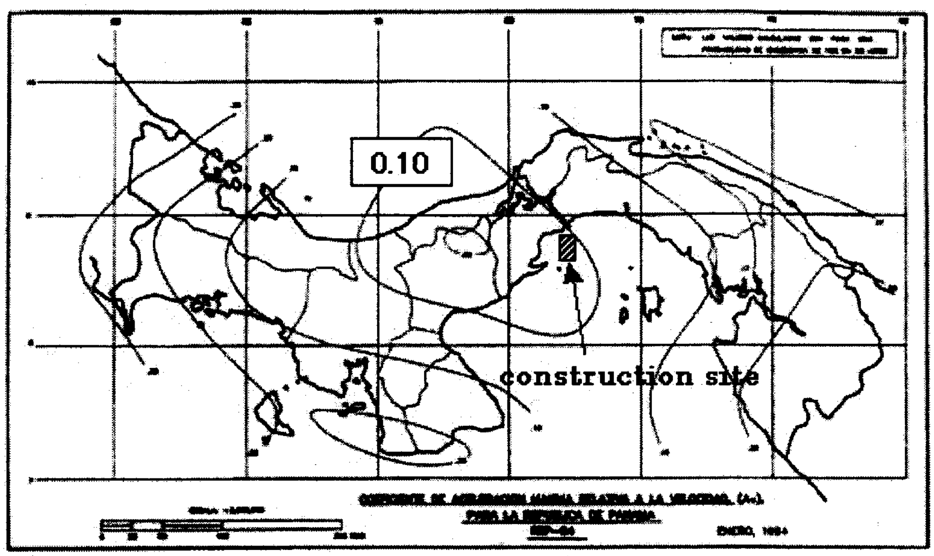


Figure 2.4.4 Maximum Acceleration Relative to Velocity for the Republic of Panama

Coefficient of base shear (Cs), which means the ration of horizontal force to dead load of structure, is calculated by the following equation:

$$C_s = 2.5\,A_a / R \leqq 2.5\,A_v / R \qquad (2.4\text{-}2)$$

where A_a : Effective peak acceleration

A_v : Maximum acceleration relative to velocity

R : Response modification factor

Since there is no information in terms of response modification factor R for waterfront infrastructures on "Technical Standards for Buildings in Panama", R is newly assumed as 2.5. The value of 2.5 is not so large in building whose range of R distributes from 1.25 to 8 in mentioned Technical Standards. By calculating the equation (2.4-2), the coefficient of base shear (seismic coefficient) becomes 0.1.

2.4.3 Seismic Coefficient

As discussed in Section 2.4.1 and 2.4.2, the seismic coefficient is assumed from 0.06 to 0.1. In conclusion, the seismic coefficient is set to 0.1 in this study.

CHAPTER 3 Conceptual Plan of Artificial Island

3.1 Artificial Island Construction Method

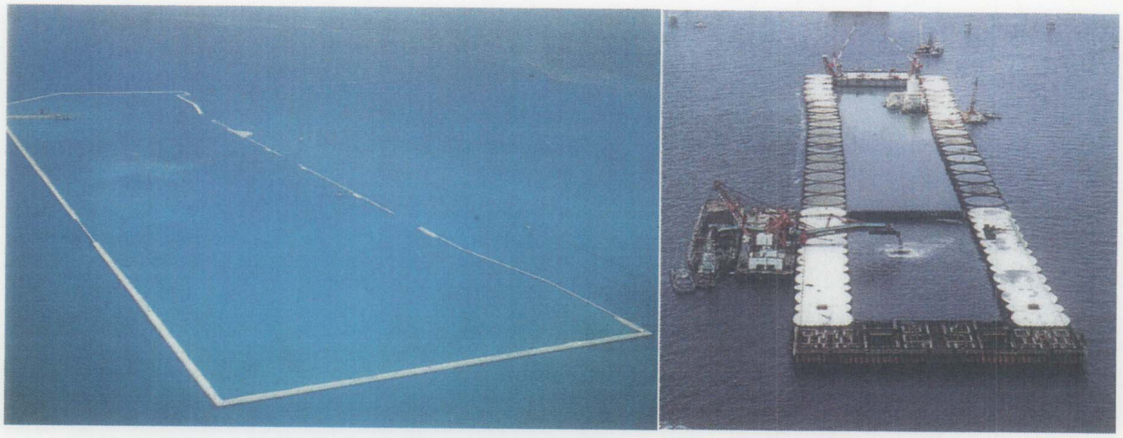
3.1.1 Construction Method in Japan

During and after construction of Artificial Island, one of the most principal observances is to achieve the minimum impact on environment. Particularly, the seawater pollution must be avoided carefully.

Nowadays, when constructing an artificial island in Japan, the reclamation is implemented after all construction of surrounding revetment. Considering anti-contamination of seawater, reclamation of inside area should be isolated from external seawater.

Bird's view of construction of reclaimed island is shown in **Figure 3.1.1** as two examples in Japan. These photographs are constructions of Kansai International Airport and Tokyo-wan Aqua Line (Umihotaru Island). Kansai International Airport was the first artificial airport island in Japan. The area of the artificial island is 800ha surrounded by revetments of total 12km. Seawater is deeper than 25m. Then, Tokyo-wan Aqua Line consists of undersea tunnel of 10km and continuous girder bridge of 5km approximately. Umihotaru Island is constructed at the connection point of undersea tunnel and girder bridge. This artificial island is 600m long and 100m wide and the water depth is 17m approximately. Reclaimer vessel can be seen just working in this photograph.

As shown in **Figure 3.1.1**, reclamation is always executed after construction of surrounding revetment in Japan. Therefore, environmental impact can be minimized because the external seawater is excluded perfectly from reclamation area.



(a) Kansai International Airport (b) Tokyo-wan Aqua Line (Umihotaru Island)

Figure 3.1.1 Construction Examples of Reclaimed Islands in Japan

3.1.2 Structural Types of Quaywall and Revetment

Among popular structural types in Japan is concrete caisson or steel sheet pile cellular-bulkhead quaywall. Concrete caisson is very popular in many countries. However, prefabricated steel sheet pile cellular-bulkhead quaywall (called as 'sheet pile cellular-bulkhead quaywall') are also popular in Japan but not so in some countries. In waterfront infrastructures of Japan, more than 20 sheet pile cellular-bulkhead quaywalls have been constructed since 1970s.

Figure 3.1.2 explains a structural configuration of sheet pile cellular-bulkhead quaywall. The stability is kept highly with sheet pile cellular and inside filling. Firstly, straight web-type sheet piles are driven by vibrohammer. Secondly, inside filling is executed. Straight web-type sheet piles can resist the hoop tension in circumferential direction, brought on by earth pressure from inside filling. Straight web-type sheet piles have stronger tension strength than U-type and Z-type sheet piles. Inside filling needs 1 to 2 days for one cellular-bulkhead quaywall. Calm climate is desirable for inside filling because empty condition of cellular-bulkhead quaywall is unstable against stormy wave.

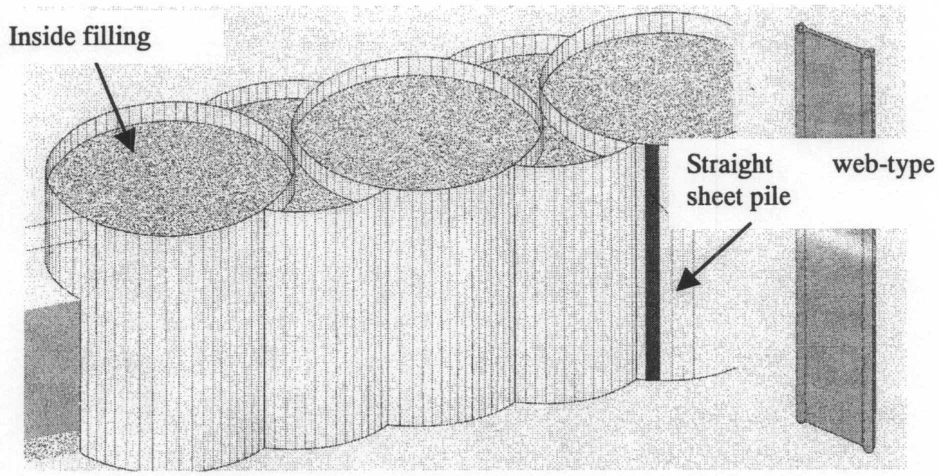
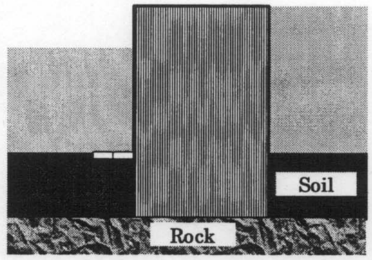
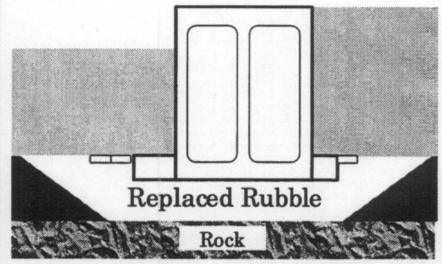


Figure 3.1.2 Prefabricated Steel Sheet Pile Cellular-bulkhead Quaywall

Sheet pile cellular-bulkhead quaywall is compared roughly with concrete caisson in **Table 3.1.1**. This Table compares both structures as for environment in installation and reclamation, construction period and cost, and durability. There are two differences between them, as in environment in installation and construction period. In construction (installation) of sheet pile cellular-bulkhead quaywall, driving sheet piles and then inside filling can keep seawater clean from contamination. On the other hand, in construction of concrete caisson, rubble replacing may make seawater dirty.

Furthermore, casting, haulage and emplacement of concrete caisson need generally longer time than driving sheet piles. Both structural types are even in construction cost and durability. Additionally, casting work and concrete plant need large sized area near the construction site in case of concrete caisson. Consequently, sheet pile cellular-bulkhead quaywall is recommended in this Study.

Table 3.1.1 Comparison between Sheet Pile Cellular-bulkhead Quaywall and Concrete Caisson

	Prefabricated Steel Sheet Pile Cellular-bulkhead Quaywall	Concrete Caisson
Side view		
Environment in erection	Good	No good (due to replaced rubble)
Environment in reclamation	Good	Good
Construction period	Short	Mediate
Construction cost	Mediate	Mediate
Durability	Good	Good
Evaluation	Recommended	Mediate

3.2 Container Terminal Planning

There is a plan to use the artificial island for a container terminal in the future. In this chapter, container terminal planning is studied to set artificial island size and its location.

3.2.1 Artificial Island Size

3.2.1.1 Target Vessel

Recently, the size of container vessels has become larger and larger to economize transportation costs and this trend has also been introduced into feeder vessels services. Historically, Panamax size containers vessels with an overall length of 294 m and a breadth of 32.6m have been built to enable to pass the Panama Canal, maximizing the number of containers loaded on ship. Upon the implementation of the Third Locks Project, it will be possible for container vessels much larger than Panamax vessels to pass the Panama Canal. Hence, in this Feasibility Study, the dimensions of the target vessel shall be in accordance with those of the Third Locks Project as mentioned below.

Length Overall (LOA)	:	385.7m
Breadth	:	54.9m
Draft	:	15.2m
DWT	:	105,000
TEU	:	10,500

Considering above ship dimensions, it can be assumed that target vessels can carry 21 rows of containers on the deck.

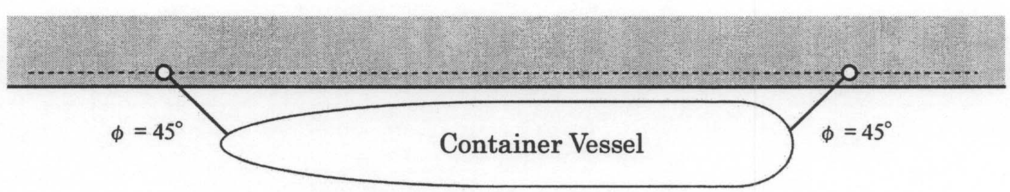
3.2.1.2 Container Demand Forecast

Balboa Port is, at present, playing an important role as a transshipment port in the Pacific Ocean side of Panama and Panama Port Company has a vision to expand Balboa Port to receive a growing number of containers in the future although the available onshore area seems narrow to handle potential demand of containers. The number of containers to be handled in Panama in the year 2025 has been projected to be approximately 5,690,000 TEUs as a medium transshipment scenario by the ACP Study. Under such circumstance, it can be assumed that the Artificial Island Port will receive approximately 1,000,000 TEUs for the year 2025 in consideration of the allocation each other.

3.2.1.3 Berth Dimensions

The container terminal should be designed to accommodate the target vessels as mentioned in Chapter 3.2.1.1, with a draft of 15.2m fully loaded. The length of the container berth is determined to receive the design vessel length and bow and stern mooring space. Suppose the mooring angle of vessels is 45 degrees considering that the berth line is continuous and straight, the length of the berth can be calculated to be 450m by the following formula.

Length of Container Berth = 385.7 m + 2 x (54.9/2 + 2.0) = 444.6 m → 450 m



3.2.1.4 Number of Container Berths Required

Using the container traffic forecast by ACP, the number of container berths required in the year 2025 could be determined by the following formula.

Nb = My / (Ec x Nc x (1+Rf) / (Dy x Hd) / Br

Where;

Nb	:	Required number of container berths	
My	:	Container throughput (in TEUs) in the year 2025	1,000,000 TEUs
Rf	:	Ratio of 40 foot containers	80%
Ec	:	Container handling productivity per hour	25 Boxes
Nc	:	Number of gantry crane to be allocated	2 Nos.
Dy	:	Annual operational days	356 Days
Hd	:	Working hours per day	20 Hours
Br	:	Berth occupancy rate	0.40

Nb = 1,000,000 / (25 x 2 x 1.8) / (20 x 356) / 0.40 = 3.90 → 4 berths in 2025

The required number of container berths (Nb) has been calculated to be 3.90. Therefore, four (4) container berths, each of which is equipped with two (2) gantry cranes should be planned to accommodate the prospected number of containers in the year 2025. Two (2) berths are to be planned additionally in the year 2035 provided that the container cargoes increase with an annual growth rate of five (5) percent.

3.2.1.5 Depth of Container Terminal

The area for land needed for a container terminal depends on the availability of land and soil conditions. In this case, the sufficient depth of the container terminal should be secured to cope with a growing number of container cargoes taking into account the stacking method in the yard and necessary facilities in the container terminal.

In the case of Yokohama Port, one of the biggest ports in the Tokyo Metropolitan area, Japan, the Port has recently installed mega quayside gantry cranes with an outreach of 63 m in order to accommodate container vessels, having 22 rows on the deck. Yokohama Port, handling approximately 2.3 million TEUs in 2002, has a depth of 500 m for the container terminal.

The number of grand slots in the container yard should be maximized to stack containers as many as possible in the terminal. Hence, considering the future increase in container cargoes and future deployment of larger size container vessels, a depth of 500 m for the container terminal would be planned.

3.2.1.6 Phase-wise Development

(1) Phase I

As the transshipment study by ACP is targeted at the year 2025, the Phase I development of the Artificial Island Project can be set as the same year as well. Based on the required number of container berths, the Phase I development has been determined. Also, dredging plan has been planned phase-wisely to achieve cost effective development.

(2) Phase II

The Phase II development is targeted at the year 2035, which is 10 years later of the Phase I. Two (2) additional container berths would be provided to meet the container demand in 2035 and additional work for dredging and the construction of onshore facilities is required.

3.2.1.7 Reserved Area for Future Commercial Activity

Two (2) liquid cargo berths are provided to receive bunker oil for container vessels at the area with a depth of -12.0 m. No dredging is necessary to accommodate 30,000 DWT class tankers at the future liquid cargo berth area and tidal operation is not needed for such size of tankers. Some tank storages are also to be provided onland to stock oil.

Bunker oil can be transported from the storages to the container berth through pipelines.

Once the Artificial Island is constructed by use of the material generated from the Third Locks Project, various distribution facilities would be located near the container terminal. Also, expected are various commercial activities on the Island to be generated.

3.2.2. Access Channel and Turning Basin

3.2.2.1 General

The design of an access channel encompasses a number of disciplines including ship handling and maritime engineering in order to ensure a desired level of navigation and safety. Access channel design involves layout planning including dimensions of the water area with reference to the following items.

- Depth of the channel
- Alignment and width of the channel
- Size and shape of maneuvering

PIANC (Permanent International Association of Navigation Congress) is applied in determining the required width/space of the access channel and turning basin.

3.2.2.2 Channel Depth

Container vessels should approach or leave the berth without appreciable delay. Therefore, the channel depth for container vessels, in principle, should be determined without considering tidal operation which may impose the vessels to wait for flood tides. Adequate provision for clearance beneath vessels and under keel clearance is needed to ensure that vessels do not ground during navigation of the channel. The depth of water needed by container vessels is determined by its sailing draft and sufficient additional clearance (under keel clearance). In general, the required additional water depth is almost equal to 10% of the draft. More detailed, the required clearance varies depending on the size of vessel, its speed, extent of the channel, wave conditions, current conditions, and wind conditions.

The following are requirements to be taken in calculating the water depth in the channel.

- Loaded vessel draft including trim
- Squat
- Wave spectrum
- Safety clearance
- Dredging tolerance
- Advanced maintenance dredging

[Loaded draft]

A fully loaded draft of 15.20m for the target vessel as mentioned in Chapter 3.2.1.1 has been adopted.

[Squat]

Squat is the combined effect of sinkage and trim due to the forward velocity of the vessels. It is noted that accurate prediction can be made by the use of computer models developed for squat in both calm water and waves.

[Wave spectrum]

In a channel subject to wave action, it is important to ensure that adequate underkeel clearance is available to accommodate ship motions generated by waves. Since the Artificial Island area is protected by Taboga and Taboguilla Islands from south direction waves, resulting in little consideration on wave spectrum.

[Safety clearance]

A net underkeel clearance should be considered depending on the channel bed condition. A safety clearance of 0.6 m has been adopted because the seabed consists of sand or silts.

[Dredging tolerance]

An additional tolerance depth of 0.5 m has been considered since it is difficult to dredge the seabed accurately, depending on dredging equipment.

[Advanced maintenance dredging]

The magnitude of siltation has not been assumed yet although it might take place at the channel area. Therefore, an additional depth should be considered to secure necessary water depth before maintenance dredging is carried out.

Water density and its effect on sailing draft are not needed to be considered this time although it might be considered if vessels maneuver in a river or lake. It is noted that all dredging depths and draft are referred to Mean Lower Water Spring (MLWS) tide elevation. Considering the above under-keel clearance, the required depth of the access channel and the container berth is MLWS-16.75 m, which is almost same as the figure from the previous ACP Study.

3.2.2.3 Alignment of Channel

In principle, the access channel should be aligned to reduce the channel length without unnecessary bends if no restrictions are imposed in a waterway. Also, excessive impact to the maneuvering vessel by the wave force from behind should be eliminated because it may take time for vessels to stop under such conditions especially for large vessels. Two islands, namely Taboga Island and Taboguilla Island, could hinder from offshore waves. Avoiding shoals and rock crops appearing on the seabed is also important in setting up the alignment. As shown in Figure 3.2-1, the channel with an approximate length of 2.0 km has been aligned to pass between the two Islands where enough water depths are secured.

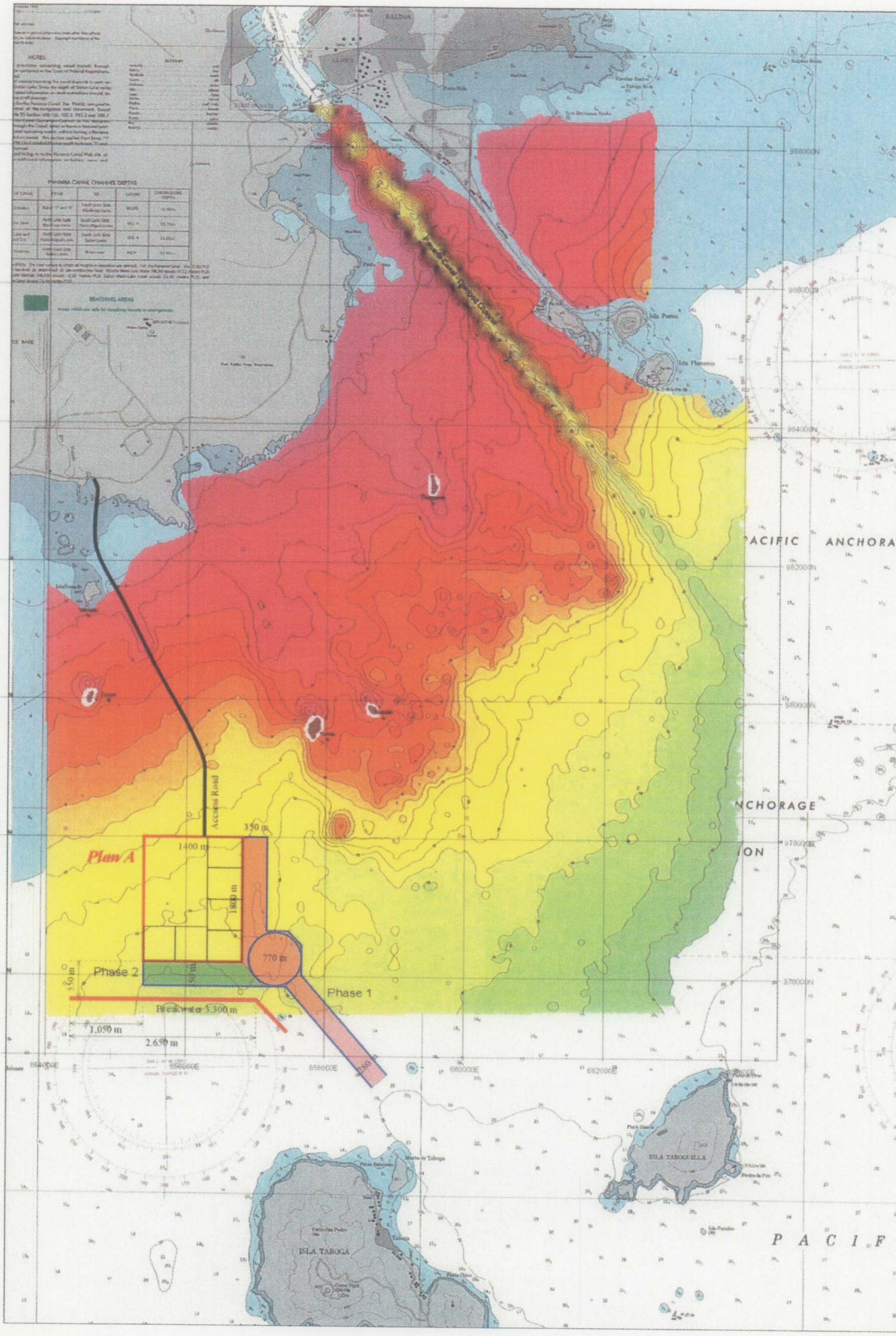


Figure 3.2-1 General Plan for Artificial Island

3.2.2.4 Channel Width

The minimum width of the channel is governed by the breadth of the largest vessel to pass and the relationship depends on a number of factors affecting the navigation including vessel speed, winds, currents, waves, bottom surface, waterway depth, cargo hazard level, ship clearance and bank clearance.

[Cross Wind]
Cross wind affects the vessels at all speeds, but will have its greatest effect at low ship speeds. It will cause the vessel to drift sideways or to take up an angle of leeway, both of which need an additional width for maneuvering.

[Current]
Cross currents affect a vessel's ability to maintain maneuvering in the channel. As analyzed in Chapter 5 "Current Analysis", the current in the channel after the construction of the Artificial Island might not cause any affect on the vessel navigating the channel due to the result that the speed of the currents would be less than one (1) knot.

[Waves]
Waves naturally have an effect on channel depth. If the wave fronts move across the channel, they will also have an effect on maneuvering, and hence channel width.

The breadth of the target vessel is 54.9 m which is 1.7 times of that of Panamax vessels. It is costly for dredging the channel based on only the dimensions of the largest vessels to be called. Also, as explained in Chapter 3.2.2.4, the length of the channel is approximately two (2) km. It is therefore suggested that the initial channel width should be 280 m which equals five (5) times of the breadth of the target vessels. However, it is noted that exactly required and optimum width of the channel should be determined by above considerations and by use of ship simulations in the succeeding detailed planning.

3.2.2.5 Side Slope

It is too early to employ mathematical methods to determine the most appropriate side slopes for the channel. The side slope of the dredged channel and basin can be determined based on experience of slope behavior under similar soil and hydrodynamic conditions. In this case, the slope of one (1) in five (5) has been adopted for dredging the access channel and the turning basin.

3.2.2.6 Navigation Aids

Navigation aids along the channel and turning basin would be mandatory. Channel entrance buoys, channel marker buoys, and basin marker buoys are to be provided for safe maneuvering. The number of the buoys will be increased in accordance with the dredging plan. Also, safety markers and light beacons are to be installed.

3.2.2.7 Turning Basin

The area of a turning basin should be determined considering the conditions such as the size of vessels, sea and weather condition and the number of tug boats to be used for assistance. A turning basin should have a diameter of two (2) fold of the largest vessel length if tug assistance is provided. Therefore a diameter of 700m has been adopted for the turning basin. The turning basin should be allocated to enable the vessels to approach the container berth safely.

3.2.3. Container Terminal Layout Alternatives

3.2.3.1 Concept of Terminal Layout Planning

At present, there is a variety of operation systems used around the world. These vary extremely sophisticated and virtually fully automated handling concepts to fairly simple operation practices. There are four (4) commonly applicable container handling system such as Transfer Crane System , Straddle Carrier System, Reach Stacker System and Forklift System, each of which has advantages and disadvantages as summarized in Table 3.2-1. The choice of yard handling and stacking method is fundamental to terminal design, its performance and its cost. The decision on the container handling system affects the area and arrangement of the stacks and the strength of the pavement needed and can have significant effect on the capital and running costs of the container terminal. According to the overall evaluation, the Transfer Crane System is recommended.

Table 3.2-1 Comparison of Yard Handling Systems

Evaluation Item	Forklift System	Reach Stacker System	Straddle Carrier System	Transfer Crane System
Handling Capacity	Small	Slightly small	Normal	Large
Storage Capacity	Small	Slightly small	Normal	Large
Initial Investment	Small	Small	Slightly High	High
Adaptability by Several Operators (Stevedore)	Acceptable	Acceptable	Acceptable	Acceptable
Computerization	Difficult	Difficult	Difficult	Suitable
Pavement	All Heavy Pavement	All Heavy Pavement	All Heavy Pavement	Travelling Lanes only Heavy Pavement
Damage of Container	Large	Large	Slightly large	Small
Flexibility of Operation	Flexible	Flexible	Flexible and simple	Small
Required Stacking Area	Huge	Huge	Slightly Large	Small
Overall Evaluation	Not Recommended	Not Recommended	Normal	Good

3.2.3.2 On-land Facilities

(1) Container Yard

The container terminal requires extensive space for marshalling containers including empty and reefer containers. The required space for container stacking and marshalling is dependent on container handling system to be employed such as transfer crane system, straddle carrier system, reach stacker system, and forklift system. The transfer crane system will be applied for the container terminal at the Artificial Island since the stocking capacity is large and future computerized system is possible. The depth of the terminal has been set to be 500 m as explained in Chapter 3.2.1.5. The detailed layout of the container yard is shown in Figure 3.2-2.

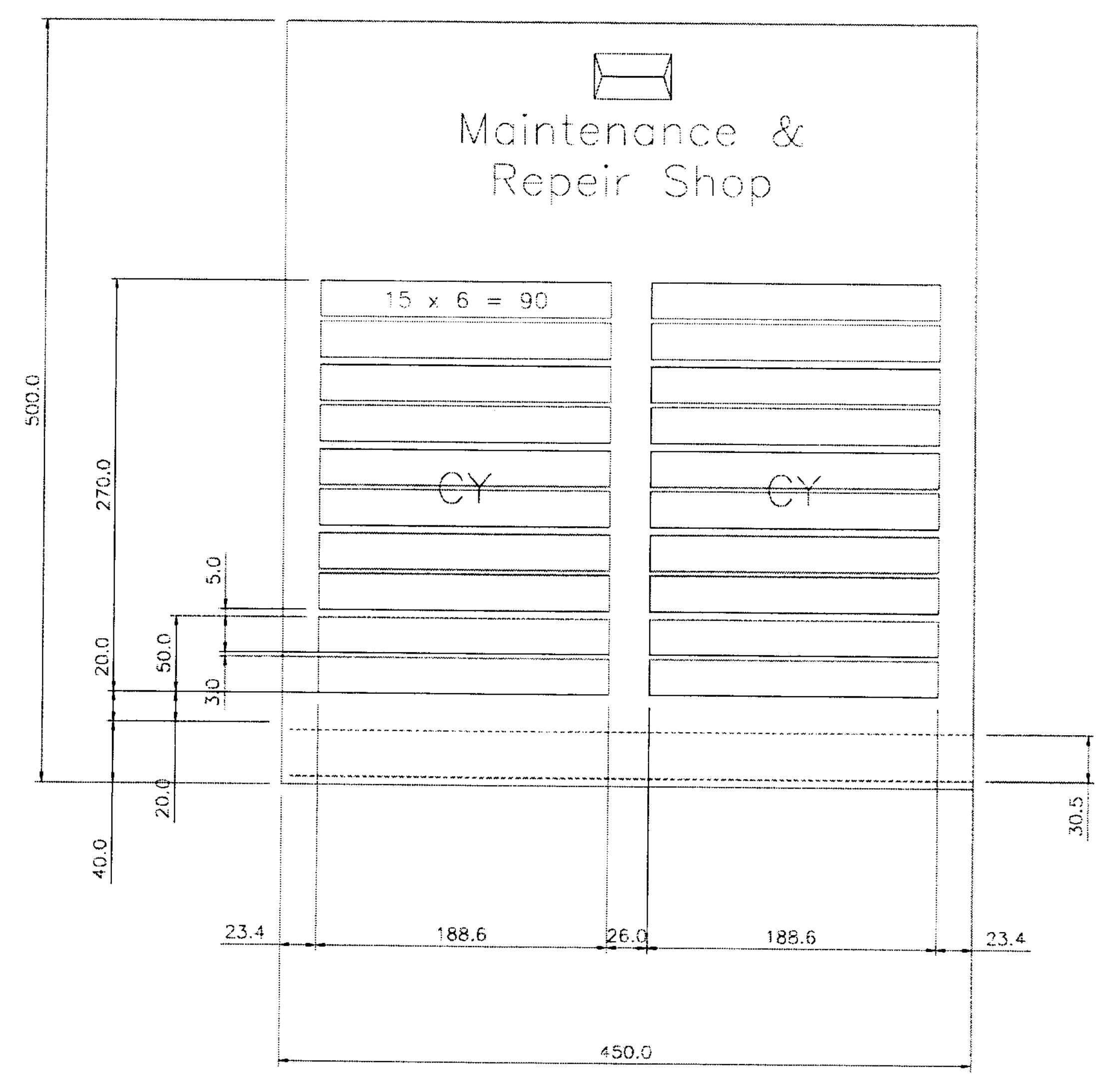


Figure 3.2-2 General Container Yard Arrangement Plan

(2) Container Freight Station

In general, a container freight station (CFS) is provided in the terminal for handling LCL (Less than Container Load) containers for stuffing or un-stuffing work. Also, the CFS is not always situated inside the terminal and it should be located at the convenient place for transportation. Since the Artificial Island handles transshipment containers in most cases, it is not necessary to construct a CFS in the terminal.

(3) Gate

The gate is a facility for performing the works of transfer of documents required containers move in and out of the terminal. Enough number of lanes should be provided to reduce the waiting time at the Gate. The Gate should be located functionally to streamline the movement of trucks in the container yard. Two (2) Gates will be provided in the Island.

(4) Maintenance & Repair Shop

Maintenance & Repair Shops are situated functionally to maintain and repair cargo handling equipment and containers including reefer. The scale of the Maintenance & Repair Shop should be designed to accommodate transfer cranes, forklifts, and containers in the Shop and the Shop should be located considering transfer crane's accessibility. In addition, other equipment such as forklifts, top lifters can be stored in the Shops. Three (3) Maintenance Shops are provided in the Terminal.

(5) Administration Office

The Administration Office, accommodating an administration department should be located, in general, adjacent to the entrance of the terminal to provide pivot functions such as collection.

(6) Other Facilities

Water tower, electric substation, garbage shed would be provided in the container yard as well.

3.2.3.3 Equipment

(1) Quayside Gantry Crane

Considering the size of the target vessels, quayside gantry cranes should have an out reach of 60m, having a rail span of 30m.

(2) Transfer Crane

Transfer cranes are installed for stacking loaded containers to the designated module. In general, three (3) transfer cranes (rubber tire type gantry cranes) are provided for each quayside gantry crane to maximize the operation of the gantry cranes. If two (2) numbers of transfer cranes are employed per quayside gantry crane, the efficiency of container handling tends to be controlled by the efficiency of the transfer crane.

(3) Other Equipment

Forklift and reach stackers are expected to be installed for container cargo handling in the yard.

3.2.3.4 Container Terminal Layout Alternatives

(1) Plan-A

Plan-A is located at the north end of N978,000 and the east end of E656,800 as shown in Figure 3.2-3. Plan-A is located approximately 1,500 m south of the location of the ACP Study in December 2001. Plan-A has four (4) container berths on the east side of the Island as the Phase I development, while two (2) berths are to be provided on the south side as the Phase II development. The area of the Island is 252 hectares, extending 1,800 m from the south to the north and 1,400 m from the east to the west. The red colored area will be dredged for the Phase I development, while the blue area is for the Phase II development. A rubble mound type breakwater with a length of 3,300 m is provided to secure defined calmness in front of the container berths as detailed explained in Chapter 4 "Wave Calmness Analysis". Figure 3.2-4 depicts the layout of the Island for Plan-A.

The length of the access channel is approximately 2.0 km extending to the southeast direction. The alignment of the channel has been determined to avoid the shallow area, which appears in the bathymetric map. A turning basin with a radius of 770m is provided at the east of the Island. An accessway is configured to minimize the quantities of the materials to be used for the Accessway.

(2) Plan-B

The northeast corner of Plan-B is same as that of Plan-A. Plan-B as shown in Figure 3.2-5 has an area of 198 hectares, extending 1,800 m from the north to the south and 1,100 m from the east to the west. Four (4) container berths are provided on the east side of the Island and two (2) berths are to be secured on the west side. Two (2) turning basin with a radius of 770 m should be provided, one is situated on the west of the Island and the other is on the east of the Island. No breakwater is needed to secure defined calmness in the berths as detailed in Chapter 4. Figure 3.2-6 depicts the layout of the Island for Plan-B.

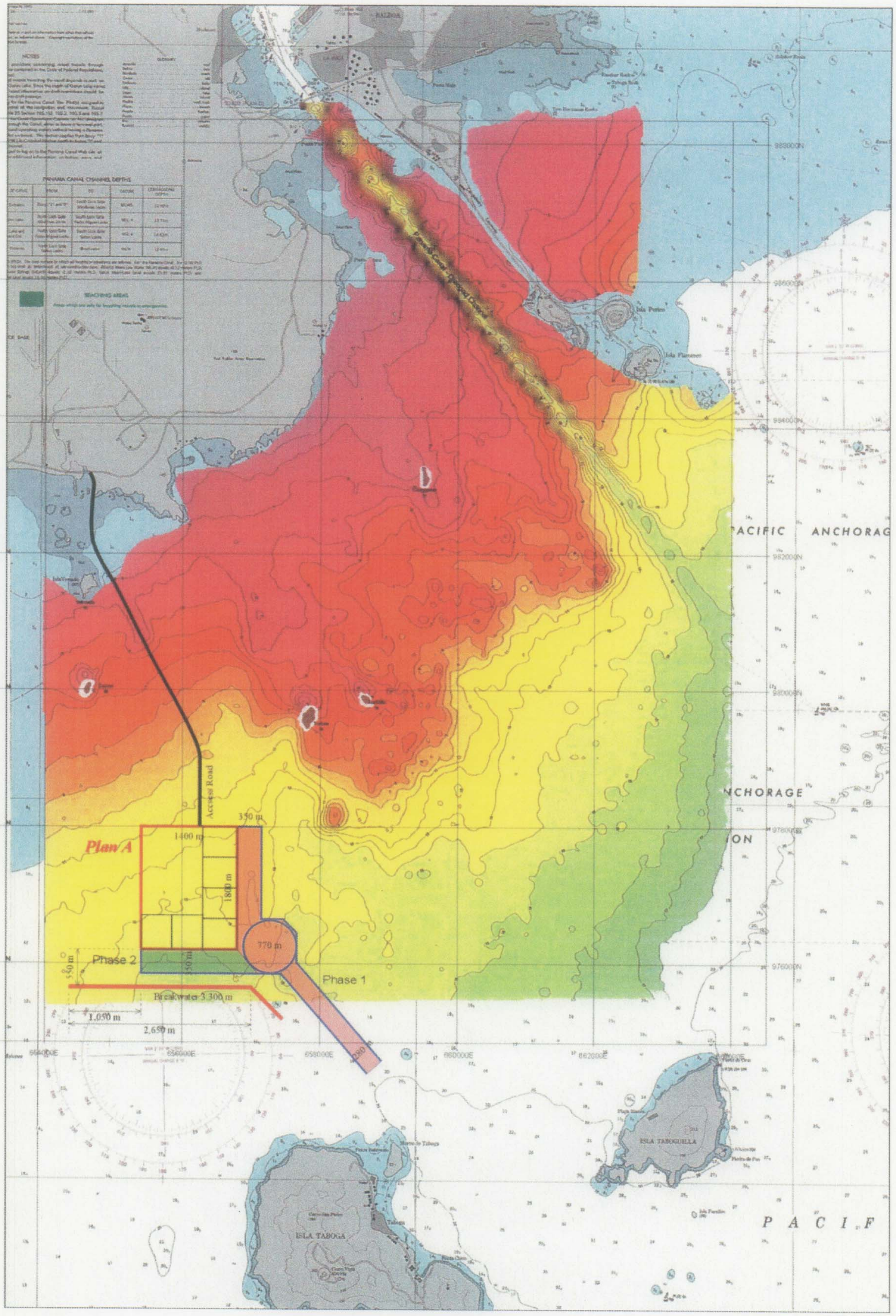


Figure 3.2-3 Plan-A

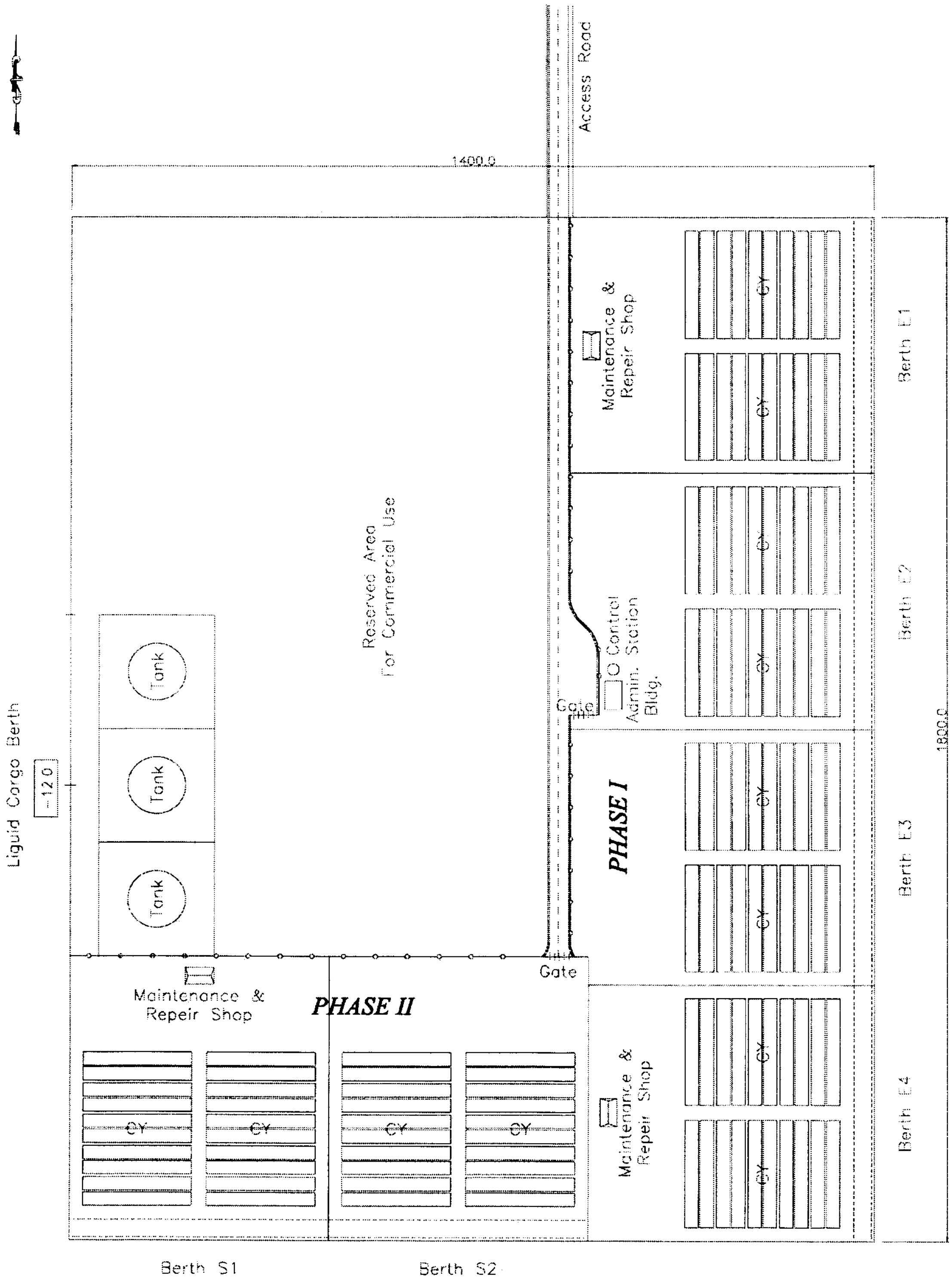


Figure 3.2-4 Detailed Layout for Plan-A

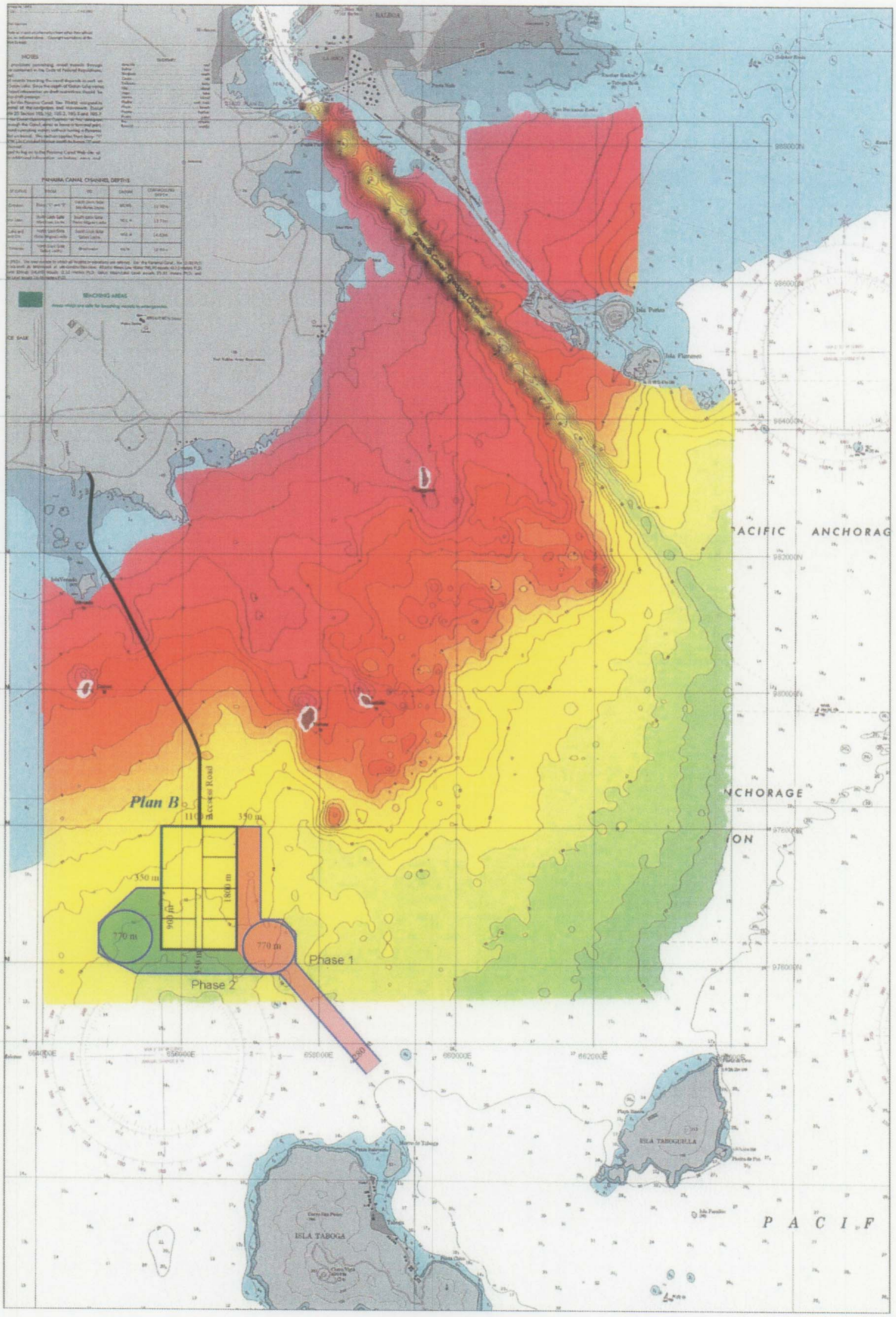


Figure 3.2-5 Plan-B

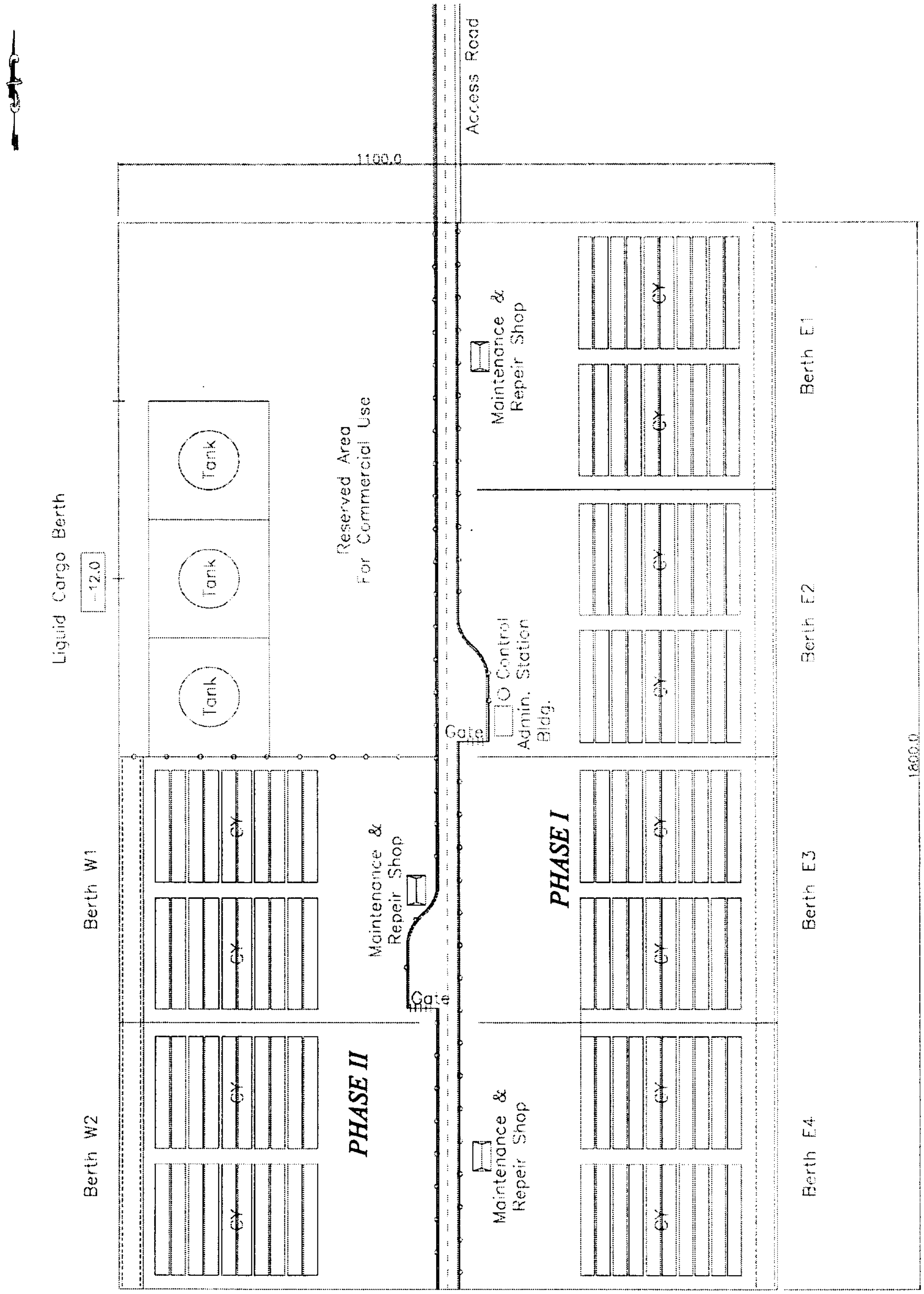


Figure 3.2-6 Detail Layout for Plan-B

(3) Plan-C

The northeast corner of Plan-C is same as those of Plan-A and Plan-B. Plan-C as depicted in Figure 3.2-7 has an area of 198 hectares, extending 2,700 m from the north to the south and 733 m from the east to the west. Six (6) container berths are provided on the east side of the Island. Northern four (4) berths are for the Phase I development and the remaining southern two (2) berths are provided for the Phase II development. One (1) turning basin with a radius of 770 m is located on the east of the Island. The length of the channel is approximately 2,300 m a bit longer than those of Plan- B' and C. No breakwater is needed to secure defined calmness in the berths as detailed in Chapter 4. Figure 3.2-8 depicts the layout of the Island for Plan-C.

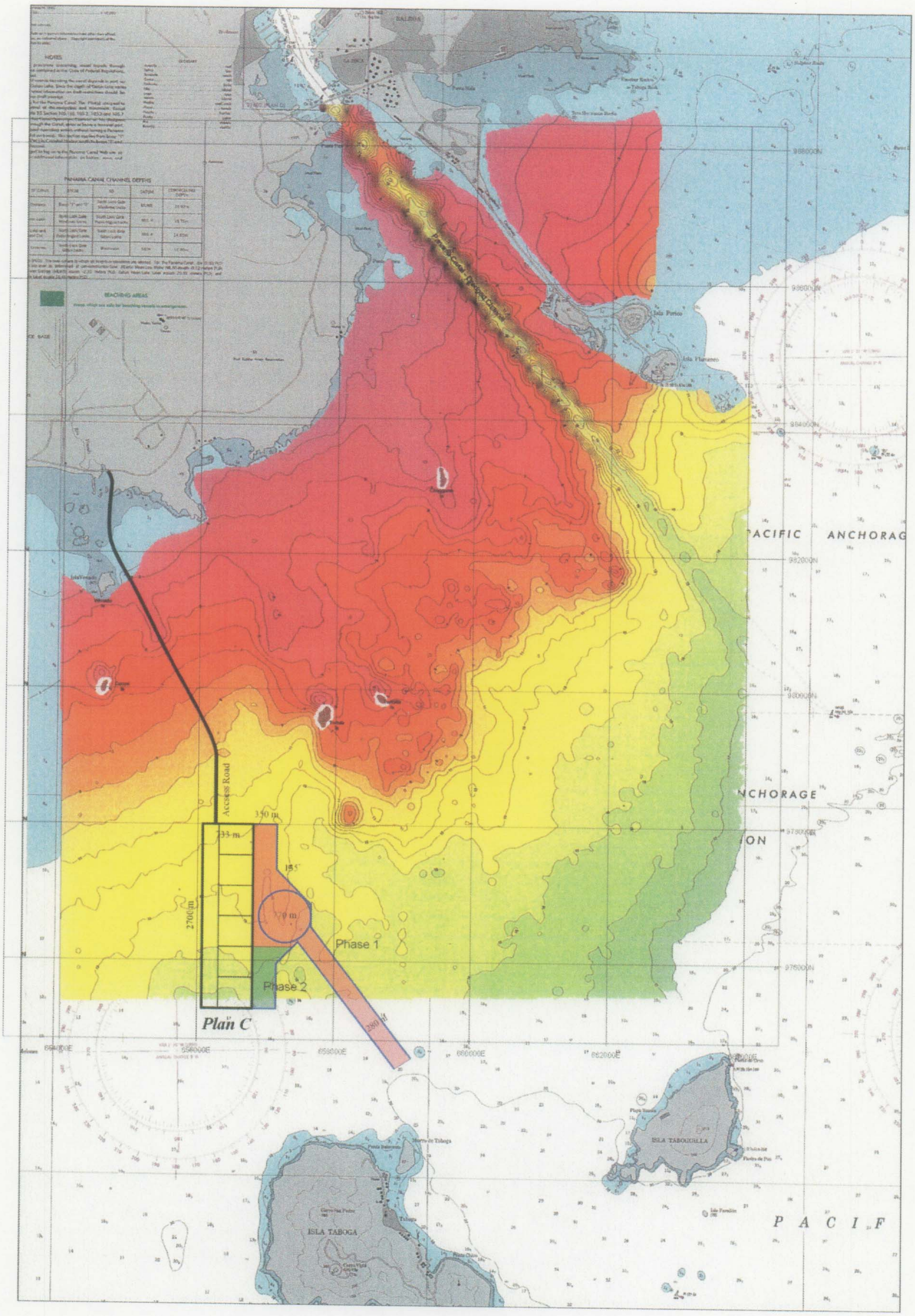


Figure 3.2-7 Plan-C

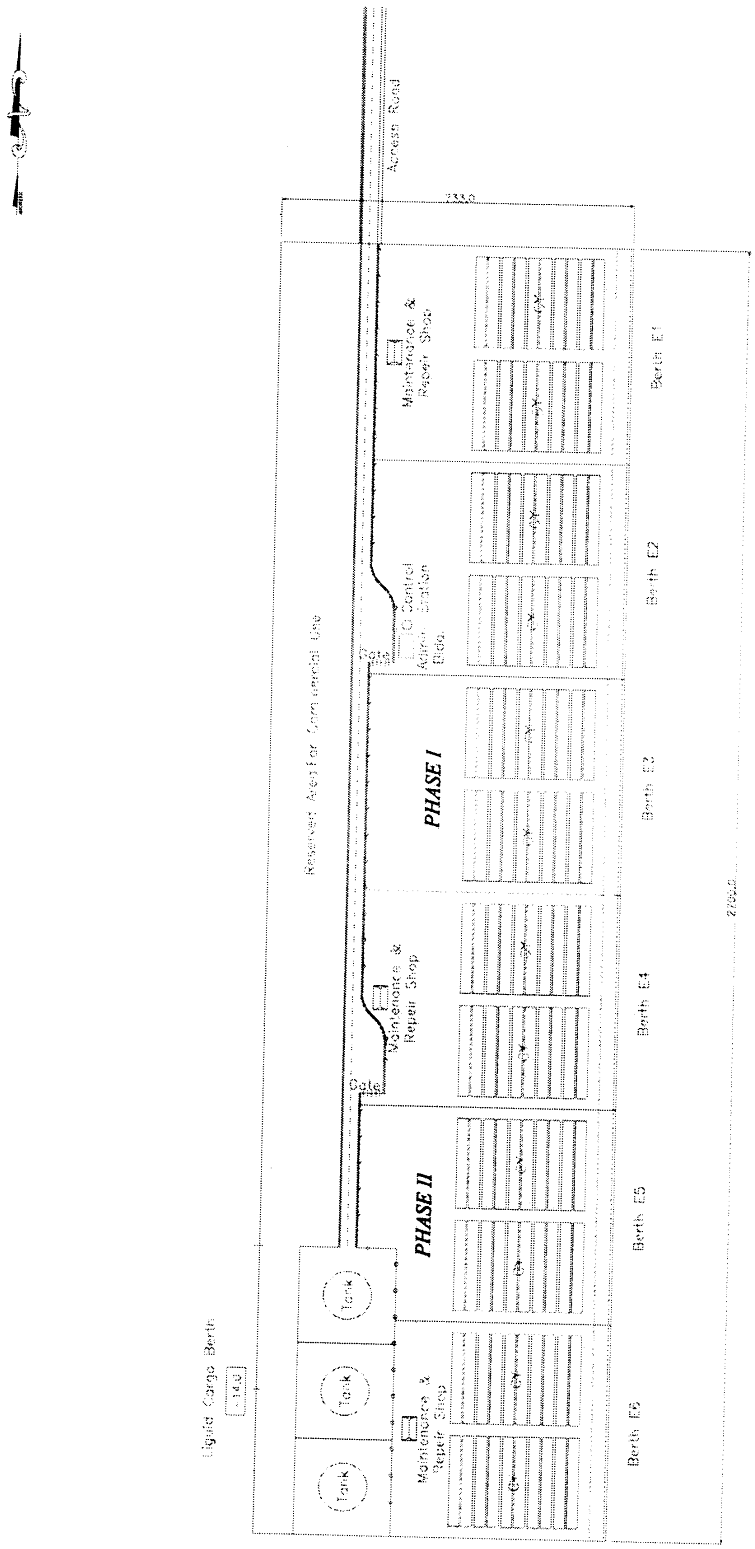


Figure 3.2-8 Detail Layout for Plan-C

3.3 Artificial Island Location

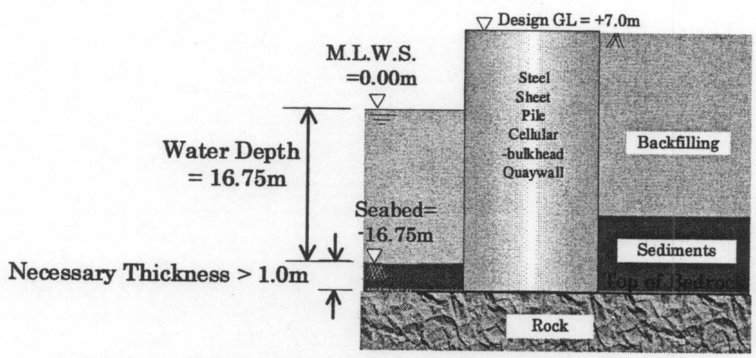
3.3.1 Study Area

Location of Artificial Island is studied within the same area as Pre-feasibility Study in 2002. That is the oceanic area enclosed by the Entrance to the Panama Canal, the Cape Bruja, Taboga Island and Taboguilla Island.

3.3.2 Location on North-South Direction

As shown in Section 2.3, the existing seabed level becomes gradually deeper according to going offshore southbound from landside.

Necessary depth for the berth facility is planned as MLWS –16.75m. Roughly estimating the unevenness of existing seabed level at 1 m, the shallowest level of installment of steel sheet pile cellular-bulkhead quaywall should be set to MLWS –18m. This minimum depth is illustrated in **Figure 3.3.1**.



Minimum depth of bedrock
< M.L.W.S. –16.75m - 1.0m = -17.75m ⇨ -18.0m

Figure 3.3.1 Minimum Depth for Installment of Cellular-bulkhead Quaywall

If Artificial Island is constructed on the shallower rock layer than MLWS –18 m, the construction cost can increase considerably due to huge excavation volume of stiff rock layer.

On the other hand, the farer away from landside to offshore (southbound) the construction site is located, the larger the infrastructures becomes, such as the sectional size of cellular-bulkhead quaywall and the total length of Accessway. It follows that the construction cost will be much more expensive.

In this study, the following alternative cases are compared in terms of construction cost to decide the best location of Artificial Island on north-south direction. The layout of the Island for Plan-B in Section 3.2 is used for this comparison.

a) Location I (see **Figure 3.3.2**)

Artificial Island is located to correspond the north edge of Island with the contour line of rock layer level of MLWS -18 m. There is no need to excavate stiff rock layer in this case.

b) Location Alternative II-a (see **Figure 3.3.3**)

Artificial Island is located to correspond the south edge of Island with the south edge of Location P1 defined in ACP Report "Preliminary Study of Island Development at the Pacific Entrance of the Panama Canal". In this case, rock excavation is needed to construct two berths in north side of island, but not needed to construction four berths in south side.

c) Location Alternative III (see **Figure 3.3.4**)

Artificial Island is located to correspond the north edge of Island with the north edge of Location P1 defined in ACP Report as well. Though there is a merit in this case of reducing the total length of Accessway, huge quantity of stiff rock have to be excavated for all six berths unfortunately.

d) Location Alternative II-b

The location of Artificial Island is the same as Location Alternative II-a. However, the necessary depth of berth is changed to MLWS -13.5 m for the first northern berth and MLWS -14.5 m for the second northern berth. This case allows intentionally the reduction of berthing ability of two northern berths, in which the berth depth should have been MLWS -16.75 m originally. Other four (southern) berths can keep the sufficient depth of MLWS -16.75 m.

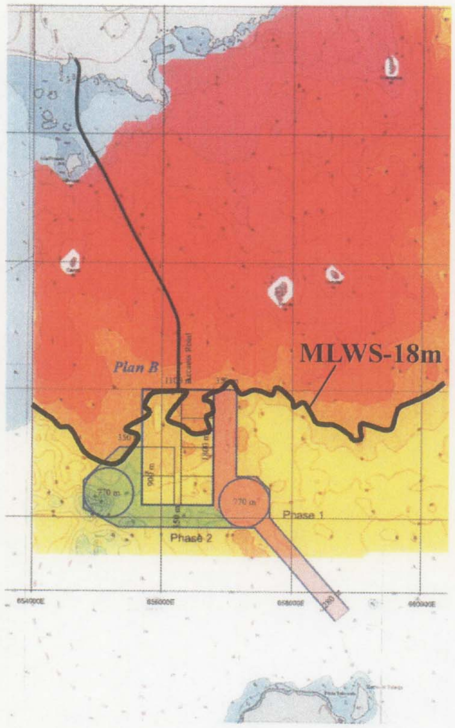


Figure 3.3.2 Location Ⅰ

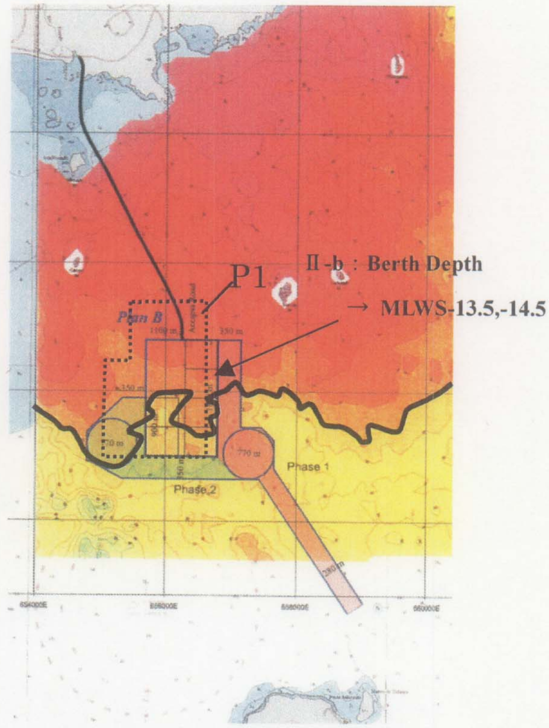


Figure 3.3.3 Location Ⅱ-a and Ⅱ-b

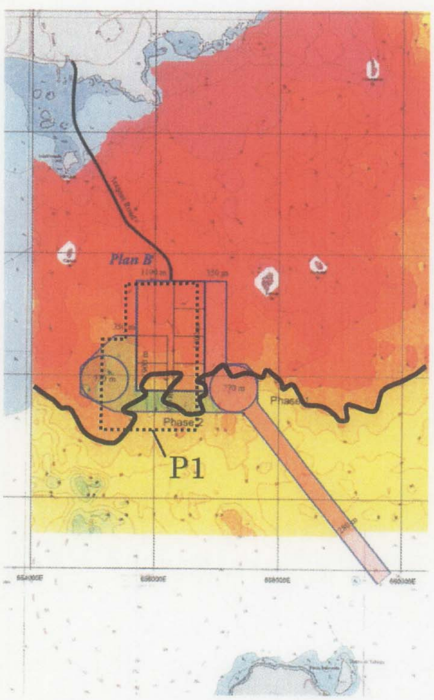


Figure 3.3.4 Location Ⅲ

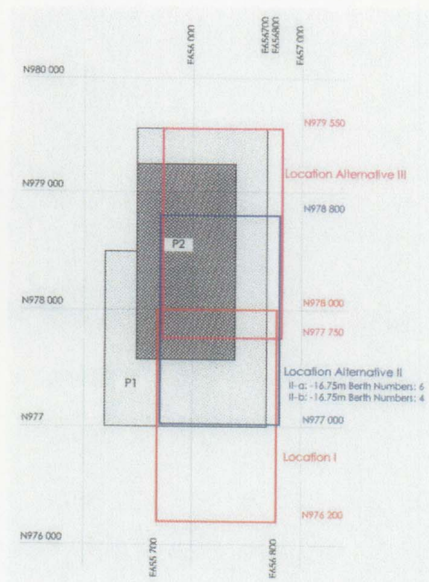


Figure 3.3.5 Comparison of Location

Table 3.3.1 Comparison of Location Alternatives

	Location I	Location Alternative II-a	Location Alternative III	Location Alternative II-b
1. POV				
1.1 Artificial Island Location	On the northern limit without rock dredging [Latitude] North end: N978 000 South end: N976 200	South end latitude is equal to the one of ACP-P1 [Latitude] North end: N978 800 South end: N977 000	North end latitude is equal to the one of ACP-P1 [Latitude] North end: N979 550 South end: N977 750	= Location Alternative II-a [Latitude] North end: N978 800 South end: N977 000
1.2 Number of -16.75m berth	-16.75m berth: 4+2 = 6			-16.75m berth: 4 -14.5m berth: 1 -13.5m berth: 1
2. Features				
2.1 Length of accessway	5,525m [Base]	4,645m [-880m]	3,820m (same as ACP-P1) [-1,705m]	= Location Alternative II-a
2.2 Reclamation Volume	39 Mm3	37 Mm3	34 Mm3	37 Mm3
2.3 Dredging volume	Soil: 9.0 Mm3 Total: 9.0 Mm3	Soil: 11.0 Mm3 Rock: 0.4 Mm3 Total: 11.4 Mm3	Soil: 12.3 Mm3 Rock: 2.0 Mm3 Total: 14.3 Mm3	Soil: 10.6 Mm3 Total: 10.6 Mm3
3.Construction Cost				
(1) Quaywall/Revetment	269 M US$	263 M US$	262 M US$	262 M US$
(2) Reclamation	96 M US$	93 M US$	88 M US$	93 M US$
(3) Accessway	99 M US$	85 M US$	72 M US$	85 M US$
(4) Dredging	65 M US$	139 M US$	371 M US$	76 M US$
Total Cost	529 M US$	580 M US$	793 M US$	516 M US$
4. Evaluation	AA	A	B	A

The result of comparison of these four Location Alternatives is shown in **Table 3.3.1** and **Figure 3.3.5**. The construction cost in **Table 3.3.1** includes that of Accessway.

In comparison of Location Alternatives I, II-a and III, it is obviously proved that the construction sites in northern side from the line of rock layer level of MLWS -18 m lead to be more expensive. This is because the cost-push for rock excavation is larger than the cost-down by shortening the total length of Accessway. Meanwhile, the construction cost is getting larger according to setting the construction site farer away to offshore (southern) direction as mentioned previously. Consequently, the cost minimum can be achieved when the Artificial Island is located to correspond the north edge of Island with the contour line of rock layer level of MLWS -18 m.

Actually, Location Alternative II-b can be constructed with cheaper cost than Location I due to no rock excavation. However, Location Alternative II-b can not keep satisfied berthing ability.

In this study, it is concluded that Location I is the best location for construction of Artificial Island on north-south direction.

3.3.3 Location on East-West Direction

As shown in **Figure 3.3.6**, rock layer level of Area A and B are especially deeper than MLWS –18 m. These Area A and B should be avoided from candidates for construction site of Artificial Island, in which the construction volume and cost become larger.
Meanwhile, rock layer forms marine valley in Area C. The soil volume of excavation (dredging) can be reduced when the construction site is set along this valley.
Therefore, the best location of Artificial Island on east-west direction can be achieved by corresponding the east edge of Island with valley line in Area C as indicated by enclosed area in **Figure 3.3.6**.

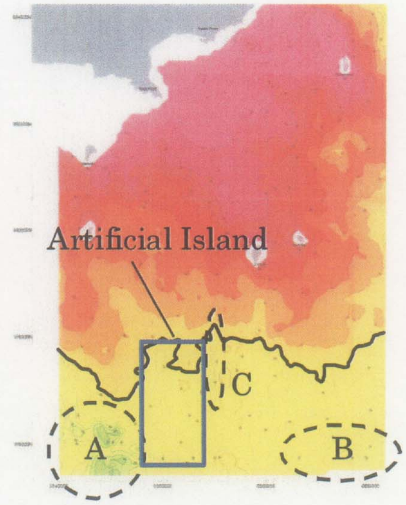


Figure 3.3.6 Level Contour of Rock Layer under Seabed

3.3.4 Recommended Location for Artificial Island

As a results of the above comparison study, the recommended location of Artificial Island is set to the followings (see **Figure 3.3.7**):

North Edge of Artificial Island: N978000

East Edge of Artificial Island: N656800

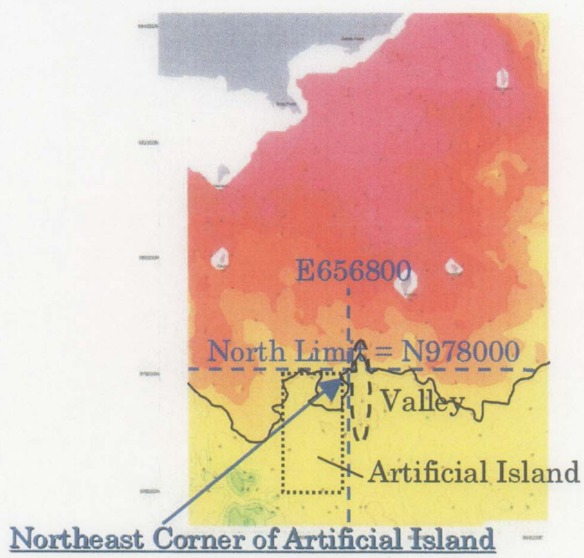


Figure 3.3.7 Best Location of Artificial Island

3.4 Accessway

The alignment of the Accessway has been determined as shown in Figure 3.4-1 to pass on the shallow area in order to reduce construction costs. Structures of the Accessway have been examined such as causeway as shown in Figure 3.4-2, bridge, and trestle as shown in Figure 3.4-3, while the best structure is causeway in terms of construction costs.

On the other hand, causeway could hamper currents and it might impact on the environment. Therefore, current analyses have been conducted as detailed in Chapter 5 and Appendix 3 for four (4) cases in terms of structure type such as causeway, causeway plus trestle, causeway plus bridge, and bridge. It is evident that the best structure from a view point of the environment is a bridge type. A 50 m length bridge will be constructed for small vessels' passage at the point where water depth is -5.0m (Zone 2).

Comparison of the construction costs for the Accessway has been made in three (3) structural types as explained in Table 3.4-1.

Table 3.4-1 Comparison of Accessway Types

	Type A	Type B	Type C
1. Structure of Accessway			
Zone 1	Causeway: 1,700m	Trestle: 50m*7=350m Causeway: 1,350m	Trestle: 1,700m
Zone 2	Bridge: 50m	Bridge: 50m	Bridge: 50m
Zone 3	Causeway: 3,775m	Causeway: 3,775m	Trestle: 3,775m
2. Impact on Current Flow (see Chapter 5)	B	A	AA
3. Construction Cost	$ 92 M.	$ 99 M.	$ 210 M.
4. Comprehensive Evaluation	B	AA	A

As a result, the selected structures were causeway plus trestle at the section shallower than -3.0 m (Zone 1) and causeway at the section deeper than -3.0 m (Zone 3).

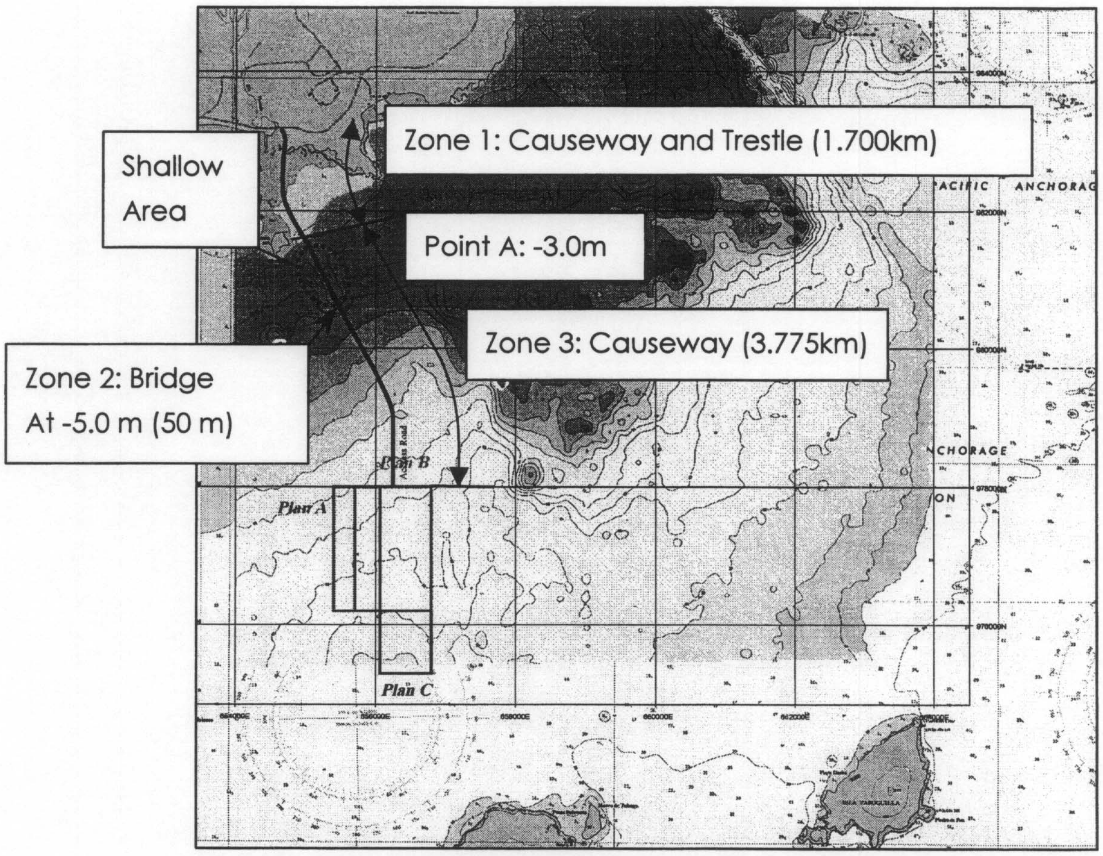


Figure 3.4-1 Layout of Accessway

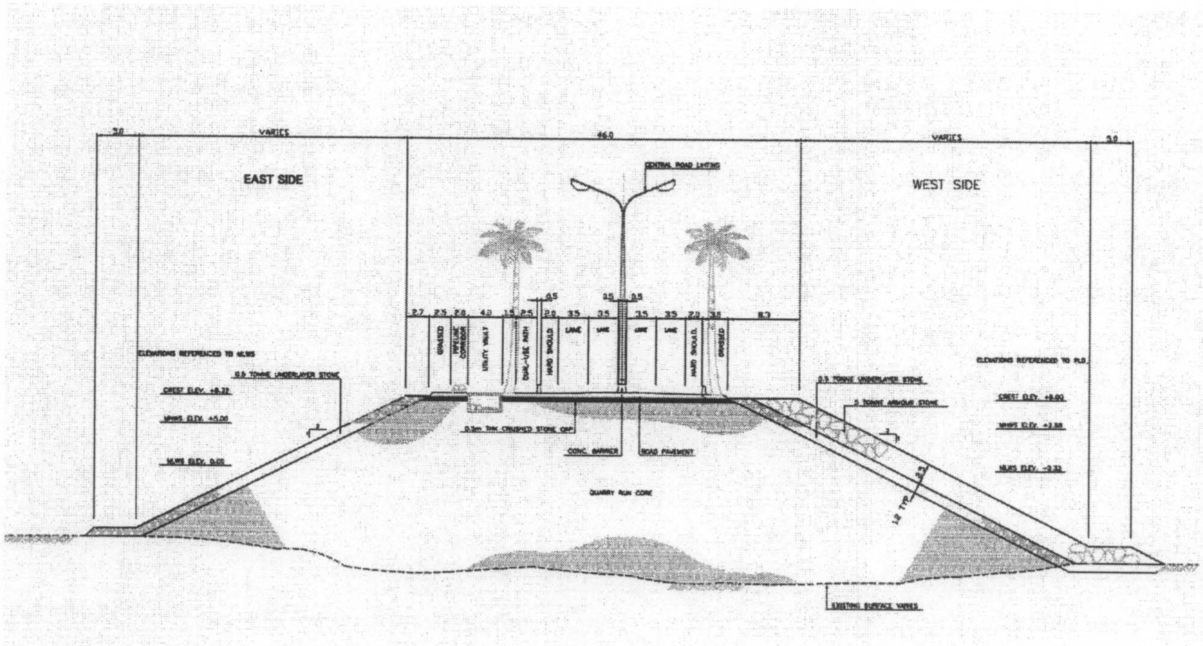


Figure 3.4-2 Cross Section of Causeway

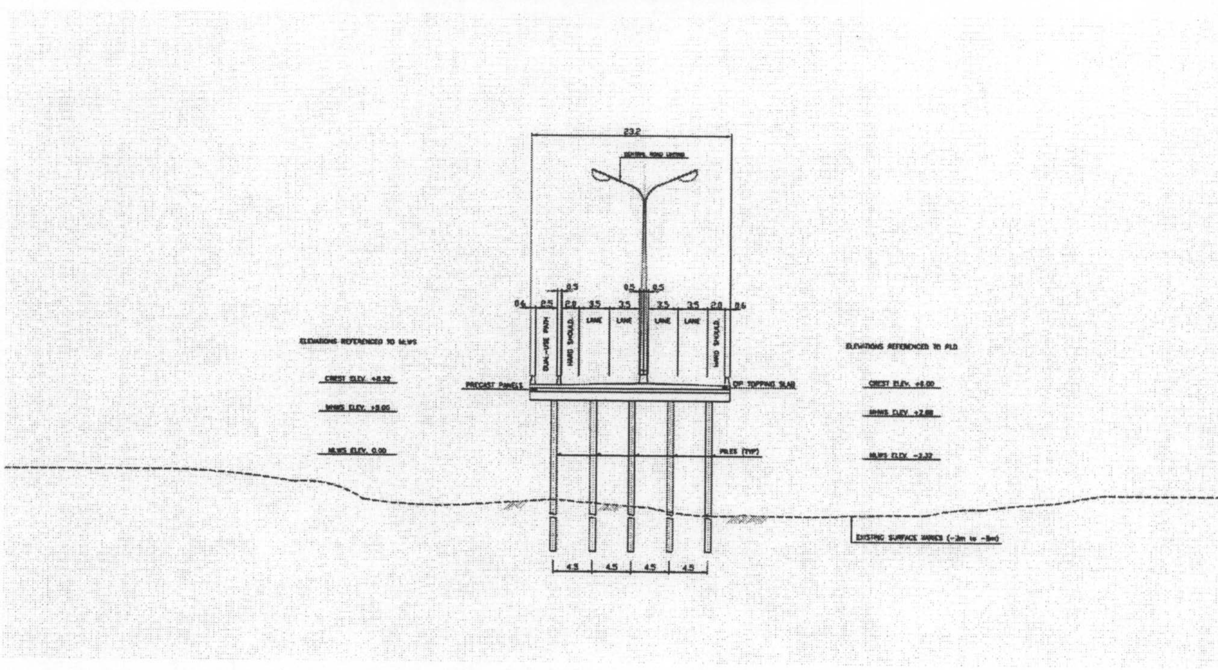


Figure 3.4-3 Cross Section of Trestle

CHAPTER4 Analysis of Wharf Operation Efficiency

4.1 Introduction

Based on the location of the artificial island presented in Chapter2 and 3, the effect of wave transformation and calmness of the existing basin condition due to the placement of the proposed artificial island were investigated in this chapter. And finally, wharf operation efficiency was calculated.

The objectives of this chapter are:

- To calculate the transformed wave climate in the region of the proposed artificial island under existing conditions
- To evaluate the wharf operation efficiency for cargo handling at each container berth

At first, offshore wave climate was investigated. Secondly, wave transformation from offshore to near-shore was analyzed. Thirdly, calmness around the proposed island was analyzed and lastly, using the above data, the wharf operation efficiency for cargo handling at each container berth was evaluated. **Figure 4.1.1** shows flowchart of examination.

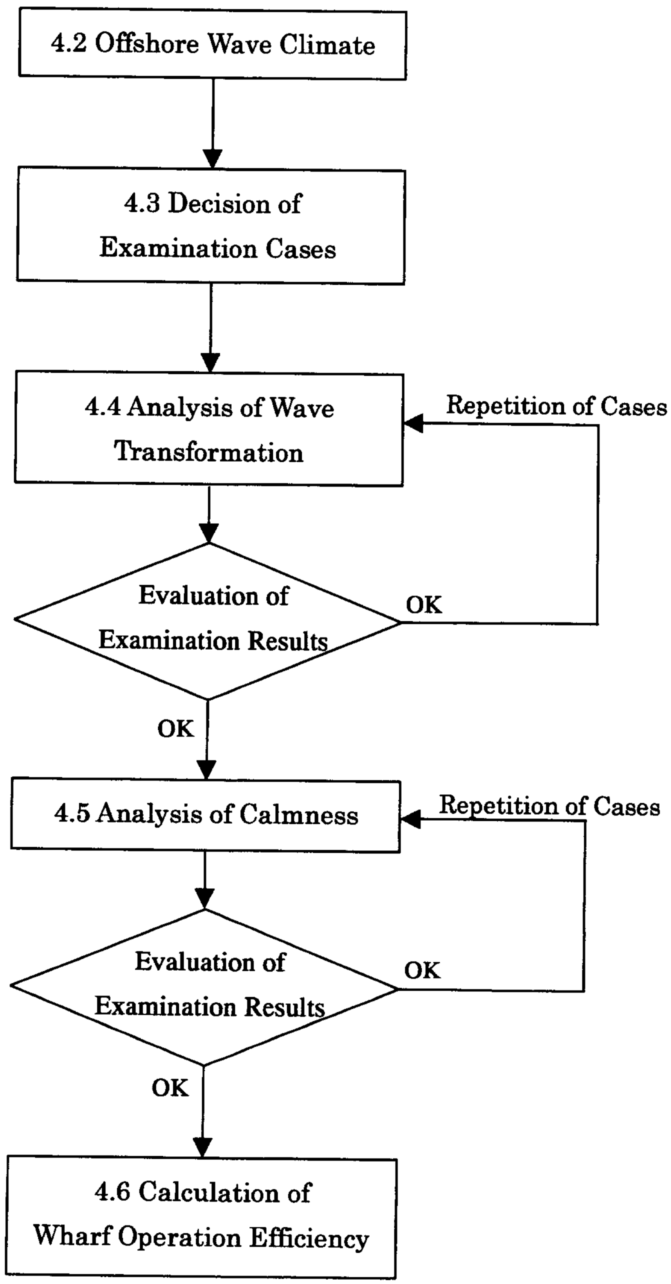


Figure 4.1.1 Flowchart of Examination

4.2 Offshore Wave Climate

A preliminary evaluation of the environmental conditions impacting the site was necessary to develop the appropriate modeling strategy.

A 31 year wave hindcast, from the start of 1970 through the end of the year 2000, was obtained from Oceanweather Inc. It was quoted from ACP report, 'WAVE TRANSFORMATION STUDY' by Moffat & Nichol Engineers. The hindcast utilized Oceanweather's CROW (Global Reanalysis of Ocean Waves) model to produce a time series of wave parameters at a location just offshore of the entrance to the Gulf of Panama. The GROW model provides global wind and wave hindcast data at grid points throughout the globe. The global oceans are divided into a 0.625 by 1.25 degrees latitude/longitude grid. Wave and wind fields are archived every 3 hours. For this study, the hindcast wave data was obtained for GROW2000 model grid point 30275 and included a time series of significant wave height, wave direction, and wave period, output every three hours for the entire 31 year period (1970-2000). This data was used as the offshore deepwater wave conditions. Grid point 30725 is located at 6.875° latitude and 280.0° longitude, just offshore of the Gulf of Panama near the southwest edge of the gulf mouth, shown on **Figure 4.2.1**. This point was selected because it is located in an area that captures the wave climate from the predominant directions expected to impact the site.

Wave energy can only reach the entrance to the Gulf of Panama from a restricted directional window due to the geometric shape of the Gulf itself and the surrounding geography (as can be observed in **Figure 4.2.1**). The offshore fetch to the south is limited by the shape of South America with the west coast of Ecuador blocking some of the large swells that originate near the Antarctic. **Table 4.2.1** shows percent occurrence of offshore waves about peak wave period (*Tp*) by mean wave direction (degrees clockwise from North). The only significant wave energy that can affect the project site is from a window extending from south to southwest (200° -240°).

Table 4.2.2 shows percent occurrence of offshore waves about significant wave height (*Hs*) by peak wave period (*Tp*). The table shows that significant wave heights are almost ranged from 0.5 to 3.0 meters. Predominant wave heights are centered around 1.0-1.75 meters. On the other hand, over 95% of the peak offshore wave periods were between 6 and 20 seconds.

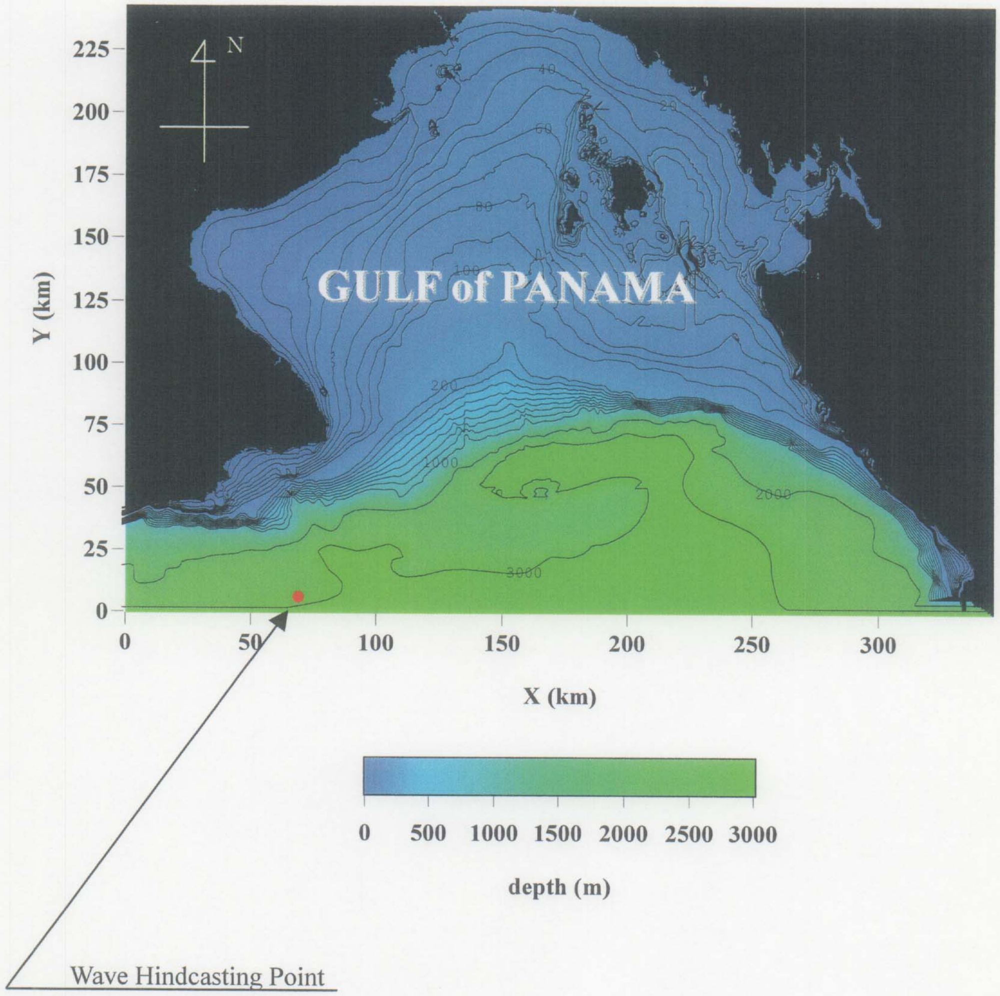


Figure 4.2.1 Location of Oceanweather's Grid Point

Table 4.2.1 Percent Occurrence –Peak Wave Period by Mean Wave Direction (1970-2000)

Peak Wave Period, Tp (sec)	Wave Direction (degrees azimuth) 0-180 degrees																																				
	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120	125	130	135	140	145	150	155	160	165	170	175	180
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%	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%	0.0%
2	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%	0.0%	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%
4	0.0%	0.0%	0.0%	0.0%	0.1%	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%	0.0%	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%
6	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%	0.0%	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%
8	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%	0.0%	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%
10	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%	0.0%	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%
12	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%	0.0%	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%
14	0.0%	0.1%	0.1%	0.1%	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%	0.0%	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%
16	0.0%	0.0%	0.0%	0.1%	0.1%	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%	0.0%	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%
18	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%	0.0%	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%
20	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%	0.0%	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%
22	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%	0.0%	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%
24	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%	0.0%	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%
26	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%	0.0%	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%
Total Percent Occurrence	0.1%	0.2%	0.2%	0.3%	0.3%	0.2%	0.1%	0.1%	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%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Peak Wave Period, Tp (sec)	Wave Direction (degrees azimuth) 185-355 degrees																																			Total Percent Occurrence
	185	190	195	200	205	210	215	220	225	230	235	240	245	250	255	260	265	270	275	280	285	290	295	300	305	310	315	320	325	330	335	340	345	350	355	
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%	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	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%	0.0%	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%
4	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.3%	0.5%	0.6%	0.4%	0.3%	0.1%	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%	0.0%	0.0%	0.0%	0.0%	2.6%
6	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.3%	0.7%	0.8%	0.7%	0.5%	0.2%	0.1%	0.1%	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%	0.0%	0.0%	0.0%	3.8%
8	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.2%	0.2%	0.2%	0.1%	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%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.0%
10	0.0%	0.0%	0.0%	0.2%	0.4%	0.9%	0.9%	0.9%	0.5%	0.2%	0.1%	0.1%	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%	0.0%	0.0%	0.0%	0.0%	0.0%	4.5%
12	0.0%	0.0%	0.0%	0.2%	1.0%	2.3%	2.6%	2.6%	1.7%	1.1%	0.7%	0.4%	0.2%	0.1%	0.1%	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%	0.0%	0.0%	13.3%
14	0.0%	0.0%	0.0%	0.1%	1.1%	3.2%	5.3%	5.8%	4.5%	2.9%	1.6%	0.8%	0.4%	0.3%	0.2%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	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%	27.5%
16	0.0%	0.0%	0.0%	0.1%	0.7%	2.5%	5.3%	6.4%	4.4%	2.4%	1.4%	0.7%	0.4%	0.3%	0.2%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	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%	25.9%
18	0.0%	0.0%	0.0%	0.0%	0.4%	1.3%	3.2%	3.6%	2.5%	1.3%	0.7%	0.4%	0.2%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	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%	14.9%
20	0.0%	0.0%	0.0%	0.0%	0.1%	0.4%	1.0%	1.3%	0.8%	0.4%	0.1%	0.1%	0.1%	0.1%	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%	0.0%	0.0%	0.0%	4.8%
22	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.3%	0.4%	0.3%	0.1%	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%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.4%
24	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	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%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%
26	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%	0.0%	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 Percent Occurrence	0.0%	0.0%	0.0%	0.5%	3.7%	10.9%	19.5%	22.2%	16.3%	10.0%	5.6%	3.1%	1.6%	1.1%	0.6%	0.5%	0.4%	0.3%	0.3%	0.3%	0.3%	0.2%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	100.0%

Table 4.2.2 Percent Occurrence –Significant Wave Height by Peak Wave Period (1970-2000)

	Peak Wave Period, Tp(sec)														
Significant Wave Height, Hs(m)	0	2	4	6	8	10	12	14	16	18	20	22	24	26	Total Percent Occurrence
0	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
0.25	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
0.5	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.03%
0.75	0.00%	0.02%	0.04%	0.01%	0.06%	0.34%	1.16%	2.40%	1.67%	0.81%	0.26%	0.05%	0.02%	0.00%	6.86%
1	0.00%	0.00%	0.26%	0.03%	0.10%	0.83%	3.14%	6.36%	5.23%	2.58%	0.79%	0.24%	0.08%	0.00%	19.64%
1.25	0.00%	0.00%	1.16%	0.18%	0.29%	1.11%	3.52%	7.45%	6.89%	3.46%	1.07%	0.32%	0.09%	0.00%	25.54%
1.5	0.00%	0.00%	1.16%	0.80%	0.28%	1.20%	2.81%	6.08%	5.85%	3.65%	1.18%	0.37%	0.08%	0.00%	23.45%
1.75	0.00%	0.00%	0.02%	1.38%	0.09%	0.79%	1.79%	3.24%	3.86%	2.48%	0.87%	0.22%	0.05%	0.00%	14.80%
2	0.00%	0.00%	0.00%	0.90%	0.01%	0.17%	0.75%	1.42%	1.64%	1.22%	0.39%	0.12%	0.04%	0.00%	6.65%
2.25	0.00%	0.00%	0.00%	0.35%	0.01%	0.05%	0.12%	0.44%	0.60%	0.46%	0.14%	0.03%	0.01%	0.00%	2.21%
2.5	0.00%	0.00%	0.00%	0.11%	0.06%	0.00%	0.03%	0.08%	0.16%	0.13%	0.04%	0.01%	0.00%	0.00%	0.63%
2.75	0.00%	0.00%	0.00%	0.00%	0.05%	0.00%	0.00%	0.02%	0.03%	0.03%	0.01%	0.00%	0.00%	0.00%	0.14%
3	0.00%	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.01%	0.01%	0.00%	0.00%	0.00%	0.00%	0.04%
3.25	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.01%
Total Percent Occurrence	0%	0%	3%	4%	1%	4%	13%	28%	26%	15%	5%	1%	0%	0%	100.00%

4.3 Examination Cases

Based on the previous analysis of offshore wave climate, wave periods from 6 to 20 seconds and wave directions from 205 to 235 degrees were chosen for the case study about wave transformation and calmness in the basin. Then, examination cases were shown in **Table 4.3.1**, with just 54 cases. The cases of 6 and 8 second-period-waves coming from 205 degrees were not examined, because those cases may not occur as shown in **Table 4.2.1**.

Then, assuming that offshore waves occur only this sphere as shown in **Table 4.3.1**, joint frequency tables are provided in **Appendix 2.1** for the whole period of hindcast for the following pairs of variables:

- Significant wave height (*Hs*) by peak wave period (*Tp*)
- Peak wave period (*Tp*) by mean wave direction
- Significant wave height (*Hs*) by mean wave direction
  for each peak wave period(*Tp*)

Table 4.3.1 Examination Cases

Wave Direction (degrees)	Peak Wave Period, Tp(sec)							
	6	8	10	12	14	16	18	20
205			case03_1	case04_1	case05_1	case06_1	case07_1	case08_1
210	case01_2	case02_2	case03_2	case04_2	case05_2	case06_2	case07_2	case08_2
215	case01_3	case02_3	case03_3	case04_3	case05_3	case06_3	case07_3	case08_3
220	case01_4	case02_4	case03_4	case04_4	case05_4	case06_4	case07_4	case08_4
225	case01_5	case02_5	case03_5	case04_5	case05_5	case06_5	case07_5	case08_5
230	case01_6	case02_6	case03_6	case04_6	case05_6	case06_6	case07_6	case08_6
235	case01_7	case02_7	case03_7	case04_7	case05_7	case06_7	case07_7	case08_7

4.4 Analysis of Wave Transformation

4.4.1 Modeling Approach

As deepwater waves propagate toward shore and into shallower water, they are modified both in direction and height, due to interaction with the sea floor. It is important to quantify these transformation effects so that a deepwater wave climate may be adapted to describe the near-shore climate at the proposed site. A wave model was required the offshore wave climate to the project region (proposed vicinity of the artificial islands). Regional grids were developed to take waves of various periods from deepwater to the near-shore project region.

Using the offshore hindcast data, the waves were transformed to the project site to account for refraction, diffraction and shoaling effects from changes in the bathymetry as waves propagate from offshore to the shallower near-shore project region. The wave transformation processes of shoaling, refraction, and diffraction depend on the period of the waves. Refraction and diffraction also depend on the incident wave direction.

Sophisticated models have been developed in recent years that use finite-difference or finite-element techniques to calculate the wave conditions (height and direction) at nodes (normally element techniques or thousand) definite within the boundaries of a model grid. One such model based on Energy Balance Equation (Karlsson;1969) was utilized for this study. That is a linear refraction model taking into account of the effects of refraction and shoaling due to varying depths. Though the presented method strictly does not include the effect of wave diffraction, the method is applicable to the estimation of wave transformation on a circular shoal and behind a breakwater, because the property of directional randomness of real sea waves weakens the effect of diffraction (Takayama et al.;1991)

The basic equations of the model are described as

$$\frac{\partial}{\partial x}(Dv_x)+\frac{\partial}{\partial y}(Dv_y)+\frac{\partial}{\partial \theta}(Dv_\theta)=0$$
$$v_x = C_g \cos\theta$$
$$v_y = C_g \sin\theta$$
$$v_\theta = \frac{C_g}{C}\left(\frac{\partial C}{\partial x}\sin\theta - \frac{\partial C}{\partial y}\cos\theta\right)$$

where, the parameter $D(f,\theta)$ stands for directional spectrum. The parameters C_g and C stand for group velocity and wave velocity. Then, directional spectrum $D(f,\theta)$ are described as

$$D(f,\theta) = S(f)G(f,\theta)$$

where, the parameter $S(f)$ and $G(f,\theta)$ represent frequency spectrum and directional function. Then, for incident spectrum, Breatschneider-Mitsuyasu frequency spectrum and Mitsuyasu directional spectrum were adapted for $S(f)$ and $G(f,\theta)$.

The main output data are integral wave parameters such as wave height, peak wave period, and mean wave direction.

4.4.2 Modeling Region

As shown in **Figure 4.2.1**, the distance from the proposed artificial island to wave hindcasting point (about 250 kilometers) is very long compared with the size of proposed artificial island (about 1.0～2.0 kilometers). So wave transformation was analyzed by two phases using two types of modeling region.

Figure 4.4.1 and **4.4.2** show the modeling regions. In order to transform the deepwater waves to those representing the nearshore wave climate at the proposed site, a Regional Model was first created as shown in **Figure 4.4.1**. The bathymetry grid for the modeling region was approximately 350 by 250 kilometers and the grid spacing of both x and y-directions is 250 x 250 meters. Wave hindcasting data was inputted on the offshore boundary.

After calculation of the regional model, Local Model as shown in **Figure 4.4.2** was simulated. The bathymetry grid for the Local Model was approximately 40 by 30 kilometers and the grid spacing is 25 x 25 meters. For the local model, the directional spectrum resulted from the regional model analysis have been taken over.

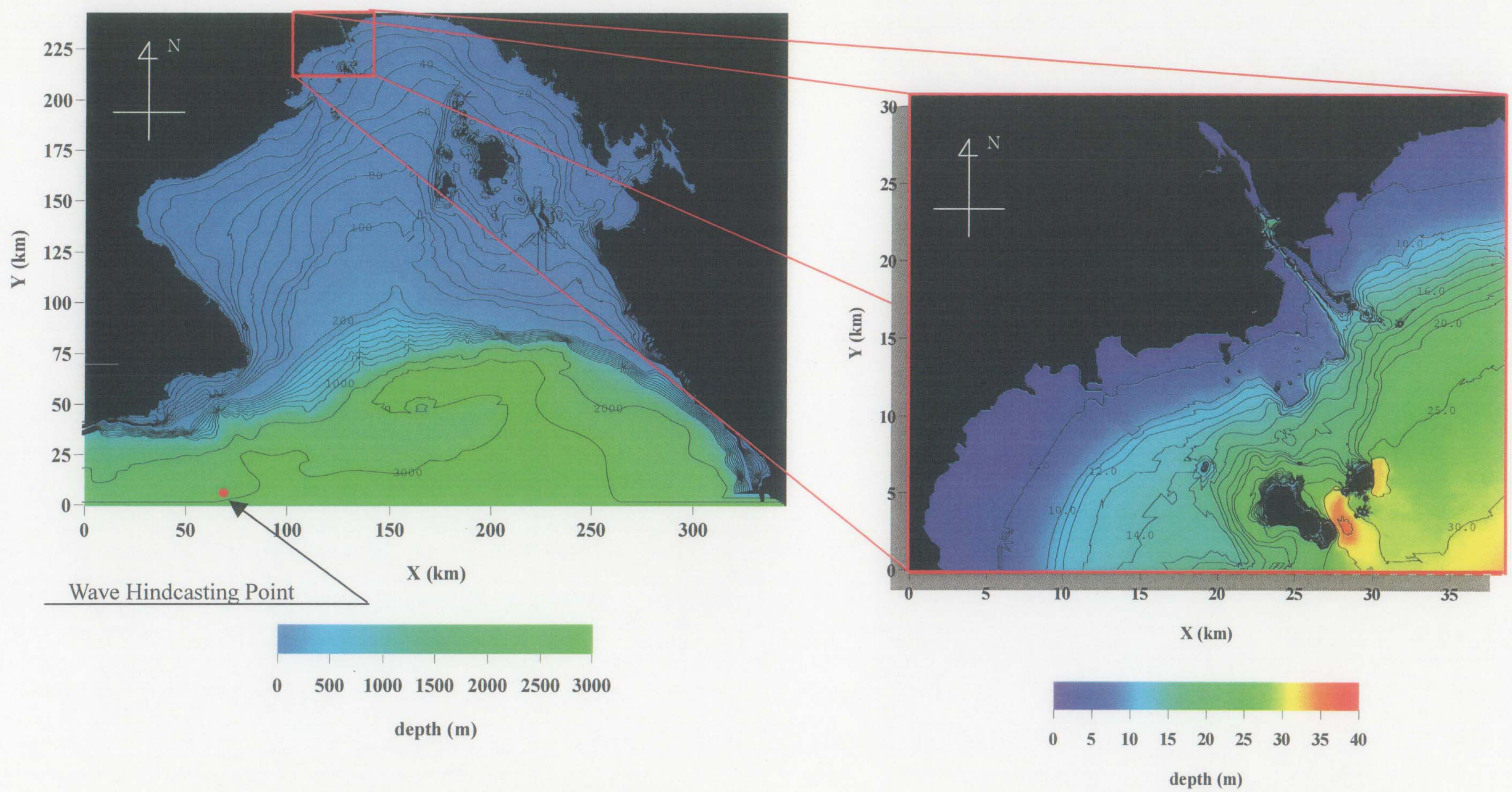


Figure 4.4.1 Regional Model Bathymetry

(250m x 250m grid)

Figure 4.4.2 Local Model Bathymetry

(25m x 25m grid)

4.4.3 Other Conditions of Analysis

In Regional Model, if water depth is over 3,000 meters, data of those grid points have been set up 3,000 meters.

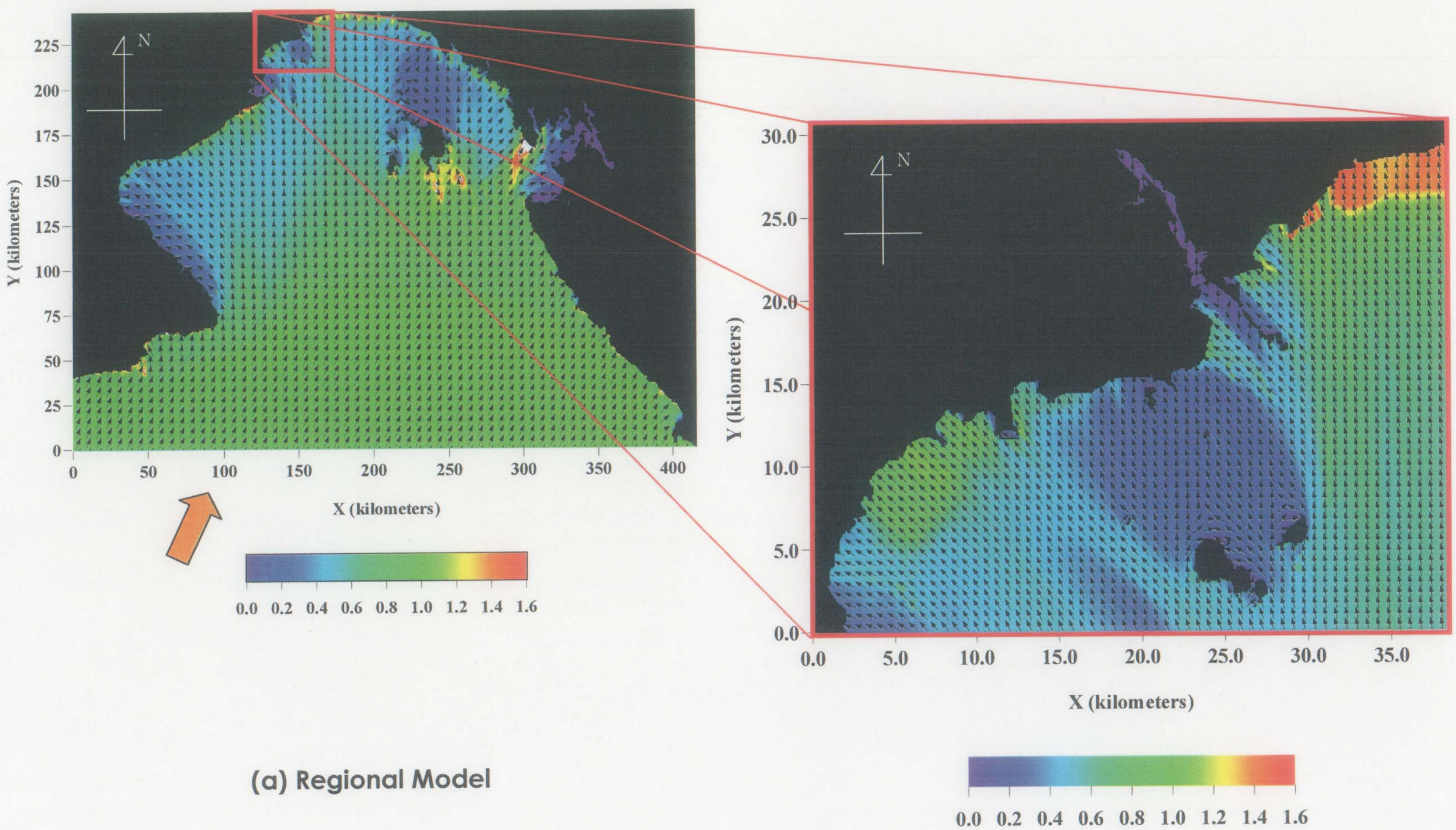
Other conditions of wave transformation have been as follows:

- division number of frequency : 10 (energy evenly divided)
- division number of directions : 45 (θ max=+90°, θ min=−90°)
- incident spectrum : Breatschneider-Mitsuyasu frequency spectrum and Mitsuyasu directional spectrum
- spreading parameter : Smax = 25
- sea bottom slope : 0.01 (=constant.)

4.4.4 Model Results and Discussion

The result of computation on wave transformation is presented in **Figure 4.4.3**. It shows contours of the wave height ratio against offshore wave height and averaged waves directions. **Figure 4.4.3(a)** shows the result of regional model and **Figure 4.4.3(b)** shows that of local model. Those results are in the case of 20-second-period waves coming from 205 degrees (case.08_1). All results of wave transformation analysis are presented in **Appendix 2.2**.

The typical wave climate in the area of the proposed artificial island is relatively mild with the geometry of the Gulf of Panama and South America limiting the directions of waves entering the region (as shown in **Figure 4.4.3(a)**). Then, the near-shore islands of ISLA TABOGA and TABOGUILLA (as shown in **Figure 4.4.4**) will provide a relatively tranquil area behind them as shown in **Figure 4.4.3(b)**, which in turn, a better position and suitable place for the proposed artificial island.



(a) Regional Model

(b) Local Model

Figure 4.4.3 Patterns of Wave Height Ratio and Wave Directions

(In the case of 20 second-period-waves from 205 degrees)

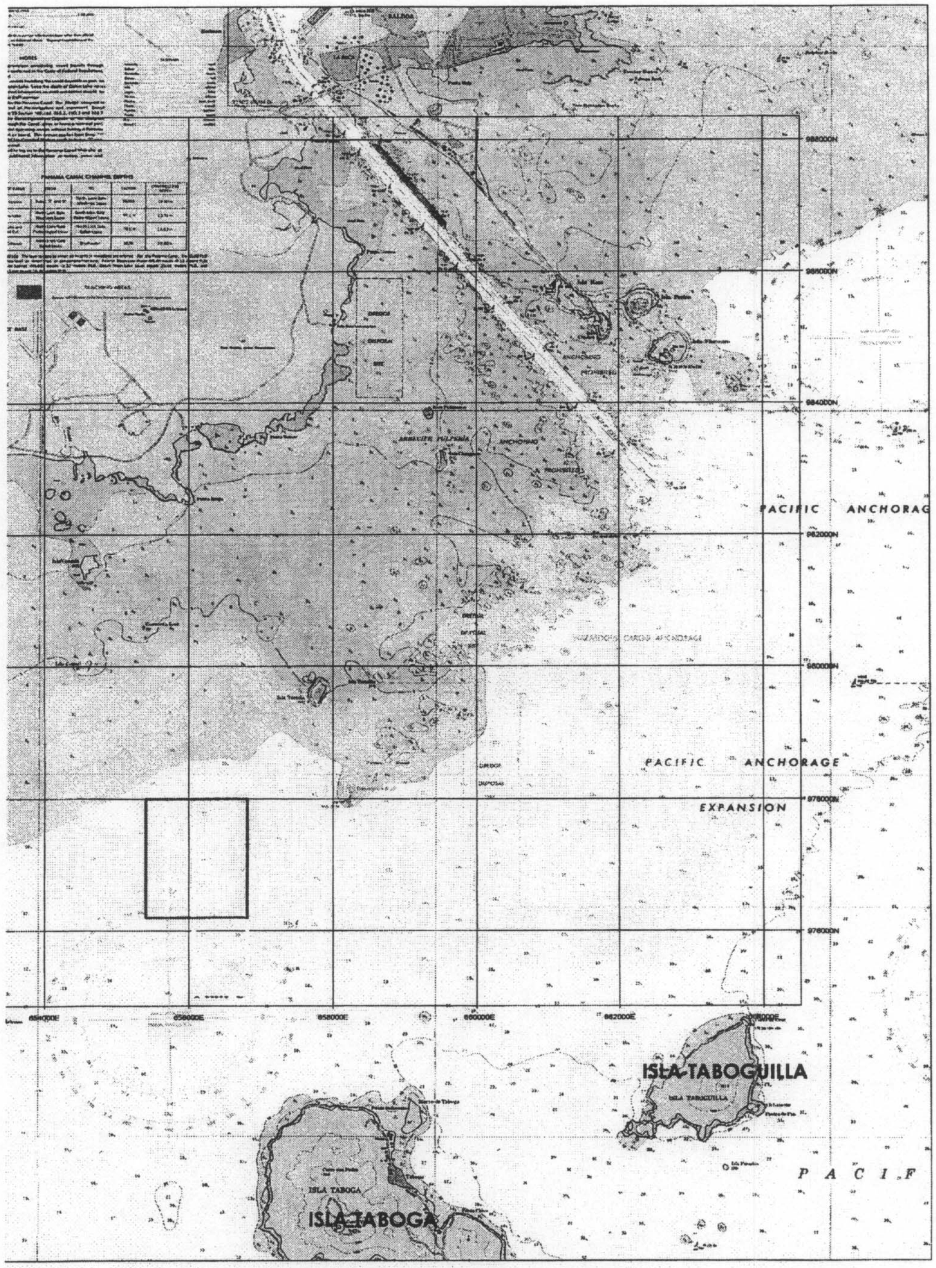


Figure 4.4.4 Position of the Artificial Island and Near-shore Islands

4.5 Analysis of Wave Calmness in the Basin

4.5.1 Modeling Approach

Using the results of analysis of wave transformation, wave calmness in the region of the proposed artificial island was simulated in this section. For the analysis of wave calmness and calculation of wharf operation efficiency at each container berth, the effect of wave diffraction and reflection from the construction of an artificial island should be strictly evaluated.

Similar to the analysis of wave transformation, sophisticated models have been developed about this field in recent years. One such model based on Green's Function Method (Gillard, 1984) was utilized for computing the calmness in the basin. This method is a linear function taking into account of the effect of wave diffraction and reflection.

4.5.2 Modeling Region

Figure 4.5.2 shows modeling region for the analysis of wave calmness in the basin. Then, **Figure 4.5.1** shows the Local Model area for the analysis of wave transformation mentioned previously.

In **Figure 4.5.2**, the bathymetry grid for the analysis of wave calmness was approximately 6 kilometers by 4 kilometers and the result of wave transformation have been taken over on the open boundaries. In this simulation, the proposed artificial island was placed about each proposed cases, Plan-A, Plan-A with a breakwater, Plan-B and Plan-C.

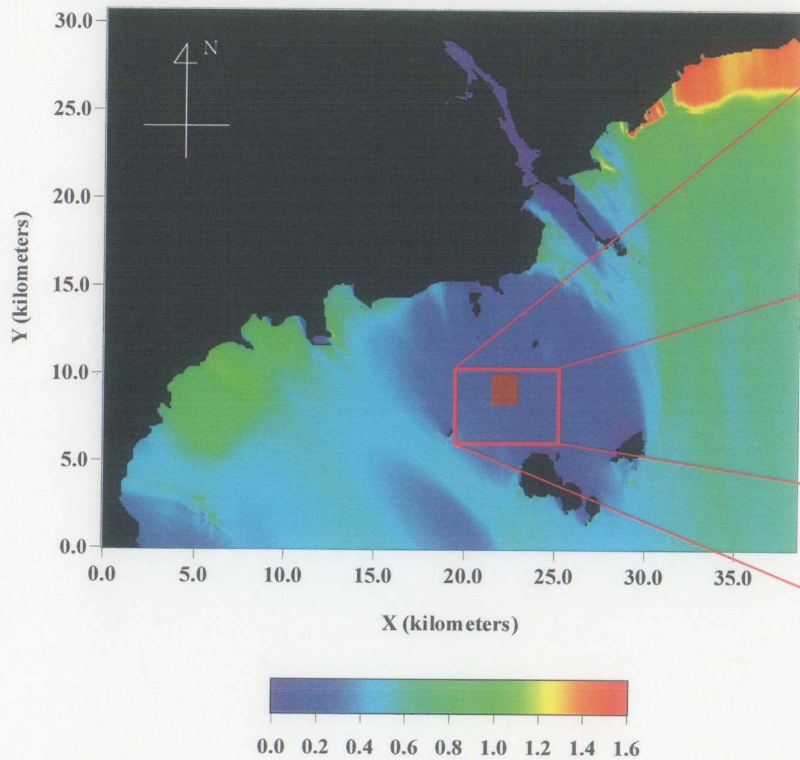


Figure 4.5.1 Local Model Area for Wave Transformation

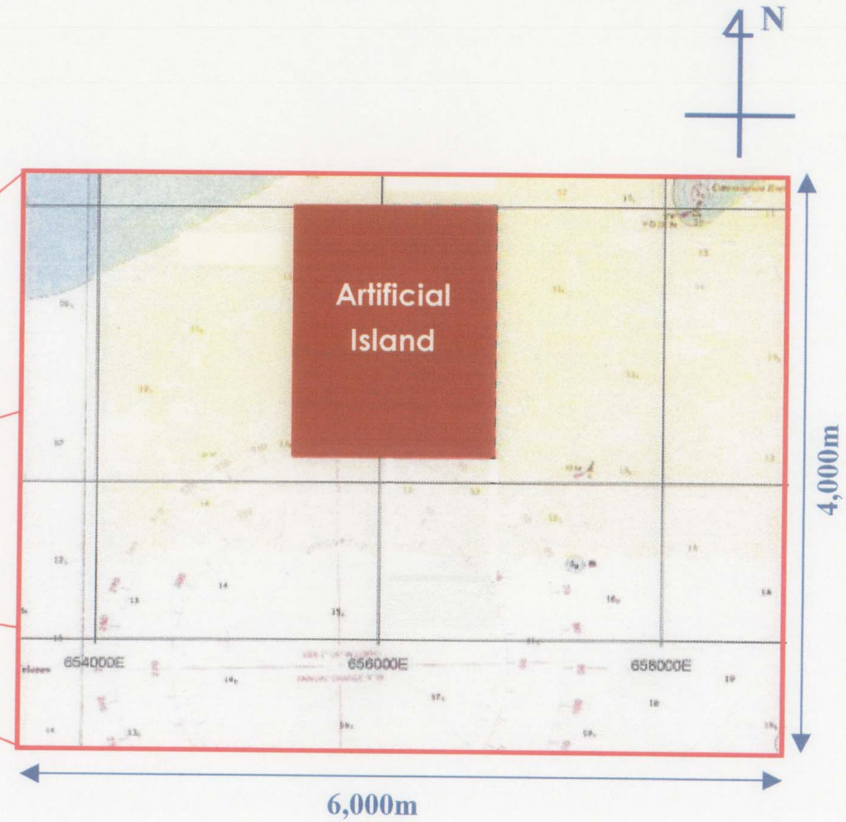


Figure 4.5.2 Modeling Region for Analysis of Wave Calmness

4.5.3 Other Conditions of Analysis

Other conditions of the analysis of wave calmness in the basin have been as follows:

- division number of frequency : 5 (energy evenly divided)
- division number of directions : 7 (θ max=+90°, θ min=−90°)
- spreading parameter : Smax = 25
- reflection coefficient
  - quaywall : 0.9
  - breakwater : 0.5
- transmission coefficient
  - quaywall : 0
  - breakwater : 0.2

4.5.4 Model Results and Discussion

Figure 4.5.3 shows the results of employing Green's Function Method about each case of proposed artificial island. It shows the ratio of wave height against offshore wave under the case of 20-second-period-waves coming from 205 degrees (case.08_1). All results of analysis of wave calmness (Patterns of Ratio of Wave Height against Offshore Wave) are presented in **Appendix 2.3**.

In Plan-A, the ratio of wave height is relatively large at the south of artificial island, because wave directions are almost southwardly at the project site. But if a breakwater constructed, it covers its behind. So wave height around the artificial island becomes very smaller.

In Plan-B and C, the ratio of wave height is similar to that of Plan-A. But there is little influence, because container berths are placed at eastern and western sides of the artificial island in Plan-B and C. The ratio of wave height at the eastern and western sides of the artificial island is relatively small, because wave directions are almost southwardly.

The numerical values of the ratio of wave height against offshore wave at each container berth are presented in **Appendix 2.4.**

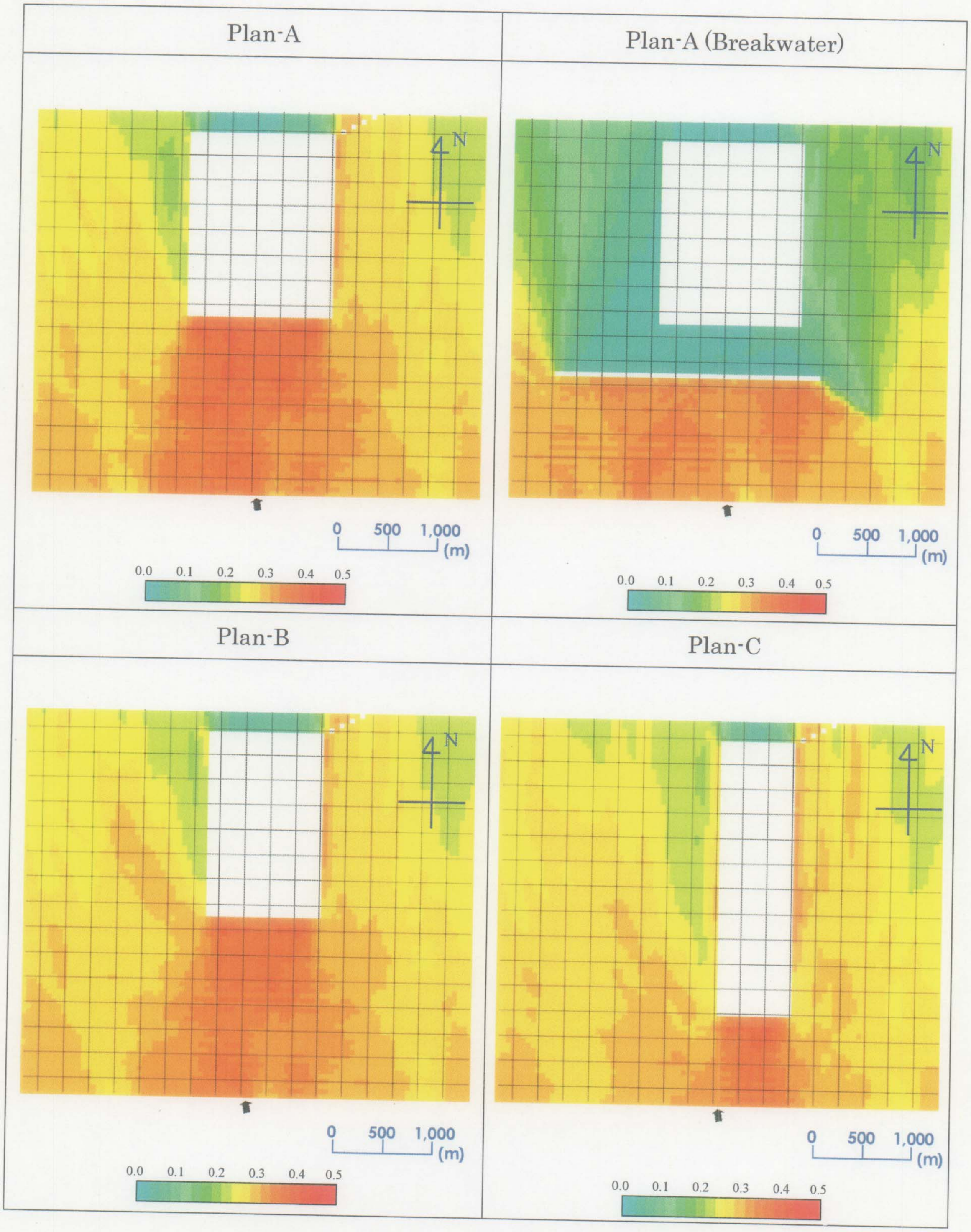


Figure 4.5.3 Ratio of Wave Height against Offshore Wave

(In the case of 20-second-period-waves from 205 degrees)

4.6 Calculation of Wharf Operation Efficiency

4.6.1 Specification of Standard Level

Using above-mentioned results of wave calmness in the basin, wharf operation efficiency for cargo handling at each container berth was calculated.

From 「Technical Standards and Commentaries for port and Harbour Facilities in Japan」, for basins that are located in front of mooring facilities and used for accommodating or mooring vessels, the calmness of a specified level shall be achieved for 97.5% or more of the days of the year, except for those cases where the use of the mooring facilities or the area in front of the mooring facilities is categorized as a special use. The threshold wave heights for cargo handling for basins in front of mooring facilities should be determined appropriately in consideration of the type, size, and cargo handling characteristics of the vessels. For this purpose, the values listed in **Table 4.6.1** may be adopted. From **Table 4.6.1**, allowable wave height for cargo handling is mentioned from 0.7 to 1.5 meters for very large vessels. In this study, 0.7 meters were selected for safety.

Calmness of basin is usually evaluated by the wave height in the basin, but it is desirable to consider as necessary the effects of wave direction and period, which affect the motions of moored vessels as well.

Table 4.6.1 Threshold Wave Height for Cargo Handling

Ship size	Threshold wave height for cargo handling (H1/3)
Small-sized ships	0.3m
Medium- and large-sized vessels	0.5m
Very large vessels	0.7 ~ 1.5m

Note: Small-sized ships are vessels smaller than about 500 GT that mainly use the basins for small crafts, and very large vessels are vessels larger than about 50,000 GT that mainly use large dolphins and offshore berths. Medium- and large-sized ships are vessels that do not belong to the small-sized and very large ship categories.

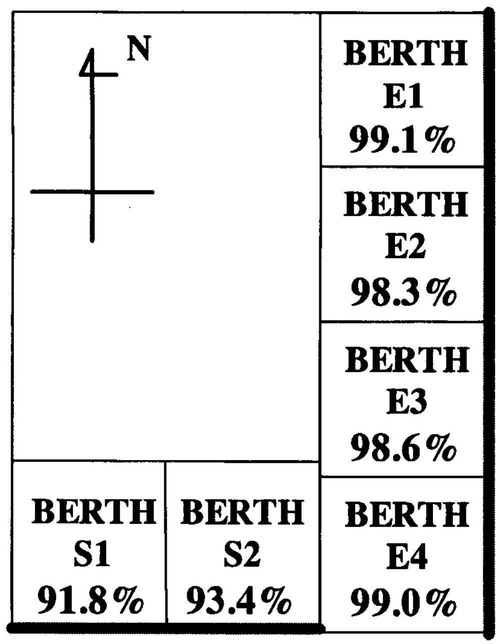
4.6.2 Wharf Operation Efficiency

From results of analysis of calmness in the basin (**Appendix 2.4**) and hindcast data of offshore wave (**Appendix 2.1**), the maximum wave height of each container berth at each simulation case could be calculated. Using those results, wharf operation efficiency for cargo handling was calculated. The maximum wave height at each container berth for each case and percent occurrence that was sum of over 0.7 meters were presented in **Appendix 2.5**.

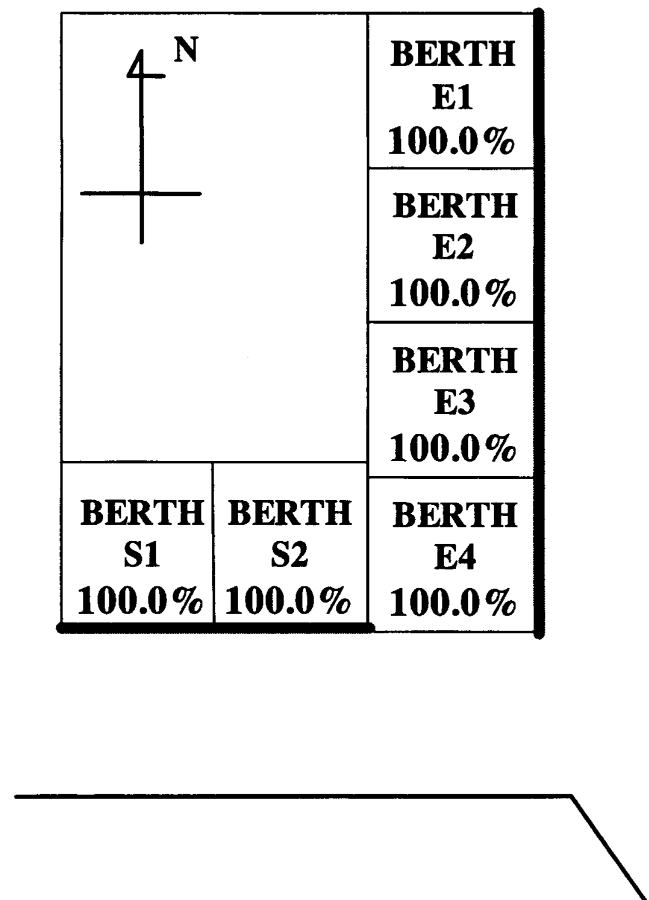
Figure 4.6.1 shows the calculation results of wharf operation efficiency at each container berth at proposed location.

In Plan-A, the standard rate of 97.5 percent would not be achieved at the southern two berths. But if a breakwater is settled, it achieved that rate. So if Plan-A is adopted, a breakwater may be needed at the south of the artificial island.

Plan-B and Plan-C achieved the same rate at all berths. Especially, the western two berths, W-1 and W-2 at Plan-B achieved higher rates because of the outstanding of southeast wave directions at the project site.

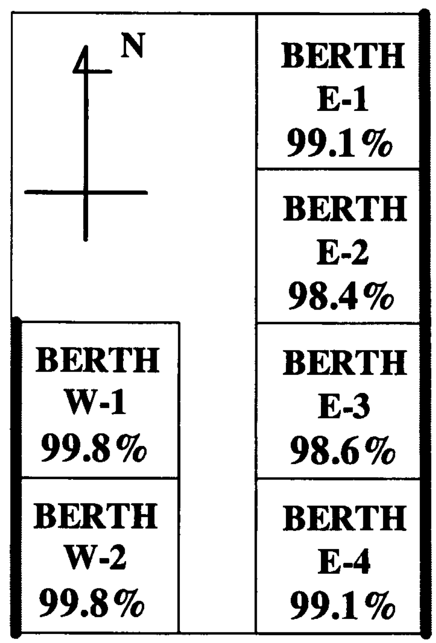


(a) Plan-A

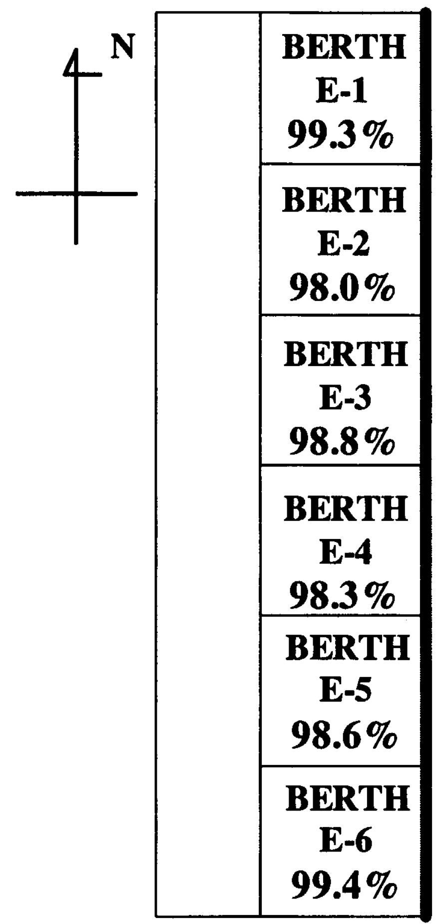


(b) Plan-A (Breakwater)

Figure 4.6.1 Wharf Operation Efficiency



(c) Plan-B



(d) Plan-C

Figure 4.6.1 Wharf Operation Efficiency

4.7 Conclusion and Recommendation

In this chapter, wave transformation and calmness of basin were analyzed and wharf operation efficiency for cargo handling was calculated. The model results have concluded the following matters.

- In the proposed layout Plan-A, the standard level of wharf operation efficiency for cargo handling, 97.5%, could not be achieved at the southern two berths.
- If the layout Plan-A is adopted, a breakwater will be needed at the south of the artificial island.
- Plan-B and C will achieve such rate even without a breakwater.

Further more, another studies as follows are recommended in the construction of an artificial island.

- This section's study was examined under existing conditions. So before the construction of an artificial island, observations of wave and current around the artificial island for several months are recommended. And a comparison of the results of wave transformation analysis with observation data should be practiced.
- Because of the oscillation of moored ship should be determined by dimensions of ship, waves, winds, structural conditions of mooring facilities, characteristics of fenders and mooring ropes, and so forth, it is reasonable to decided that the cargo handling at wharf is allowable or not, more detail, taking into account conditions above mentioned. Especially, winds should be investigated in advance.
- In the proposed site, wave height is smaller, but comparatively long period wave, such as 20 second-periods, comes from offshore. So it is recommended that the motions of moored ship against such waves should be analyzed.

4.8 References

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Gaillard, P. (1984) : Combined refraction-difraction calculations with directional wave spectra, Proc. 19th Int. Conf. Coastal Eng., Houston, pp.1040-1056.

Karlsson,T. (1969) : Refraction of continuous ocean wave spectra, Proc. ASCE, Vol.95, No.WW 4, pp.471-490.

Takayama, T., Ikeda, N., Hiraishi, T. (1991) : Practical Computation Method of Directional Random Wave Transformation, Report of the Port and Harbour Research Institute, Vol.30, No.1.

The Overseas coastal area development institute of JAPAN(2002) : TECHNICAL STANDARDS AND COMMENTARIES FOR PORT AND HARBOUR FACILITIES IN JAPAN.

CHAPTER 5 CURRENT ANALYSIS

5.1 Introduction

The current simulation was generated as per the available data to determine and confirm the potential impacts of the construction of the artificial island and the access way.

The data herein presented is at the same level of accuracy of the Pre Feasibility Study, more detail and precise results would require collection of additional information and the development of a new model.

5.2 Numerical Model

5.2.1 Modeling Approach

5.2.1.1 Basic Equations

In the coastal sea area, tidal current is basically supposed to be barotropic, which means water density is uniform in the vertical direction. Because horizontal velocity of tide and tidal current are usually very large compared with vertical velocity, a numerical model for tidal current generally deal with horizontal 2-D simulation.

The basic equations of the model are Navier-Stokes equations for an incompressible fluid, under the shallow water and the Bussinesq assumption and continuity equation. Those are described as

$$\frac{\partial u}{\partial t}+u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}-fv=-g\frac{\partial \eta}{\partial x}+A_h\frac{\partial^2 u}{\partial x^2}+A_h\frac{\partial^2 u}{\partial y^2}+\frac{\tau_x}{h}$$

$$\frac{\partial v}{\partial t}+u\frac{\partial v}{\partial x}+v\frac{\partial v}{\partial y}+fu=-g\frac{\partial \eta}{\partial y}+A_h\frac{\partial^2 v}{\partial x^2}+A_h\frac{\partial^2 v}{\partial y^2}+\frac{\tau_y}{h}$$

$$\frac{\partial \eta}{\partial t} + \frac{\partial (hu)}{\partial x} + \frac{\partial (hv)}{\partial y} = 0$$

where, the parameters u and v stand for the horizontal velocity, the parameter η and h stand for surface elevation and water depth. Similarly, the parameter f stands for Coriolis parameter and parameter g represents the acceleration of gravity. The parameter A_h represents Eddy viscosity and the parameter τ_x and τ_y are bottom friction.

Because of the difficulty of solving those basic equations exactly, the difference method, which is one of the approximate method, is applied to this numerical simulation.

5.2.1.2 Boundary Conditions

The bottom friction is considered on the bottom of the sea and that model is described as

$$\tau_x = -\gamma_b^2 \left(u^2 + v^2\right)^{1/2} u$$

$$\tau_y = -\gamma_b^2 \left(u^2 + v^2\right)^{1/2} v$$

where, the parameter γ_b stands for the coefficient of bottom friction.

The boundary between sea and land has been defined by slip condition that the horizontal friction is equal to zero. And the open boundary has been defined by the amplitude of M2 tide and Oceanic Current.

5.2.2 Modeling Region

The domain for numerical simulation of tidal current is shown in **Figure 5.1**. The area is 70 kilometers distance in the east and west direction and 60 kilometers distance in the south and north direction. The depth is over 60 meters in the offshore.

Strictly, the case of the whole area of the Gulf of Panama should be simulated at first and then the case of local area simulation (shown in **Figure 5.1**) should be carried out by using the results of the case of whole area for the open boundary conditions. But in this analysis, the local area is directly simulated because this analysis aimed at the understanding of the outline of influence due to the construction.

In this simulation, water depth is defined in the grid spacing of 100 meters. And the depth over 60 meters in offshore and under 2.0 meters in nearshore are approximated 60 meters and 2.0 meters respectively for the stability of the numerical simulation.

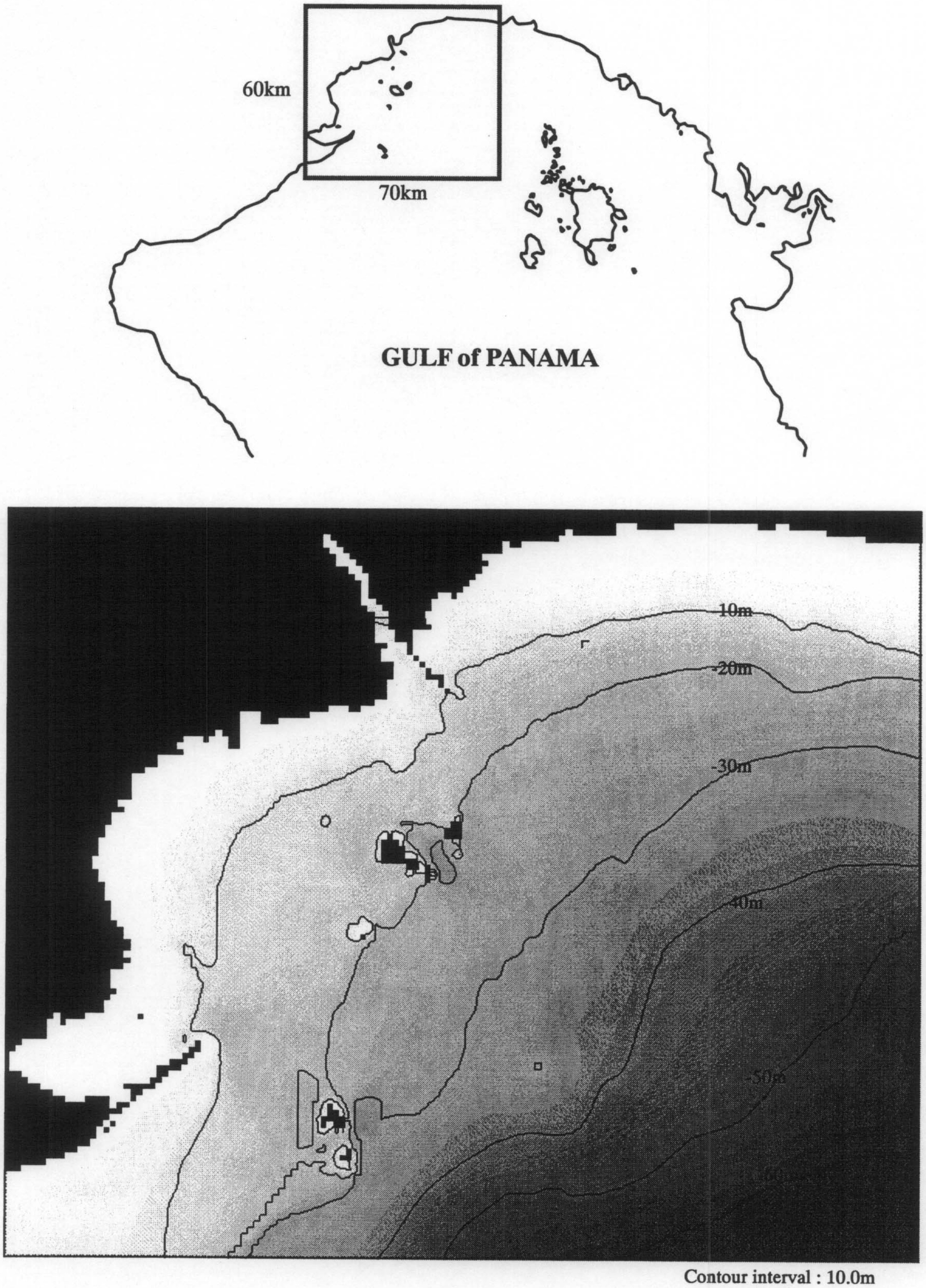


Figure 5.1 The domain for numerical simulation

5.2.3 Conditions of the Simulation

5.2.3.1 Conditions of the Simulation

This analysis aimed at understanding of the outline of influence due to the construction of an artificial island. So only tidal currents and oceanic current has been considered as the driving forces in the numerical simulations. Here, wind forcing has not been considered. And water density has been set uniformly in the whole domain.

The numerical simulation has been carried out for 5 periods of a tidal wave by using the same tide and the result obtained in the last one period is applied to the analysis of the influences. Besides the steady state of the tidal currents after successive simulation of 5 tidal periods is confirmed.

5.2.3.2 Model Parameters

The following parameters presented in **Table 5.1** have been applied in the model. Eddy viscosity A_h is based on Richardson's 4/3 law. Coriolis parameter f is calculated by using following equation.

$$f = 2\Omega \sin \varphi$$

where the parameter Ω stands for angular velocity (=7.92 × 10^{-5} (s^{-1})). The parameter φ represents the latitude of the Gulf of Panama (=9.0°).

Table 5.1 Model Parameters

Horizontal Grid Size	100 (m)
Time Step : *dt*	15 (s)
Times of simulation	62hours (about 5 periods of M2 tide)
Water Density : ρ_0	1,020 (kg/ m^3)
Acceleration of gravity : *g*	9.78 (m/s^2)
Eddy Viscosity : A_h	10.0(m^2/s)
Coriolis parameter : *f*	2.28×10^{-5}(s^{-1})

5.2.4 Simulated Cases

The cases of numerical simulation of tidal current are shown in **Table 5.1**.

Table 5.2 Cases of Numerical Simulation of Tidal Current

Island Type	Accessway					Breakwater
	Nothing	Causeway	Causeway + Trestle	Causeway + Bridge	Bridge	
Nothing	○	/	/	/	/	/
Plan A	○	*1)	*1)	*1)	*1)	○
Plan B	○	○	○	○	○	/
Plan C	○	○	○	○	○	/

*1) : Nearly equal to Plan B

*2) : Each case has 4 tidal conditions; High water level, Peak ebb, Low water level, and Peak flood

5.3 Simulation Results and Issues

5.3.1 Present State

The typical current of the Gulf of Panama originated in Oceanic Current forms a cyclonic (counter clockwise) circulation known as Gulf of Panama Current or Colombia current (Bennett; 1965).

The following figures show the existing natural conditions in high water, low water, peak ebb and peak flood. As can be appreciated, with the exception of the ebbing tide, all the other times the tide direction is parallel to the coast.

As can be observed in the case of the Peak Flood, which generates high velocity currents in the east-west direction.

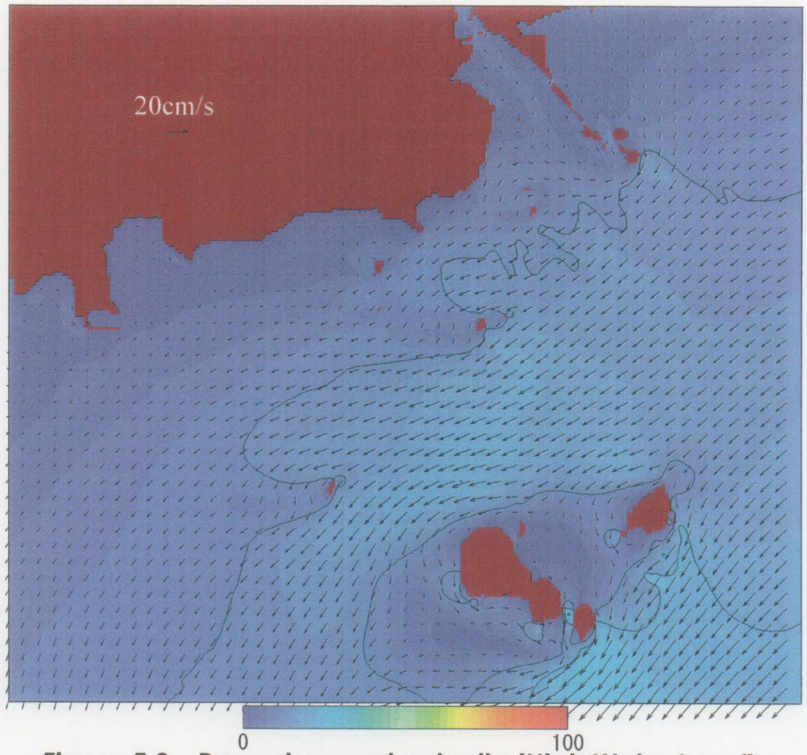


Figure 5.2 Present current velocity (High Water Level)

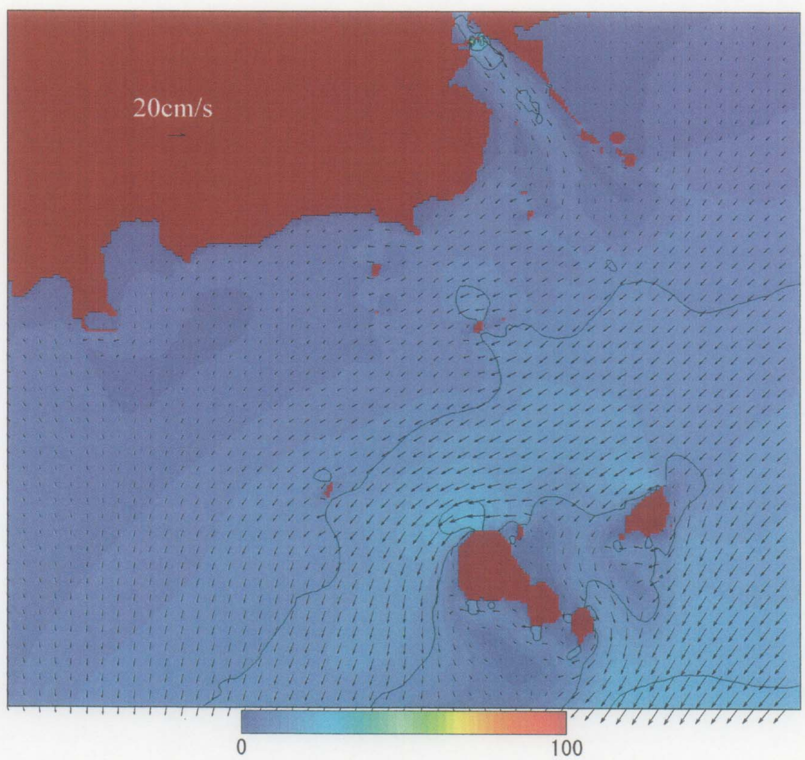


Figure 5.3 Present current velocity (Low Water Level)

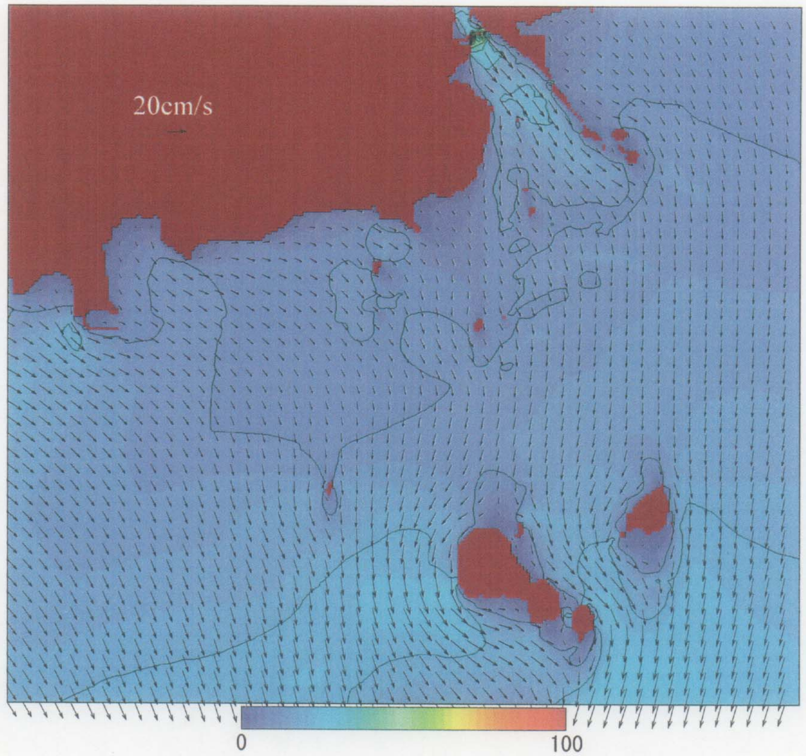


Figure 5.4 Present current velocity (Peak ebb)

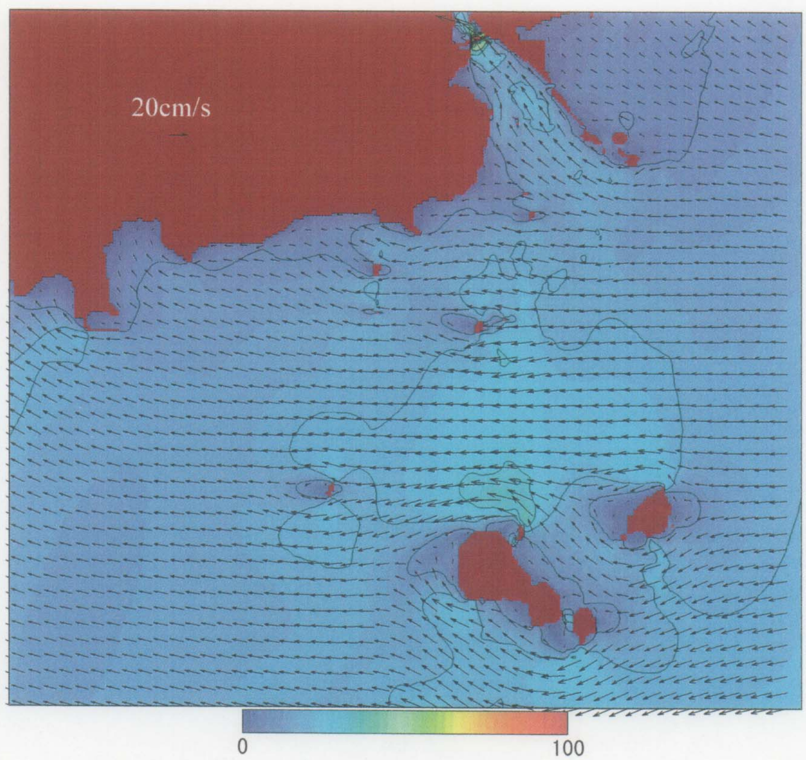


Figure 5.5 Present current velocity (Peak flood)

5.3.2 Construction of Artificial Island and Accessway

As a result of the current simulation analysis, Bridge type and Trestle + Causeway type proved to be the most favourable to avoid significant alteration of the existing currents. The following figures show the result of such simulation.

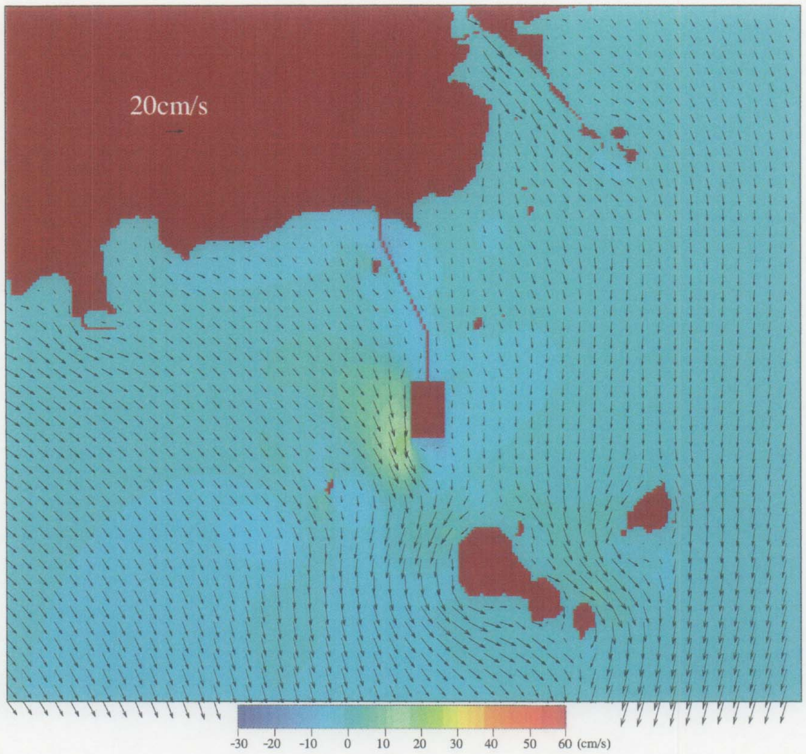


Figure 5.6 Comparison of Current Velocity : Plan B (Causeway, Peak Ebb)

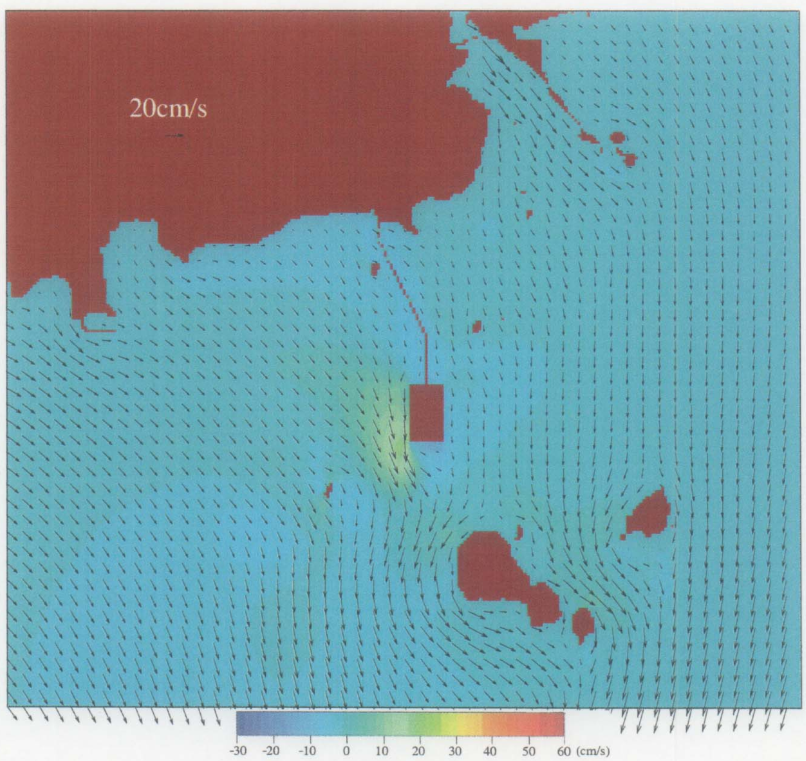


Figure 5.7 Comparison of Current Velocity : Plan B (Causeway + Trestle, Peak Ebb)

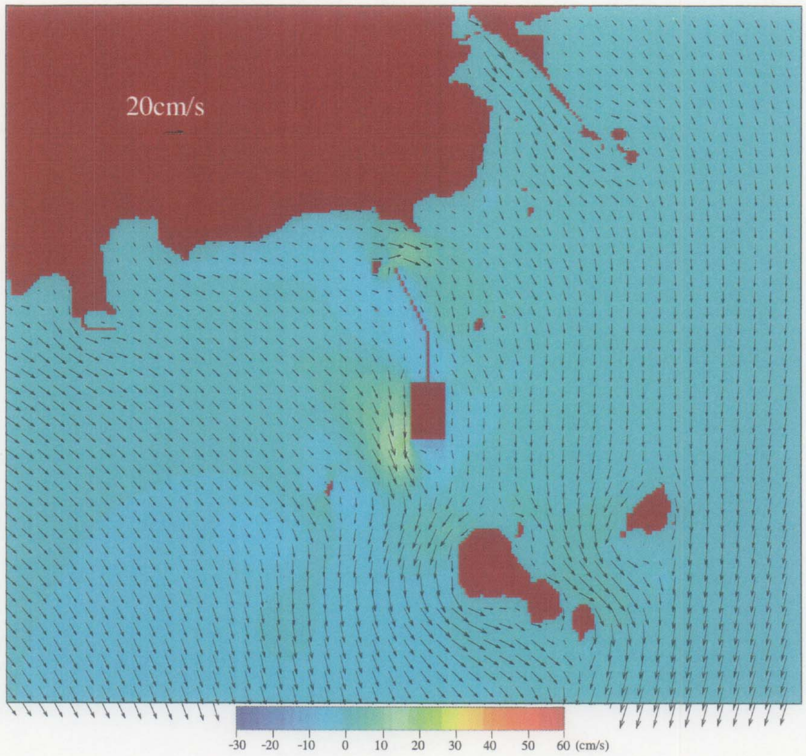


Figure 5.8 Comparison of Current Velocity : Plan B (Causeway + Bridge, Peak Ebb)

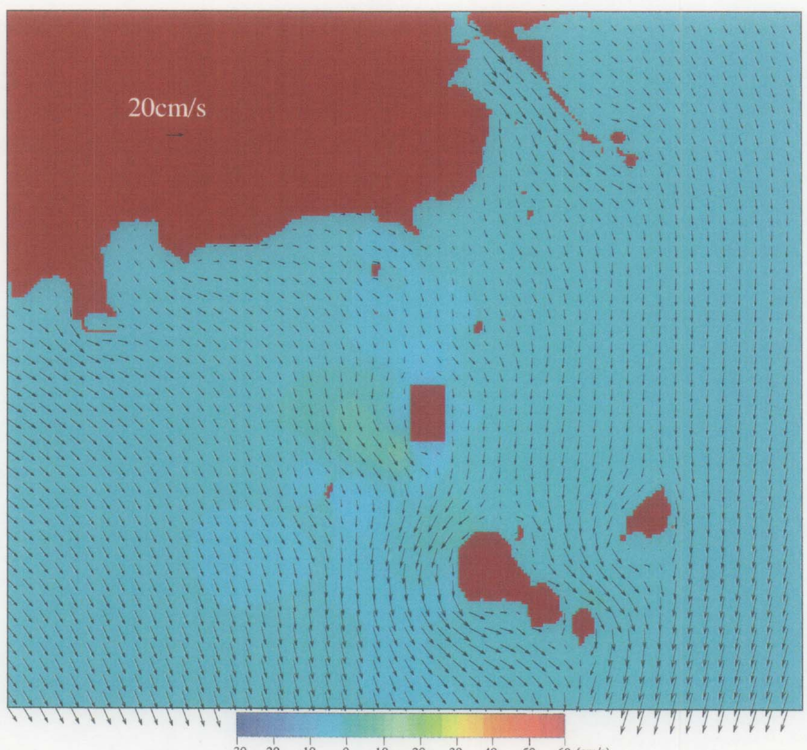


Figure 5.9 Comparison of Current Velocity : Plan B (Bridge, Peak Ebb)

+ trestle

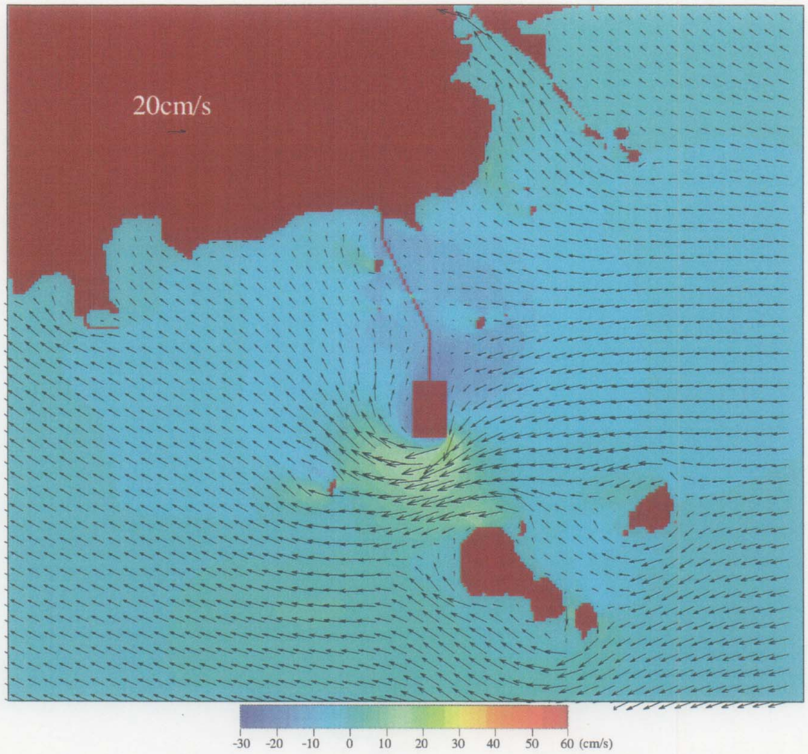


Figure 5.10 Comparison of Current Velocity : Plan B (Causeway, Peak Flood)

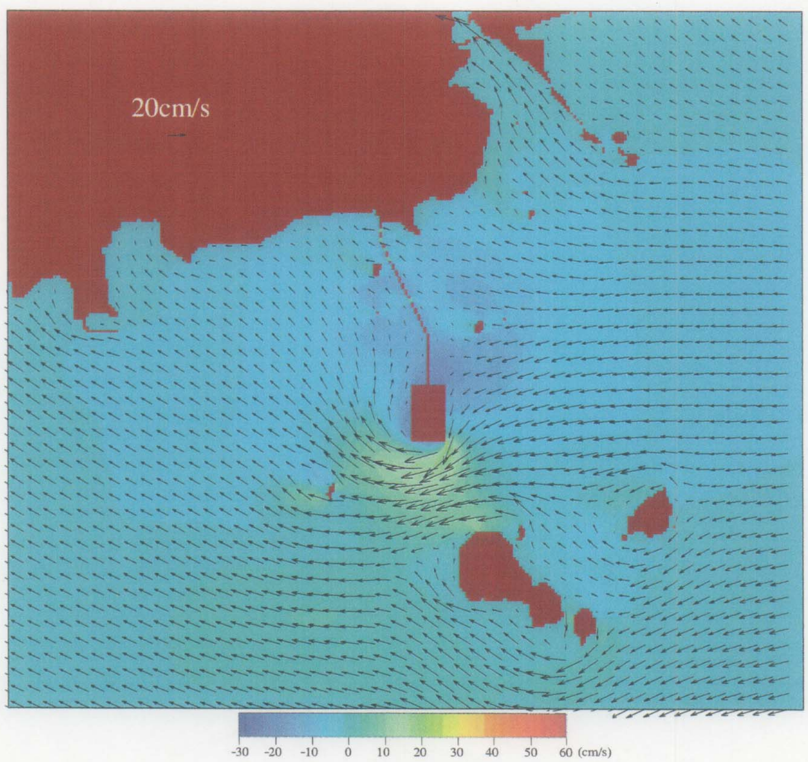


Figure 5.11 Comparison of Current Velocity : Plan B (Causeway + Trestle, Peak Flood)

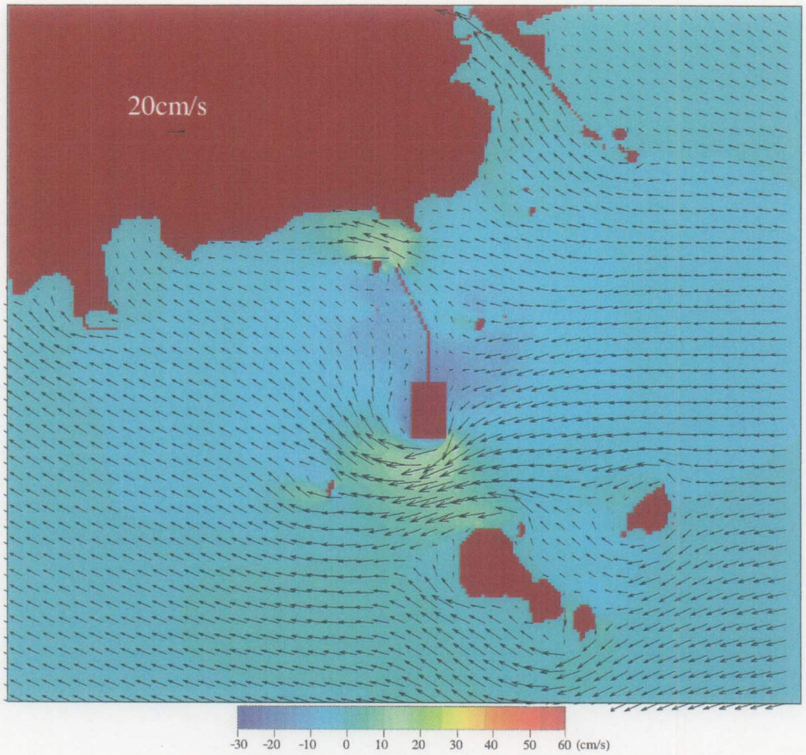


Figure 5.12 Comparison of Current Velocity : Plan B (Causeway + Bridge, Peak Flood)

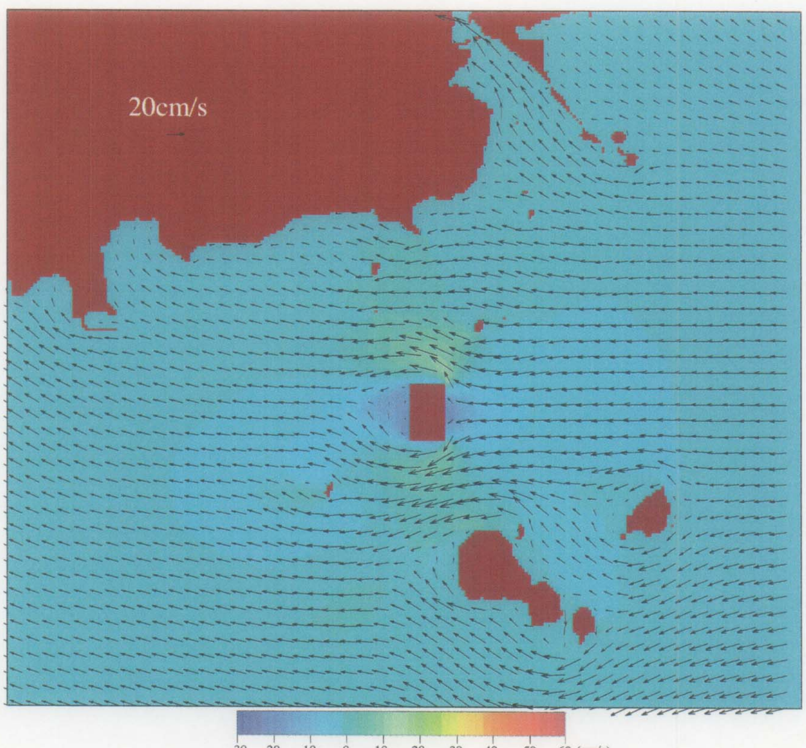


Figure 5.13 Comparison of Current Velocity : Plan B (Bridge, Peak Flood)

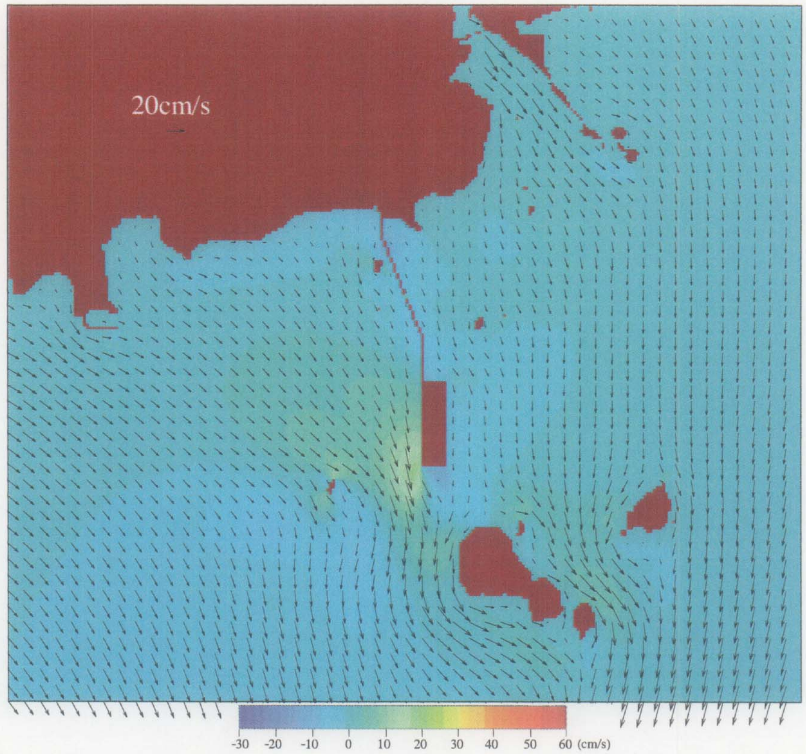


Figure 5.14 Comparison of Current Velocity : Plan C (Causeway, Peak Ebb)

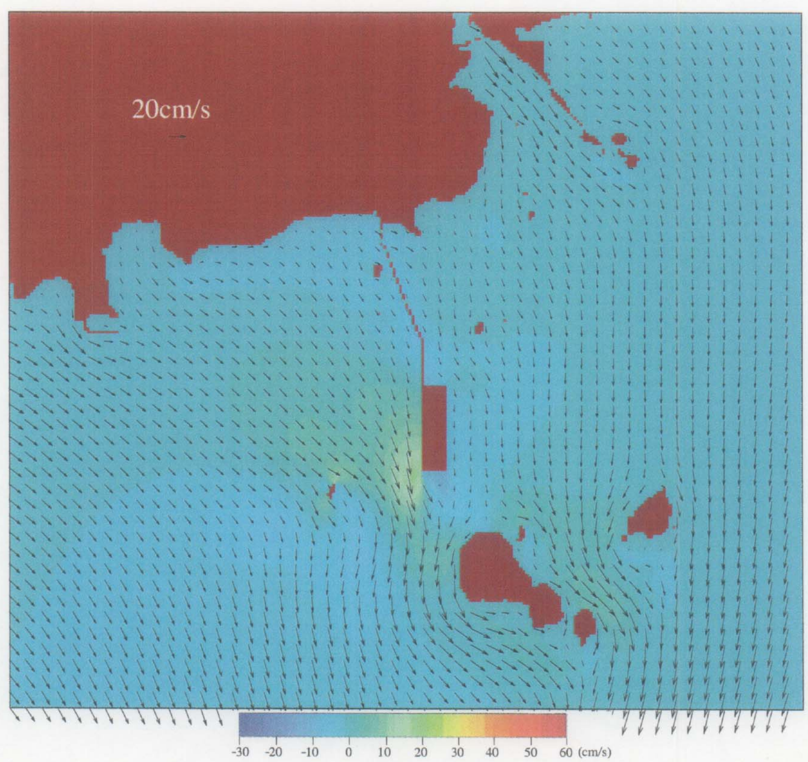


Figure 5.15 Comparison of Current Velocity : Plan C (Causeway + Trestle Peak Ebb)

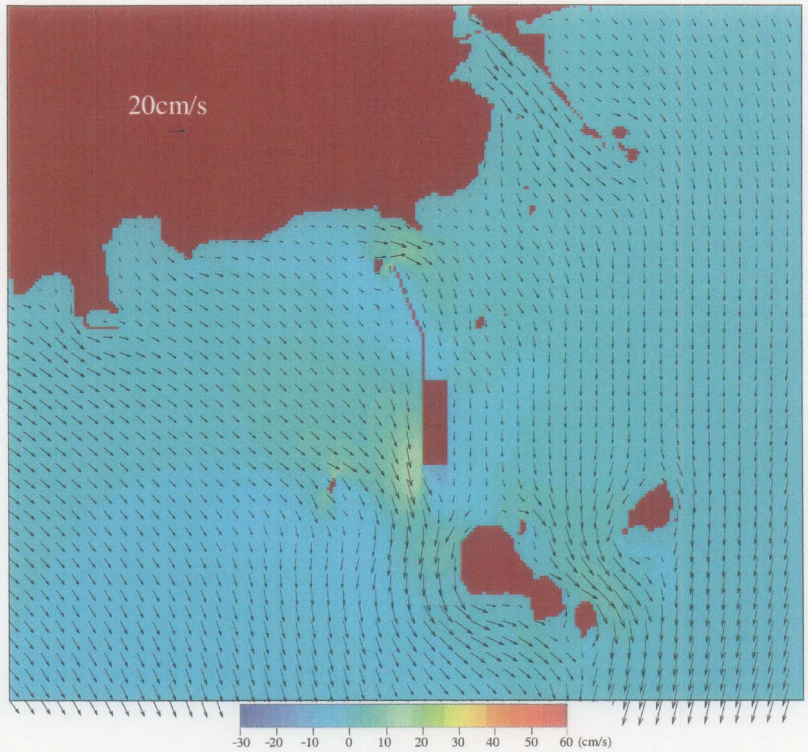


Figure 5.16 Comparison of Current Velocity : Plan C (Causeway + Bridge, Peak Ebb)

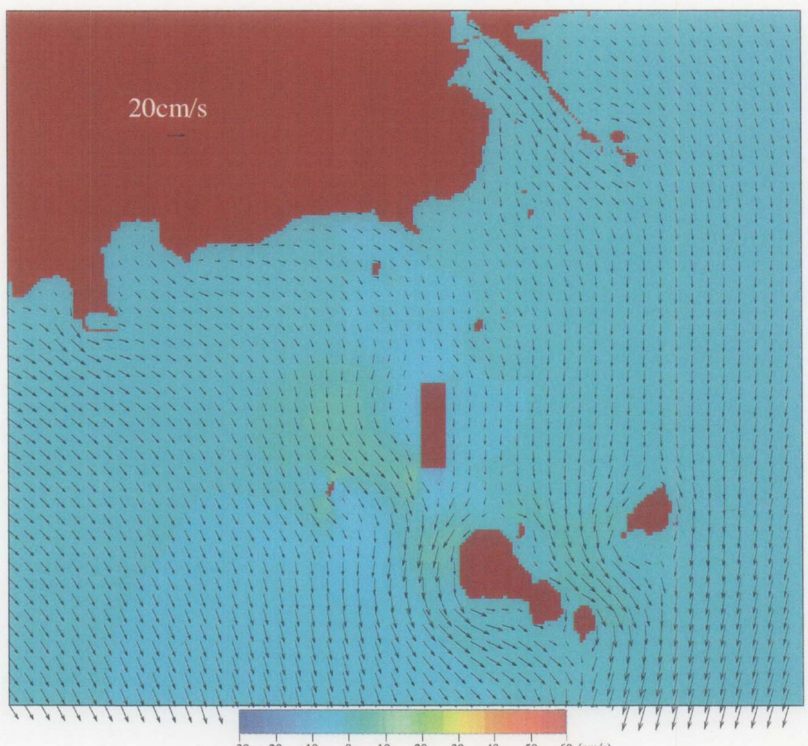


Figure 5.17 Comparison of Current Velocity : Plan C (Bridge, Peak Ebb)

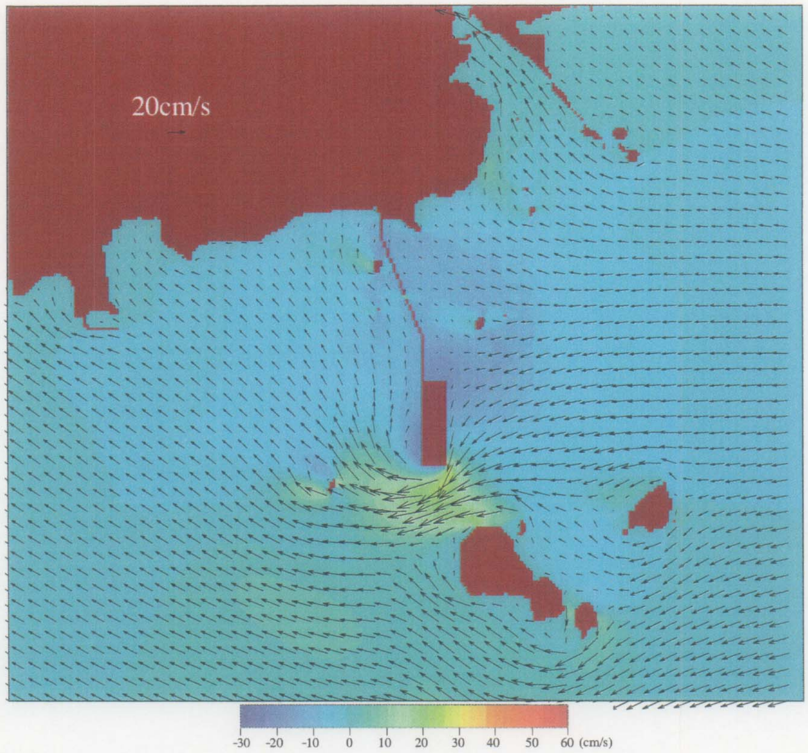


Figure 5.18 Comparison of Current Velocity : Plan C (Causeway, Peak Flood)

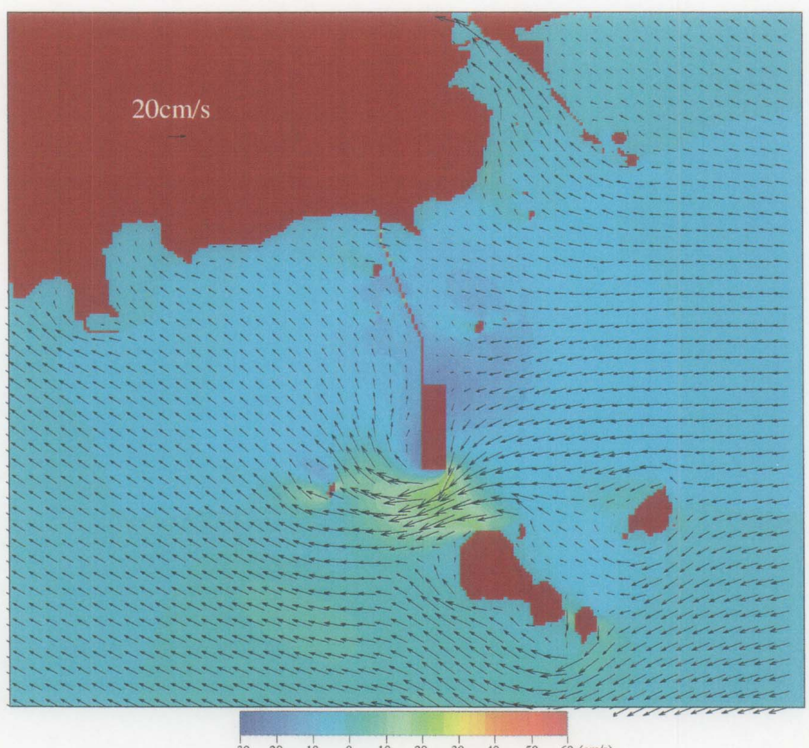


Figure 5.19 Comparison of Current Velocity : Plan C (Causeway + Trestle, Peak Flood)

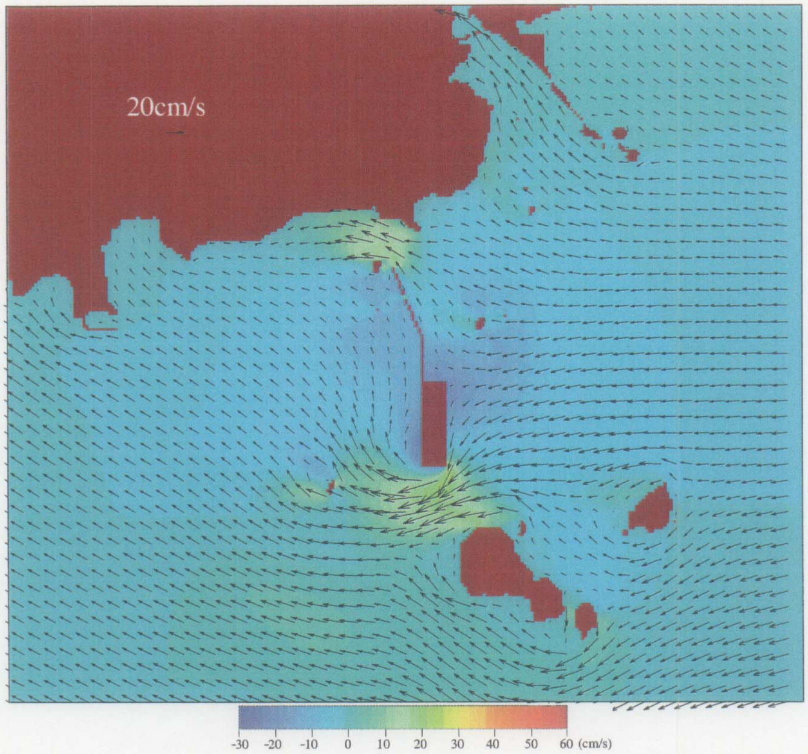


Figure 5.20 Comparison of Current Velocity : Plan C (Causeway + Bridge, Peak Flood)

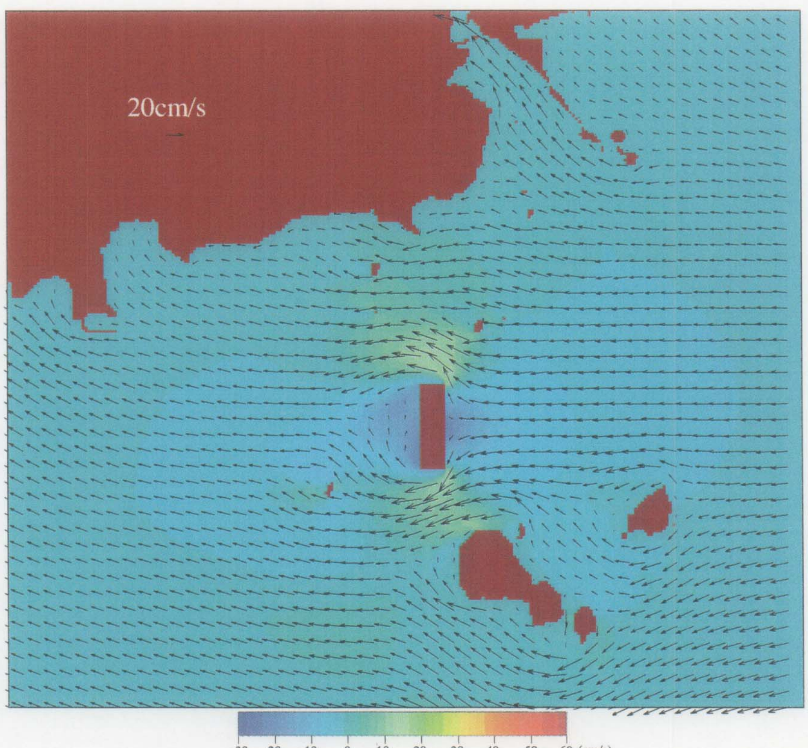


Figure 5.21 Comparison of Current Velocity : Plan C (Bridge, Peak Flood)

5.4 Coastal Condition

The Coastal area around the project site was surveyed to learn about its natural condition. The visual survey was carried out from Punta Bruja to the West towards Bique Bay. It was observed, as can be seen in the following Figure 5.22, that two types of beach conditions are predominant; sandy beach and pebble beach.

Sandy beach was found from the proposed access point to the west until approximately the beginning of the Veracruz town. The sand is mostly light brown with high contents of shells. The areas near the access point are predominately used as a tourist area with the existence of well developed food services which cater to the tourist who visit this area specially during the weekends.

Pebble beach and rocky formations were found further west from this point towards Bique Bay. Some Mangrove trees were also found in this area. This area is predominant throughout the entire length of coast in front of Veracruz Town.

A historical aerial photo analysis was carried out to investigate the natural effects of the waves and currents on the shore; the main purpose of such comparison was to learn if beach erosion conditions were naturally present near the proposed access point. Two images were compared for such purpose, see Figure 5.22; 1984 and 2002, thus providing a 20 year lapse. A blue line was drawn in the shore area in 1984 and the same line was copied and transposed on top of the image from 2002 and it was concluded that beach erosion is not a problem in this area.

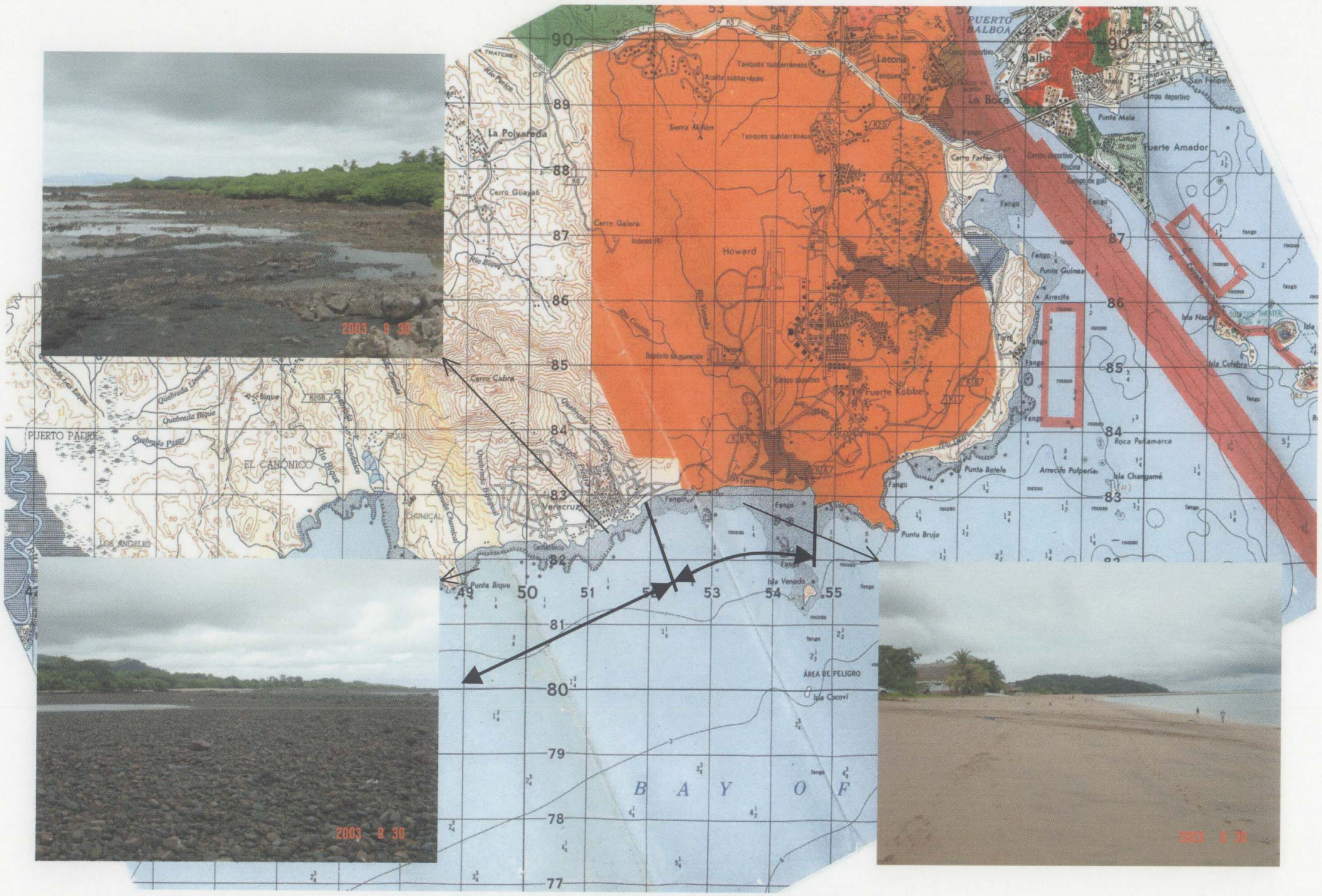


Figure 5.22 Existing Condition of Coast

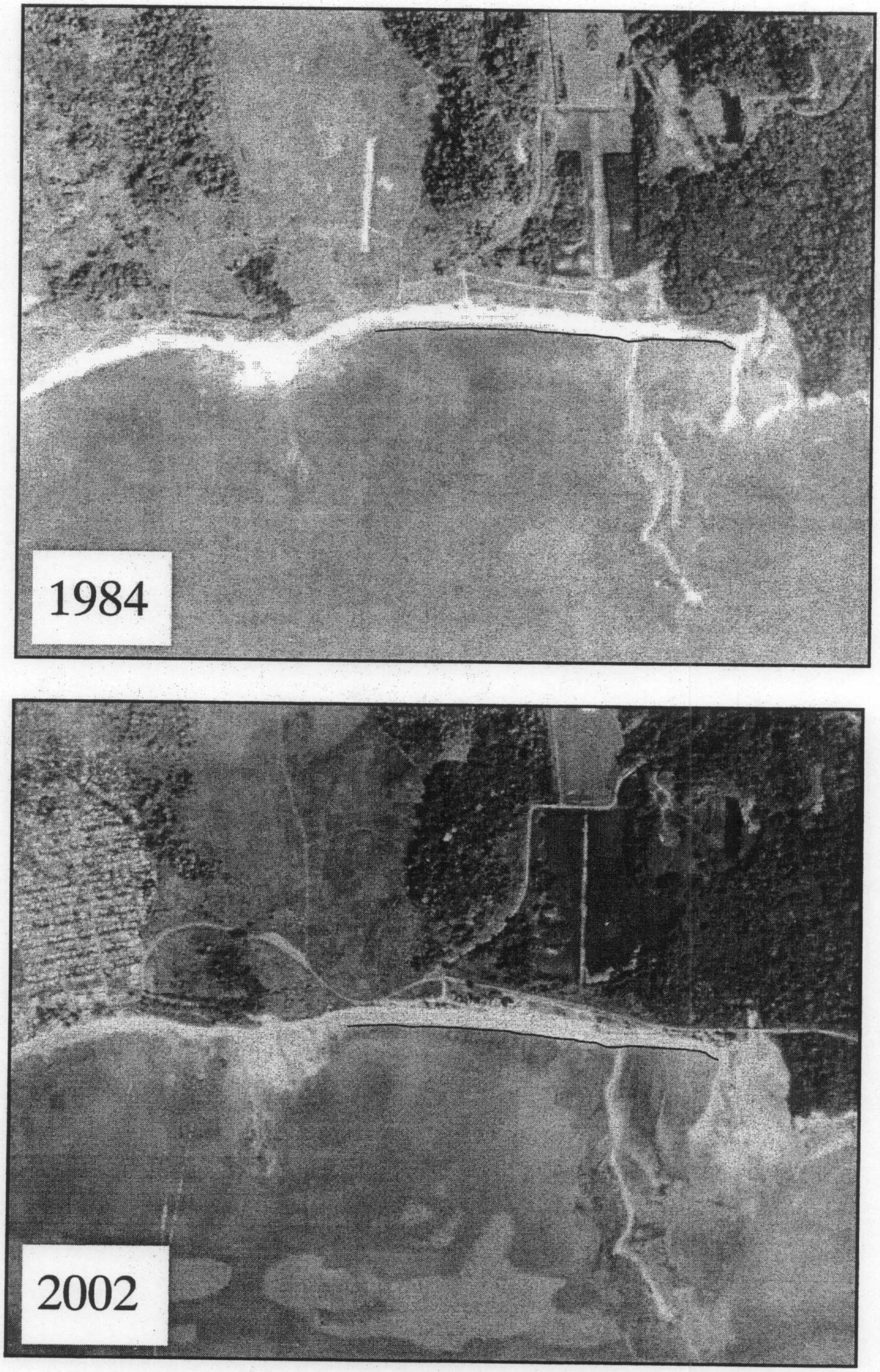


Figure 5.23 Comparison of Coastalline in 1984 and 2002

5.5 Conclusion and Recommendation

The following are concluded based on the mathematical modelling of the effects of the construction of the artificial island and the proposed Accessway:

The construction of the island will change current directions and speeds in some degrees, However such change does not significantly affect the natural current conditions of the bay as a whole. Utmost change in current speeds would occur during the peak flood in the spring tide and it would continue for 30 minutes at most for one time. In other words, it would occur one hour in a day and five (5) hours in total in the month.

The recommended Accessway design shall incorporate a bridge or intermittent trestle sections to avoid any impact on the shore area and to prevent negative effects especially due to the social and environmental value of Veracruz Beach.

The detail design of the location of the opening in the causeway (water passages) shall be subject of further design in a detail design phase; this would require collection of additional data and modelling.

The greater increases in current velocities are reported in the south east corner or the proposed island.

The impact of the increases in the currents velocities from natural condition is more significant in the north part of Taboga Island, however, the increase remains within around 10cm/s from natural condition.

The north part of Taboga island is naturally subject to currents with higher velocities than the rest of the bay area, thus implying that the natural environment in such zone shall already be adapted to such fast current conditions, the increases in this zone are also limited to approximately 10 cm/s.

CHAPTER 6 EVALUATION OF CONTAINER TERMINAL ALTERNATIVES

6.1 Evaluation Criteria

Three (3) container terminal layout alternatives are provided in Chapter 3.2.3. Also, the location of the Artificial Island can be chosen according to the bathymetric and seismic survey results by ACP in addition to the soil exploration by the JETRO Study Team in 2003.

Criteria to be applied in selecting the optimum container terminal alternatives are listed below.

- Calmness
- Terminal Operation
- Current Simulation Results
- Island Construction Cost

6.2 Comprehensive Evaluation

Table 6.2-1 shows the comprehensive evaluation results based on the evaluation criteria described in Chapter 6.1.

From a view point of calmness in the port area, Plan-B and C have sufficient results as detailed in Chapter 4 "Analysis of Wharf Operation Efficiency", while Plan-A needs a breakwater to secure designated calmness in the port.

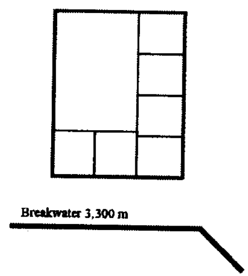
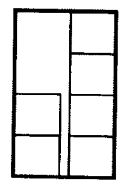
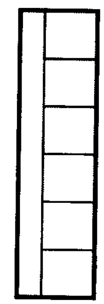
In terms of terminal operation, Plan-C is the best plan since quayside gantry cranes can be utilized to all the berths. On the other hand, it is almost impossible to utilize quayside gantry cranes installed on the south side of the Island for Plan A and the west side of the Island for Plan B for using for the east side berths of the Island.

According to the results of current simulations as indicated in Chapter 5 "Current Analysis", Plan-C will cause the biggest change on currents among the three alternatives although the current change in speed is not so significant.

The island construction cost for Plan-B is a base case and cost difference from the base case for Plan-A and Plan-C is shown in Table 6.2-1. Plan-A is most costly because a breakwater is needed to secure calmness in the port.

Hence, according to the overall evaluation, the recommended container terminal layout is Plan-B.

Table 6.2-1 Evaluation of Container Terminal Layout

	Plan-A	Plan-B	Plan-C
Container Terminal Layout			
Island Area	1,400m * 1,800m = 252 ha	1,100m * 1,800m = 198ha	733m * 2,700m = 198ha
Reclamation Volume	49 M m^3	39 M m^3	40 M m^3
Evaluation Item 1. Port Operation			
1) Calmness (Chap 4 & 6)	AA (100% > 97.5%) (Breakwater is necessary)	A (98.4% > 97.5%)	A (98.0% > 97.5%)
2) Terminal Operation	A	A	AA (Gantry cranes can be utilized to all other berths)
2. Influence to Current	A	A	B #
3. Island Construction Cost	B US$ +135 M)	AA (Base)	A (US$ +54 M)
Comprehensive Evaluation	B	AA	A

Plan-C would cause the most influence to current among the three (3) alternatives. However, this would not affect ship maneuvering so much.

CHAPTER 7 Structural Design of Quaywall and Revetment

7.1 Design Standard

To design sheet pile cellular-bulkhead quaywall, the following Japanese standard is used in this study. This is the most authoritative design code as for water front infrastructure in Japan. Chapter 7 in this standard deals with sheet pile cellular-bulkhead quaywall.

Technical Standards and Commentaries for Port and Harbour Facilities in Japan", *The Overseas Coastal Area Development Institute of Japan*, 1999.

In this study, the above standard is called as "Technical Standards in Japan".

7.2 Design Condition

7.2.1 Design Water Level

Design water levels are set at mean monthly highest high water (M.H.H.W.) and mean monthly lowest low water (M.L.L.W.) as shown in **Table 7.2.1**. In structural design, M.H.H.W. is water level for design case of wave attack. M.L.L.W. is assumed for normal case and seismic attack case in design.

Table 7.2.1 Design Water Level

Design Water Level	Design Case
Mean Monthly Highest High Water (M.H.H.W.)	Wave Attack
Mean Monthly Lowest Low Water (M.L.L.W.)	Normal, Seismic Attack

Furthermore, residual water level in sheet pile cellular-bulkhead quaywall is calculated as:

Residual Water Level = 2/3 (H.W.L. - L.W.L.) + L.W.L (7.2-1)

= M.L.W.S. + 3.41m (7.2-2)

7.2.2 Design Water Depth

Existing water depth and top of bedrock at construction site are set based on the results of seismic surveying given by ACP. For Artificial Island, the planning site is located on bathymetric map as shown in **Figure 7.2.1**. Existing water depth around the construction site distributes from –11.5m to –14.0m. On the other hand, water depth for future container terminal is planned to be M.L.W.S-16.75m. Therefore, dredging is needed for quaywall side (berth side) construction of Artificial Island because the existing water depth is from 11.5m to 14.0m as described previously. On the other hand, revetment side can be constructed on seabed without any dredging works.

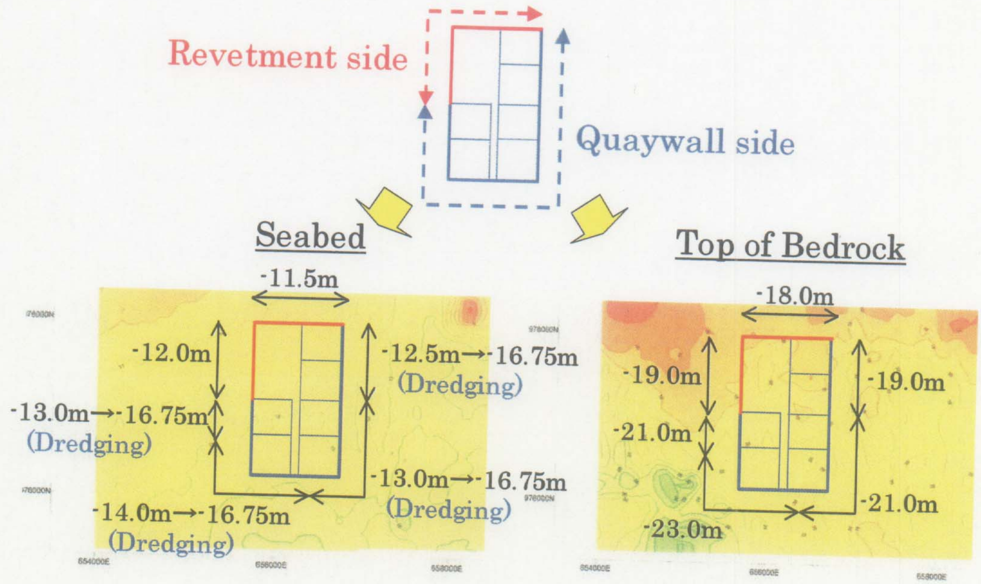


Figure 7.2.1 Water Depth at Artificial Island

7.2.3 Wave Height

In Technical Standards in Japan, Chapter 5 deals with wave force. For calculation of the wave force, it is necessary to decide highest wave height. From Chapter 4 "Analysis of Wharf Operation Efficiency", highest wave height at Artificial Island is set to 3.0m.

7.2.4 Design Ground Level

Decision of Design ground level is important to plan effective use of the berth and to estimate the volume capacity of reclamation. Technical Standards in Japan recommends typical crown heights of mooring facility above high water level as indicated in **Table 7.2.2**. Tidal range in this study accounts approximately for 6 m. Based on this Table, the tidal range is larger than 3m. Water depth is so deep as 16m approximately. This depth belongs to the category for large vessel. Therefore, the crown height should be set at +0.5 to +1.5m upper M.H.H.W..

Table 7.2.2 Typical Crown Heights of Mooring Facility above High Water Level

	When the tidal range is 3.0m or more	When the tidal range is less than 3.0m
Mooring Facilities for Large Vessel (with a water depth of 4.5m or more)	+0.5 ~ 1.5m	+1.0 ~ 2.0m
Mooring Facilities for Small Vessel (with a water depth of less than 4.5m)	+0.3 ~ 1.0m	+0.5 ~ 1.5m

Moreover, considering rain season and squall in Panama, the crown height should be a little higher as +1.655m. Consequently, the Ground level of container terminal is set at MLWS +7.0m (= +5.345m+1.655m) here. Finally, the design water level and the design ground level are summarized in **Figure 7.2.2**.

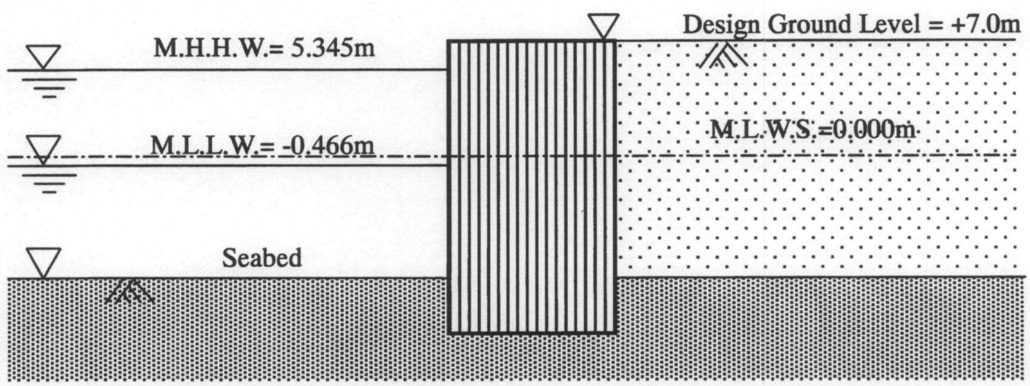


Figure 7.2.2 Design Water Level and Design Ground Level

7.2.5 Design Model for Soil Condition

From boring exploration result in Section 2.3, average of N-value at 5m depth accounts for 24 and clay is a main component of soil. The relation between N-value and unconfined compressive strength is expressed as "qu=12.5N(kN/m²)" by Terzaghi and Peck. Furthermore, the relation between unconfined compressive strength (qu) and cohesion (C) is expressed as the following equation:

$$\text{Cohesion}(C) = qu/2 = 6.25N(kN/m^2) \qquad (7.2\text{-}3)$$

Then, cohesion in 5m depth is assumed to be 150(kN/m²) as the following equation:

$$\text{Cohesion(C)} = 6.25N = 6.25 \times 24 = 150(kN/m^2) \qquad (7.2\text{-}4)$$

In this study, the distribution of cohesion in vertical direction is assumed to form triangular shape (see **Figure 7.2.3**).

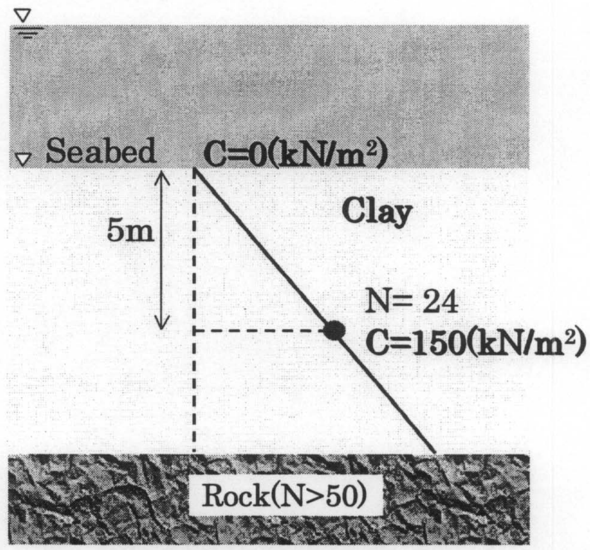


Figure 7.2.3 Design Model for Soil Condition

7.2.6 Seismic Coefficient

As discussed in Section 2.4, the seismic coefficient is set to 0.1 in this study.

7.2.7 Other Condition

Other design conditions are assumed as **Table 7.2.3**. Surcharge on the crown of quaywall and revetment is assumed modestly in consideration of similar facilities in Japan. Soil material for backfilling and inside filling is regarded as stiff rock, which will be easily obtained from the new locks excavation.

Table 7.2.3 Other Design Conditions

Items or Parts		Artificial Island
Surcharge on Quaywall and Revetment	During Construction (Wave Attack)	$0kN/m^2$
	After Construction (Normal)	$20kN/m^2$
	After Construction (Seismic Attack)	$10kN/m^2$
Soil Materials (Backfilling and Inside Filling)	Angle of internal friction	40°
	Specific weight above residual water level	$18kN/m^3$
	Specific weight below residual water level	$10kN/m^3$

7.3 Straight Web-Type Sheet Pile

In production of straight web-types of Steel sheet pile, there are two grades for steel material, SYW295 and SYW390. The difference between SYW295 and SYW390 is chemical composition and mechanical properties. These are regulated by Japanese Industrial Standard (JIS). Chemical composition and mechanical properties are shown in **Table 7.3.1** and **Table7.3.2**, respectively.

Table 7.3.1 Chemical Composition of straight web-type sheet pile

Classification	Grade	Chemical Composition (%)						Ceq. (%)
		C	Si	Mn	P	S	N	
Weldable hot rolled steel sheet piles JIS A 5523	SYW295	0.18 max	0.55 max	1.50 max	0.04 max	0.04 max	0.0060 max	0.44 max
	SYW390	0.18 max	0.55 max	1.50 max	0.04 max	0.04 max	0.0060 max	0.46 max

Note : Ceq.=C+Mn/6+Si/24+Ni/40+Cr/5+Mo/4+V/14

Table 7.3.2 Mechanical Properties of straight web-type sheet pile

Classification	Grade	Mechanical Properties			
		Yield point (N/mm^2)	Tensile strength (N/mm^2)	Elongation (%)	Charpy V-notch toughness[0℃](J)
Weldable hot rolled steel sheet piles JIS A 5523	SYW295	295min	490min	17min	43min
	SYW390	390min	540min	15min	43min

On the other hand, there are four types in web thickness for straight web-types of Steel sheet pile as shown in **Figure 7.3.1**.

FL: Web thickness is 9.5mm.
FL-10.5: Web thickness is 10.5mm.
FXL: Web thickness is 12.7mm.
FXL-13.7: Web thickness is 13.7mm.

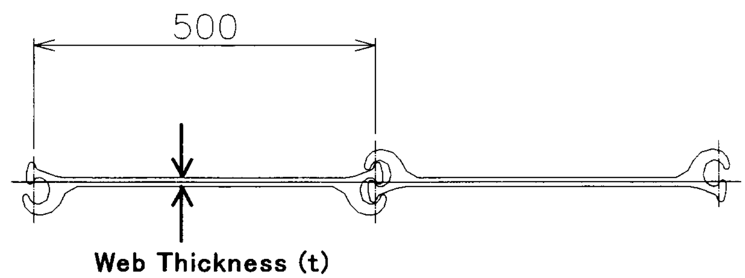


Figure 7.3.1 Straight Web-types of Steel Sheet Pile

The allowable stress of each type is shown in **Table 7.3.3**. The allowable stress allows corrosional reduction of 2mm thickness.

Table 7.3.3 The Allowable Stress of Straight Web-Types of Steel Sheet Pile

Straight Web-Type Steel Sheet Pile (YSP)		FL	FL-10.5	FXL	FXL-13.7
Web Thickness (t)		9.5mm	10.5mm	12.7mm	13.7mm
Allowable Stress	SYW295	1350kN/m	1530kN/m	1926kN/m	2106kN/m
	SYW390	1763kN/m	1999kN/m	2519kN/m	2754kN/m

7.4 Design of Quaywall and Revetment

7.4.1 Loading Cases

The design cases of loading condition are shown in **Table 7.4.1**. Design case is divided into two categories, during construction and after construction. The design case during construction assumes the state that wave attacks sheet pile cellular-bulkhead quaywall just after completion of inside filling. The structures have to withstand individually against wave attack .

On the other hand, the most critical design case after construction assumes the condition when dredging and backfilling are finished. Normal case, in which sheet pile cellular-bulkhead quaywall is subjected to dead load, surcharge and earth pressure, is considered in structural design. Furthermore, seismic force is also considered in the design as seismic attack case.

Table 7.4.1 Design Cases of Loading Condition

Design Case (Period in consideration)	Loading Condition	Design Execution
During Construction	Wave Attack	Considered
After Construction	Normal	Considered
	Seismic Attack	Considered

For example, **Figure 7.4.1** illustrates structural modeling during construction and after construction. In the case during construction, the design situation is that wave attacks sheet pile cellular-bulkhead quaywall when water rises to M.H.H.W.. As total construction period of the structures will be estimated roughly as 2 years or less, the design wave height is assumed as 3.0m based on Section 7.2.3.

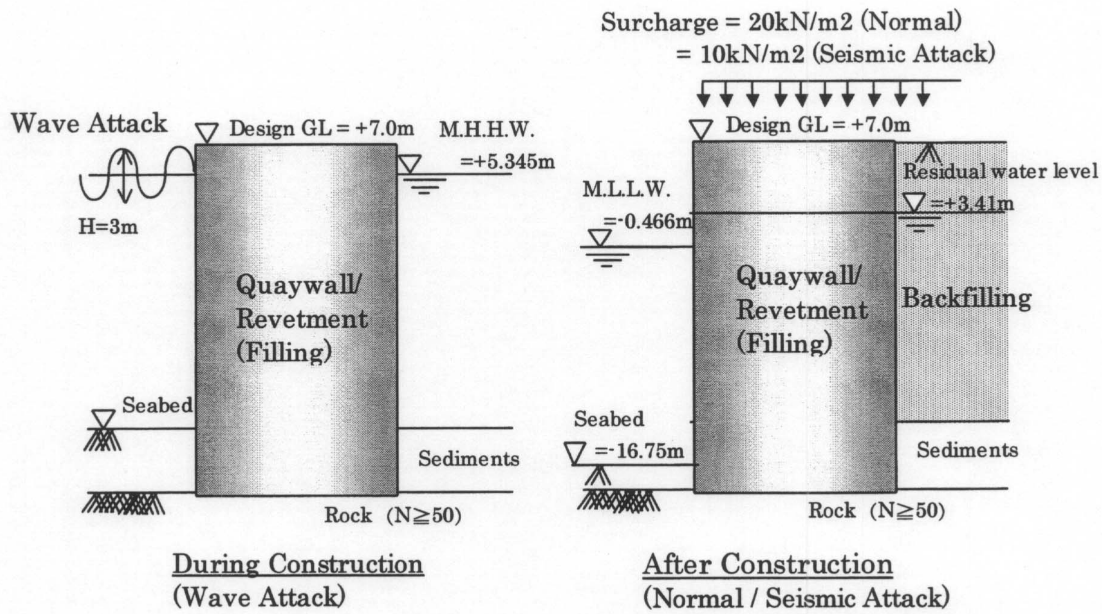


Figure 7.4.1 Structural Modeling for Loading Cases

Empty condition of cellular-bulkhead quaywall is not considered in the design. Inside filling should be carried out fastly in calm weather because empty condition of the structures is quite unstable against storm wave. Inside filling needs only 1 to 2 days for one sheet pile cellular-bulkhead quaywall.

In the case after construction, sheet pile cellular-bulkhead quaywall is subjected to earth pressure from backfilling and surcharge. Surcharge is set at 20kN/m^2 in normal case and 10kN/m^2 in seismic attack case. Water level is set at M.L.L.W. in front of the structure. Residual water level in the structure and backfilling rises 3.41m from M.L.L.W.. It is noted that the seabed in front of guaywall is dredged from existing water level to berth (design) water level of -16.75m.

7.4.2 Design Method of Steel Sheet Pile Cellular-bulkhead Quaywall

(1) Design Flowchart

Design flowchart for sheet pile cellular-bulkhead quaywall is introduced in **Figure 7.4.2**. Each design step is explained briefly in this section.

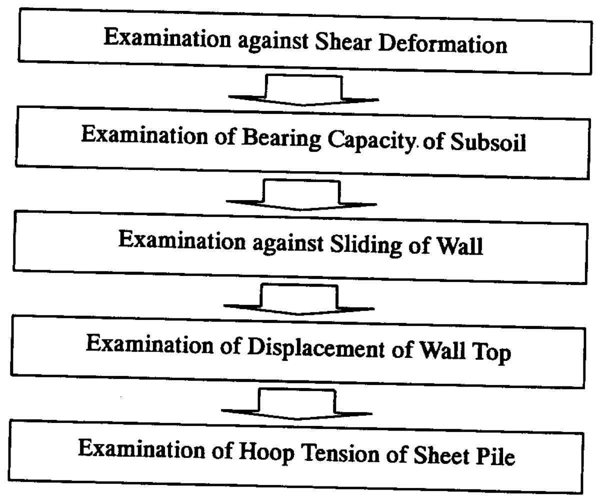


Figure 7.4.2 Design Flowchart for Sheet Pile Cellular-bulkhead Quaywall

(2) Examination against Shear Deformation

Firstly, steel sheet pile cellular-bulkhead quaywall should keep the initial shape from illegal deformation as shear deformation or bending. **Figure 7.4.3** illustrates the design model for shear deformation.

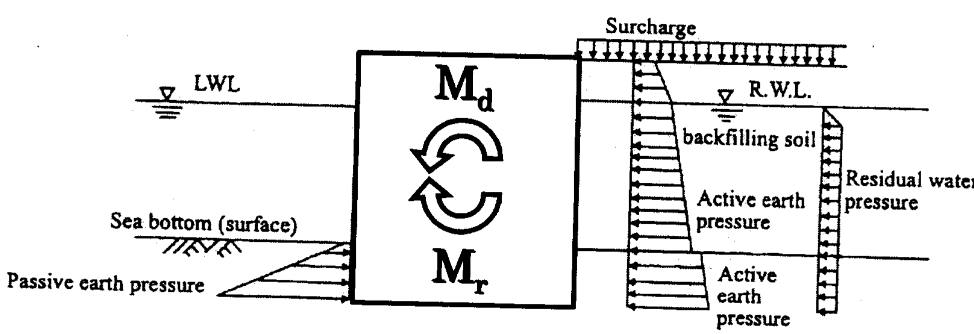


Figure 7.4.3 Shear Deformation

Resisting moment should be larger than deformation moment as the following equation:

$$M_r > M_d\,F \qquad (7.4\text{-}1)$$

where M_r : Resisting moment (Filling , Friction force of sheet pile joint)
M_d : Deformation moment (Earth pressure , Residual water pressure)
F : Safety factor (= 1.2)

Earth pressure and residual water pressure bring out deformation moment. Resisting moment is given by inside filling and friction resistance in sheet pile joints. Safety factor should be kept larger than 1.2 according to Technical Standards in Japan (1999). Generally, this shear deformation is apt to be the most critical in shape deformations. In this study, this case is critical as well.

(3) Examination of Bearing Capacity of Subsoil

Secondly, bearing capacity should be examined as illustrated in **Figure 7.4.4**. This is one of the evaluations for global stability.

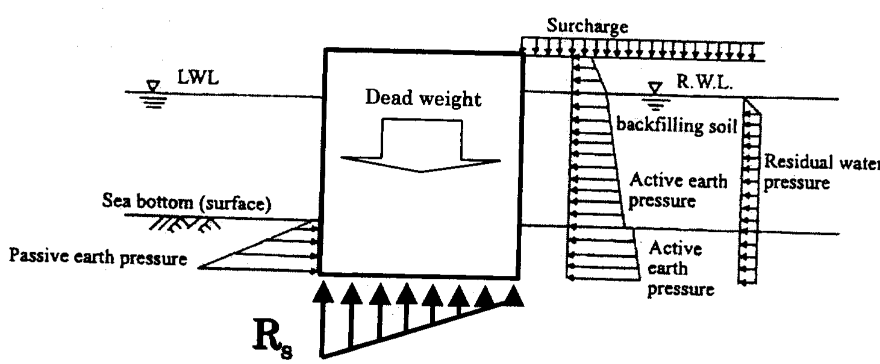


Figure 7.4.4 Bearing Capacity of Subsoil

Subgrade reaction acting on the wall bottom is calculated with dead weight of cellular-bulkhead quaywall combined by the deformation moment explained in previous page. Safety factor is set at 3 as shown in the following:

$$B_c > R_s F \qquad (7.4\text{-}2)$$

where B_c : Bearing capacity

R_s : Subgrade reaction acting on the wall bottom
(Dead weight , Earth pressure , Residual water pressure)

F : Safety factor (= 3)

In this study, this examination cannot be any serious problems because bearing soil layer has a sufficient bearing capacity.

(4) Examination against Sliding of Wall

Another examination in terms of global stability is against sliding of wall as shown in **Figure 7.4.5**.

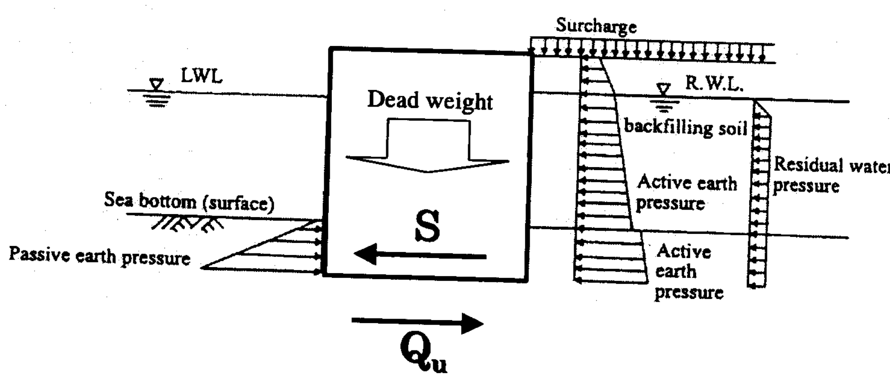


Figure 7.4.5 Sliding of Wall

Shear resistance force given from friction between the wall and the ground should be larger than acting shear force. Safety factor should be kept larger than 1.2 as the following:

$$Q_u > S F \qquad (7.4\text{-}3)$$

where Q_u : Shear resistance force acting between the wall and the ground

S : Shear force acting between the wall and the ground (Earth pressure , Residual water pressure)

F : Safety factor (= 1.2)

(5) Examination of Displacement of Wall Top

Next, horizontal displacement of wall top is examined. Horizontal displacement in quaywall's rotation is brought out by earth pressure, waves and earthquakes. Rotational displacement is sustained by the subgrade. Horizontal displacement can be calculated in spring model with coefficient of subgrade reaction as shown in **Figure 7.4.6**.

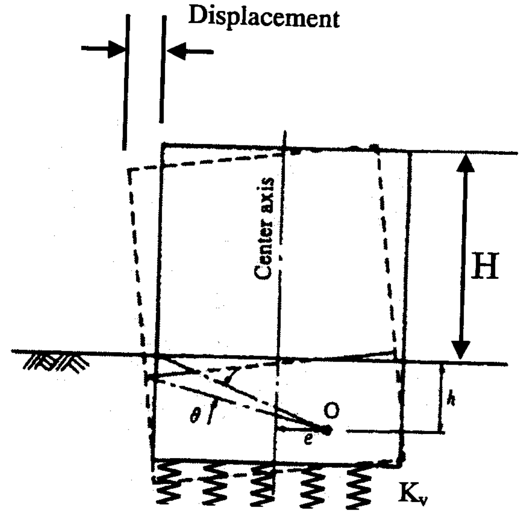


Figure 7.4.6
Horizontal Displacement of Wall Top

In this Figure, H and K_v represent the wall height and the modulus of vertical subgrade reaction, respectively. Allowable horizontal displacement is often set to 1.5% of wall height and 20cm empirically in Japan as:

Displacement < 0.015 H (Structural stability : 1.5%) (7.4-4)

< 20 cm (Safety of approaching) (7.4-5)

As a result of calculation, the horizontal displacement accounts for 1 or 2 cm only in this study because of no earthquakes in Panama and bearing soil layer.

(6) Examination of Hoop Tension of Sheet Pile

Last examination is hoop tension of sheet pile as illustrated in **Figure 7.4.7**. As shown in the left figure, large earth pressure acts on the bottom of quaywall. As shown in the right figure, the hoop tension occurs in circumferential direction.

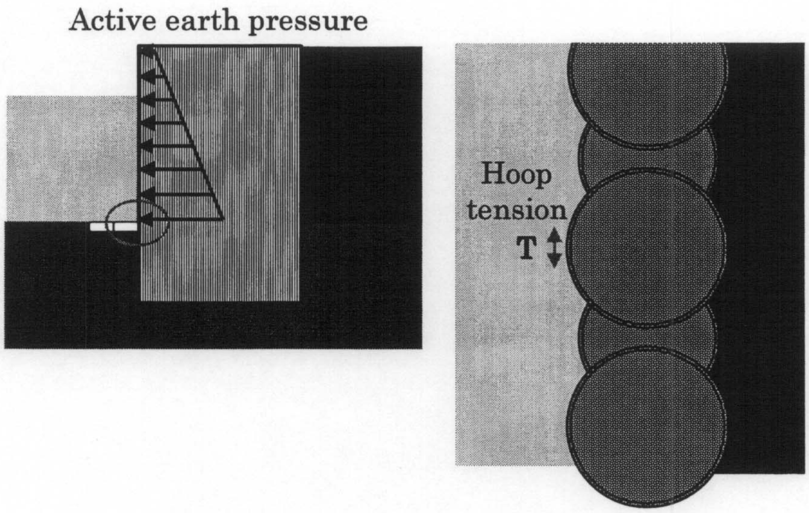


Figure 7.4.7 Hoop Tension of Sheet Pile

Steel sheet pile should resist against this hoop tension as follows:

$$T_a > T \qquad (7.4\text{-}6)$$

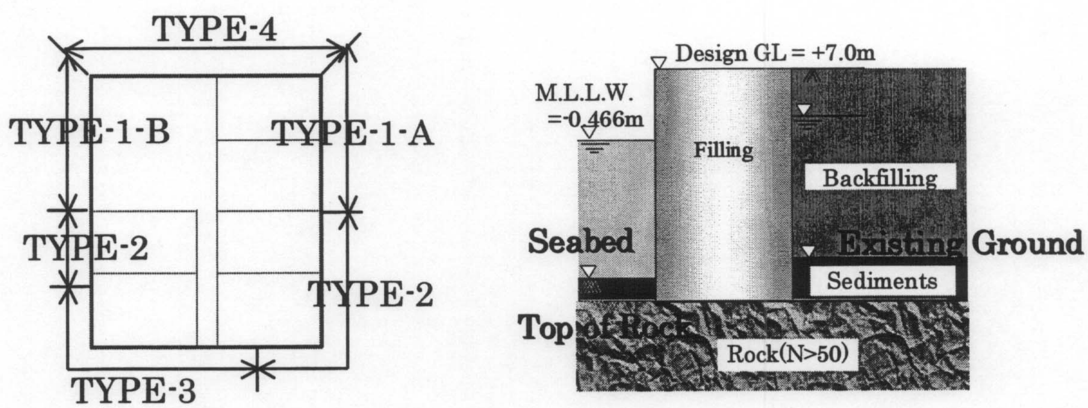
where T_a : Allowable sheet pile tension value

T : Hoop tension of sheet pile

Tensional strength of joints of steel sheet pile produced in Japan is designed stronger than full-sectional strength of steel web.

7.4.3 Design Results

Structural design was executed in terms of each part of Artificial Island as shown in **Figure 7.4.8**. These five design model types are difference in existing ground (seabed) level, planning seabed level and top level of bedrock. These level differences are indicated in **Table 7.4.2**. TYPE1-A, 2 and 3 are designed as quaywall. TYPE1-B and 4 are designed as revetment.



a) Location of Design Model Types **b)Section of Quaywall / Revetment**

Figure 7.4.8 Design Model Type

Table 7.4.2 Design Level of Existing Water Depth, Seabed and Top of Bedrock

TYPE	Existing Ground	Seabed in Plan	Top of Rock	Design for
TYPE-1-A	-12.5m	-16.75m	-19.0m	Quaywall
TYPE-1-B	-12.0m	-12.0m	-19.0m	Revetment
TYPE-2	-13.0m	-16.75m	-21.0m	Quaywall
TYPE-3	-14.0m	-16.75m	-23.0m	Quaywall
TYPE-4	-11.5m	-11.5m	-18.0m	Revetment

The designed results for steel sheet pile cellular-bulkhead quaywall are shown in **Table 7.4.3** for quaywall side and **Table 7.4.4** for revetment side, respectively. Design criteria of all types are "normal case". As a result of design, the diameter of cell lead to 21.0m for Type-1-A, B and Type-2 and Type-3. For Type-4, the diameter of cell leads to 17.2m. Straight web-type of Type-1-A and B are YSP-FXL SYW390. Straight web-type of Type-2 and 3 are YSP-FXL-13.7 SYW390. Straight web-type of Type-4 are YSP-FL-10.5 SYW390. Total weight of sheet pile of both quaywall side and revetment side accounts for 87,564 ton. For each types, the most critical design values were derived from shear deformation and hoop tension in sheet pile.

Table 7.4.3 Design Results of Quaywall Side

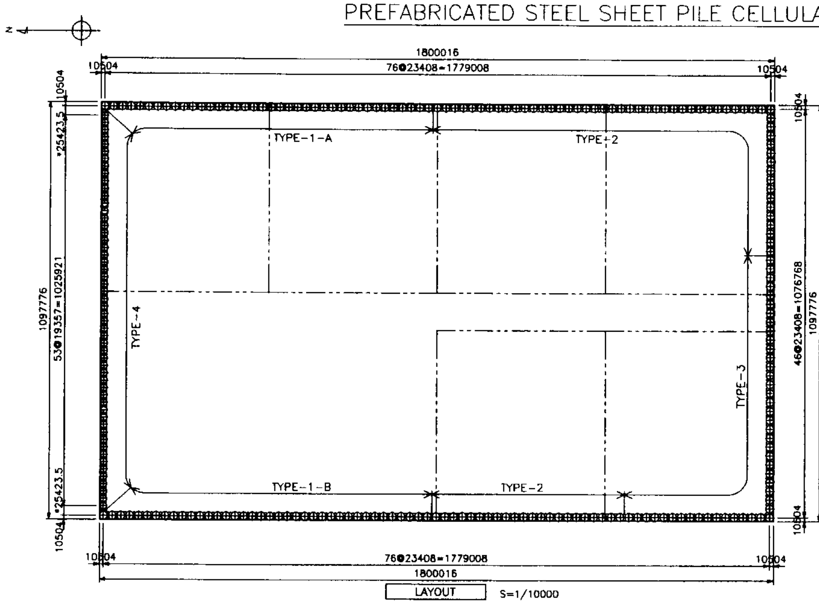
		TYPE-1-A	TYPE-2	TYPE-3
Design criteria		**Normal**	**Normal**	**Normal**
Specification	Sheet pile	YSP-FXL **SYW390**	YSP-FXL-13.7 **SYW390**	YSP-FXL-13.7 **SYW390**
	Cell's diameter	**21.0m**	**21.0m**	**21.0 m**
	Cell's central scale	**23.4 m**	**23.4 m**	**23.4 m**
Examination	Shear deformation	**1.43** > 1.2 OK	**1.28** > 1.2 OK	**1.20**= 1.2 OK
	Bearing capacity	621kN/m² < 4,341 OK	709kN/m² < 4,988 OK	772kN/m² < 5,635 OK
	Sliding	2.0 > 1.2 OK	2.4 > 1.2 OK	2.9 > 1.2 OK
	Displacement of wall top	1.3cm < 20 OK	1.6cm < 20 OK	1.8cm < 20 OK
	Sheet pile tension	**2,516kN/m** < 2,519 OK	**2,560kN/m** < 2,754 OK	**2,646kN/m** < 2,754 OK

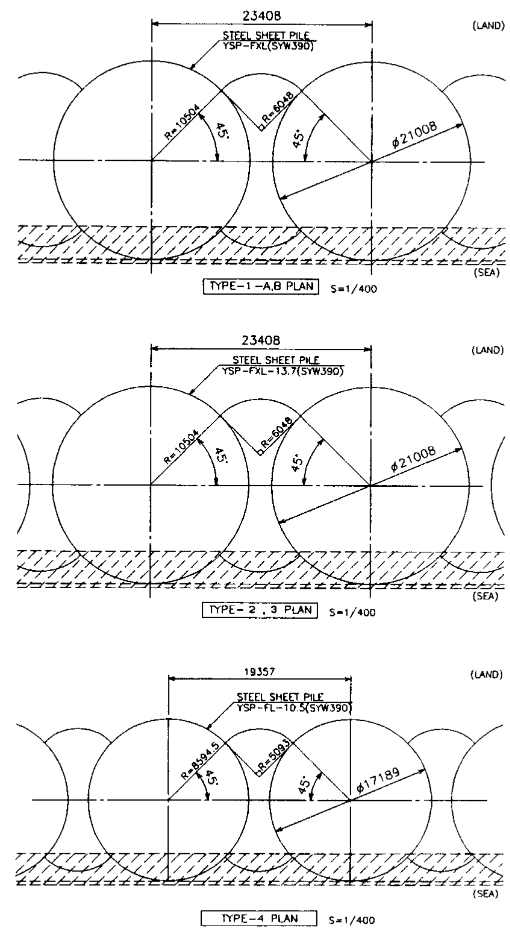
Table 7.4.4 Design Results of Revetment Side

		TYPE-1-B	TYPE-4
Design criteria		Normal	Normal
Specification	Sheet pile	YSP-FXL SYW390	YSP-FL-10.5 SYW390
	Cell's diameter	21.0m	17.2 m
	Cell's central scale	23.4 m	19.4 m
Examination	Shear deformation	1.91 > 1.2 OK	1.24 > 1.2 OK
	Bearing capacity	546kN/m² < 5,878 OK	632kN/m² < 5,061 OK
	Sliding	3.4 > 1.2 OK	3.2 > 1.2 OK
	Displacement of wall top	1.0cm < 20 OK	1.5cm < 20 OK
	Sheet pile tension	2,473kN/m < 2,519 OK	1,988kN/m < 1,999 OK

Finally, the design drawings of quawall side and revetment side are shown in **Figure 7.4.9**. The vertical sections of sheet pile cellular-bulkhead quaywall are drawn in **Figure 7.4.10, 7.4.11, 7.4.12**. Inside filling is made of crushed stone which can be obtained from the new locks excavation.

PREFABRICATED STEEL SHEET PILE CELLULAR-BULKHEAD QUAYWALLS





	Item	Type	Steel Grade	Length m	No. of pieces	No. of Cells	Unit Mass kg/m	Total Mass ton
Sheet Pile								
TYPE-1-A	Main Body	YSP-FXL	SYW390	25.500	4864	38	77.20	9,575.3
	Arc	YSP-FXL	SYW390	25.500	1460	38	77.20	2,874.1
TYPE-1-B	Main Body	YSP-FXL	SYW390	25.500	4864	38	77.20	9,575.3
	Arc	YSP-FXL	SYW390	25.500	1460	38	77.20	2,874.1
TYPE- 2	Main Body	YSP-FXL-13.7	SYW390	27.500	9856	77	81.00	21,954.2
	Arc	YSP-FXL-13.7	SYW390	27.500	2772	77	81.00	6,174.6
TYPE- 3	Main Body	YSP-FXL-13.7	SYW390	29.500	5888	46	81.00	14,069.4
	Arc	YSP-FXL-13.7	SYW390	29.500	1656	46	81.00	3,957.0
TYPE- 4	Main Body	YSP-FL-10.5	SYW390	24.500	5616	54	65.00	8,943.5
	Arc	YSP-FL-10.5	SYW390	24.500	1620	54	65.00	2,579.9
Joint-Sheet Pile								
TYPE-1-A	Main Body	YSP-FXL	SYW390	25.500	152	38	115.80	448.8
TYPE-1-B	Main Body	YSP-FXL	SYW390	25.500	152	38	115.80	448.8
TYPE- 2	Main Body	YSP-FXL-13.7	SYW390	27.500	308	77	121.50	1,029.1
TYPE- 3	Main Body	YSP-FXL-13.7	SYW390	29.500	184	46	121.50	659.5
TYPE- 4	Main Body	YSP-FL-10.5	SYW390	24.500	216	54	97.50	516.0
						Sheet Pile	82,577.4 ton	
						Joint-Sheet Pile	3,102.2 ton	
						Total Mass	85,679.6 ton	

* YSP-FXL-13.7 :FXL-Modified,Thickness = 13.7mm
YSP-FL-10.5 :FL-Modified,Thickness = 10.5mm

8001-OP_NO_C_NO_R4.DWG

Figure 7.4.9 Plan of Steel Sheet Pile Cellular-bulkhead Quaywall

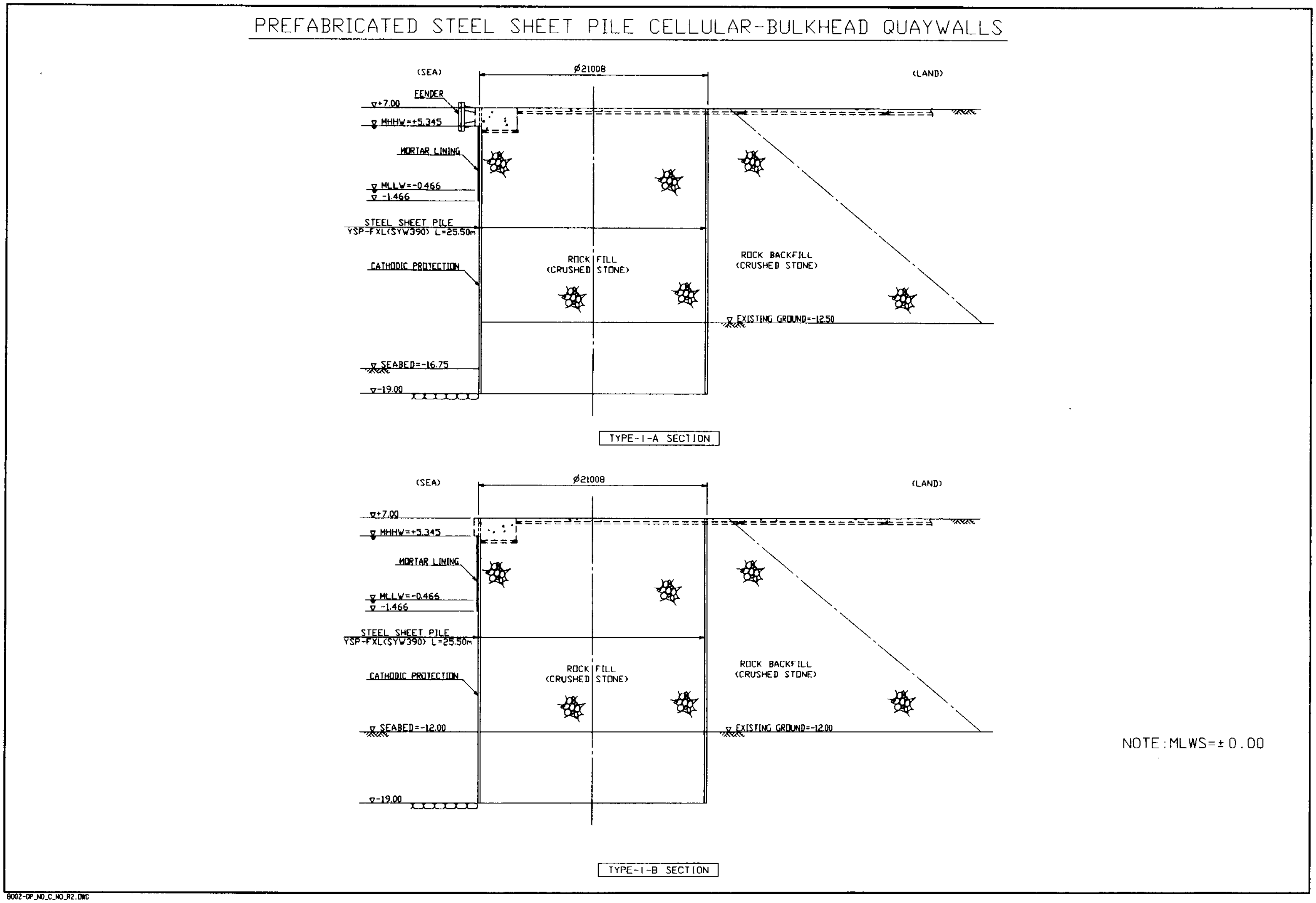


Figure 7.4.10 Section of Steel Sheet Pile Cellular-bulkhead Quaywall (TYPE-1-A,1-B)

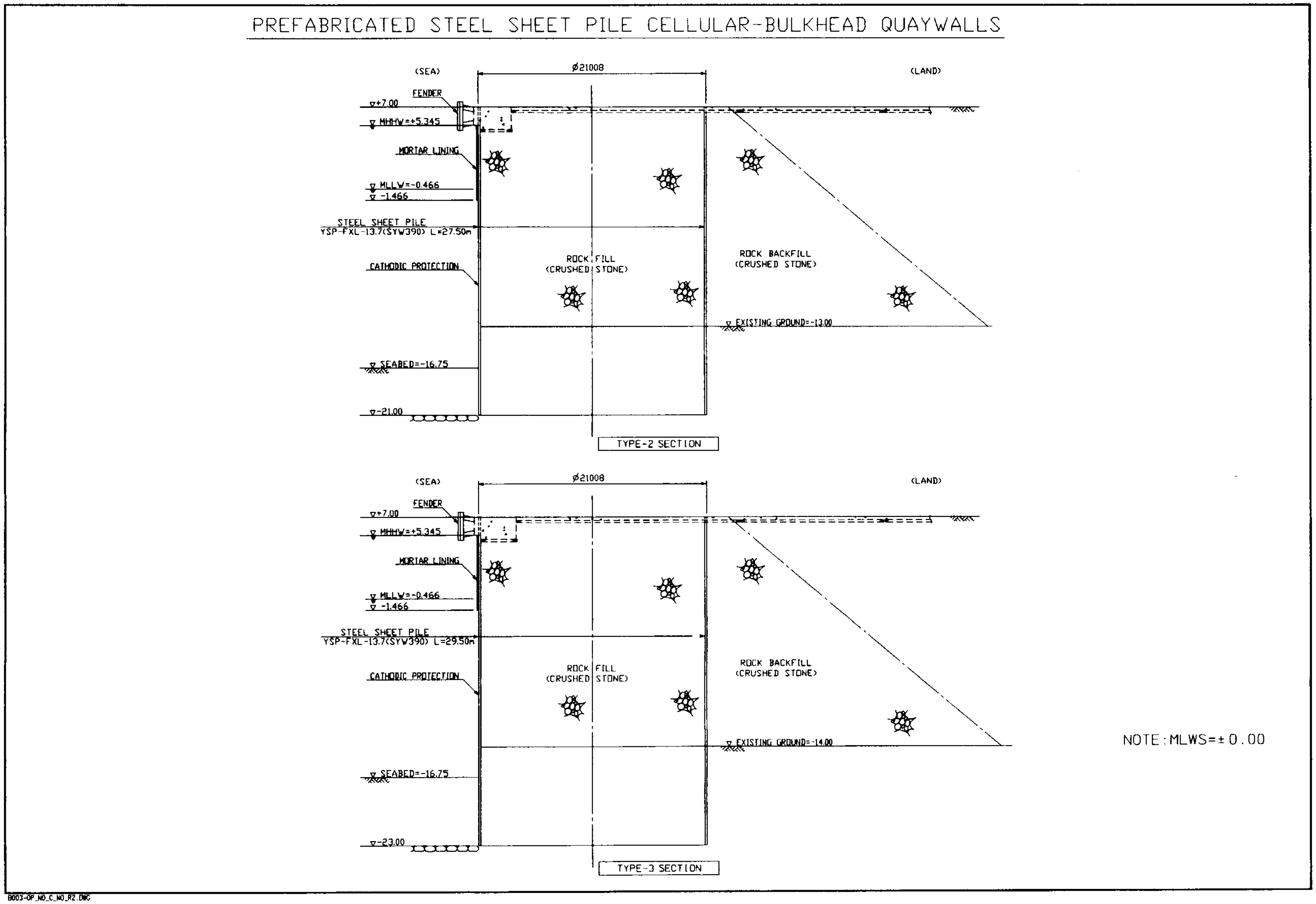


Figure 7.4.11 Section of Steel Sheet Pile Cellular-bulkhead Quaywall (TYPE-2,3)

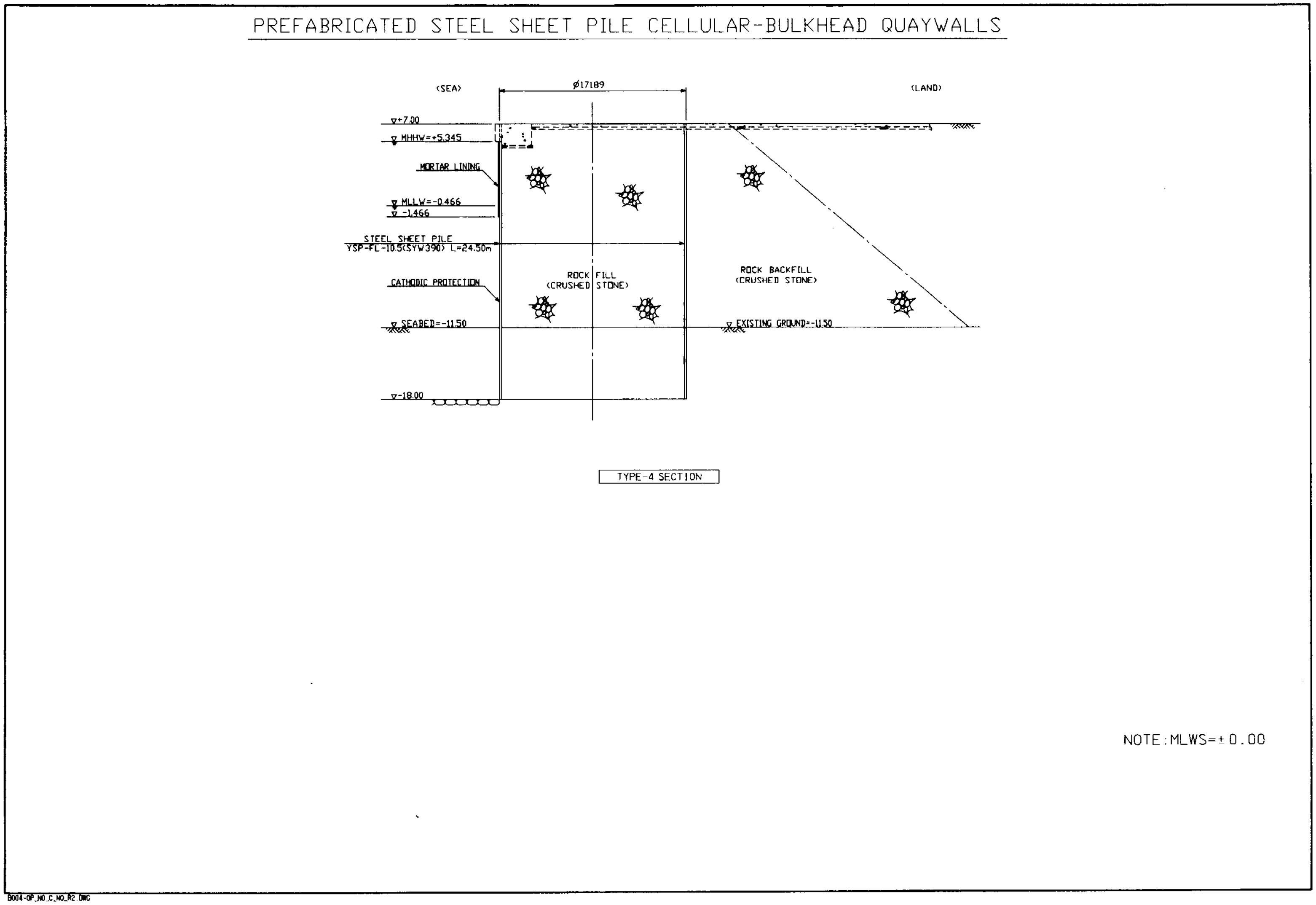


Figure 7.4.12 Section of Steel Sheet Pile Cellular-bulkhead Quaywall (TYPE-4)

7.4.4 Anti-corrosion for Steel Sheet Pile

Steel material is very durable in strength but not in corrosion. Countermeasure as anti-corrosion should be considered for steel sheet pile. **Figure 7.4.13** shows the anti-corrosion plan for steel sheet pile in this study. Two major countermeasures are introduced as mortar lining and cathodic protection.

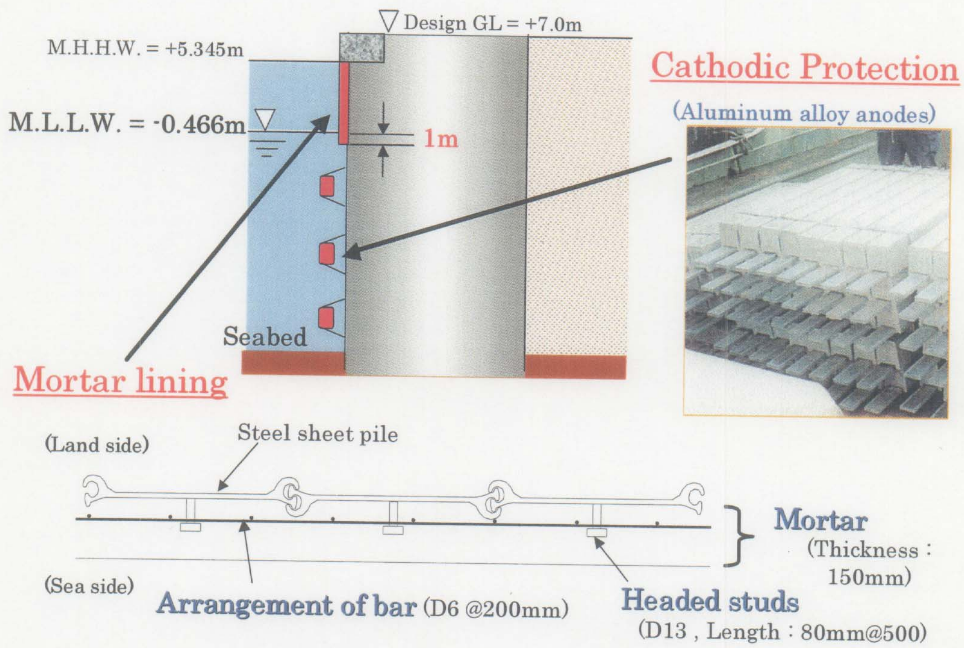


Figure 7.4.13 Anti-corrosion for Steel Sheet Pile

Mortar lining covers and protects the surface of steel sheet pile above level of M.L.L.W.–1m, including splash zone. This is because the splash zone is apt to be not only corroded but also injured by flowing objects as wooden piece and disposal wastes. Mortar thickness is 150mm. After the studs will be welded on the sheet pile surface, the wire mesh and formwork will be installed then cast the mortar. Above Mean Sea Level (M.S.L = +2.63m) the work will be carried out typically using scaffolding. Under M.S.L., the lining will be carried out underwater therefore, the mortar mixture is that design for underwater mortar.

In seawater under the level of M.L.L.W.-1m, cathodic protection with aluminum alloy anodes is suitable to keep the steel material from corrosion. Anodes, which hanged temporarily on the Cellular by track crane, will be installed on the sheet pile surface by diver's underwater welding. It is noted that aluminum alloy anodes must be renewed regularly, according to the speed of alloy consumption.

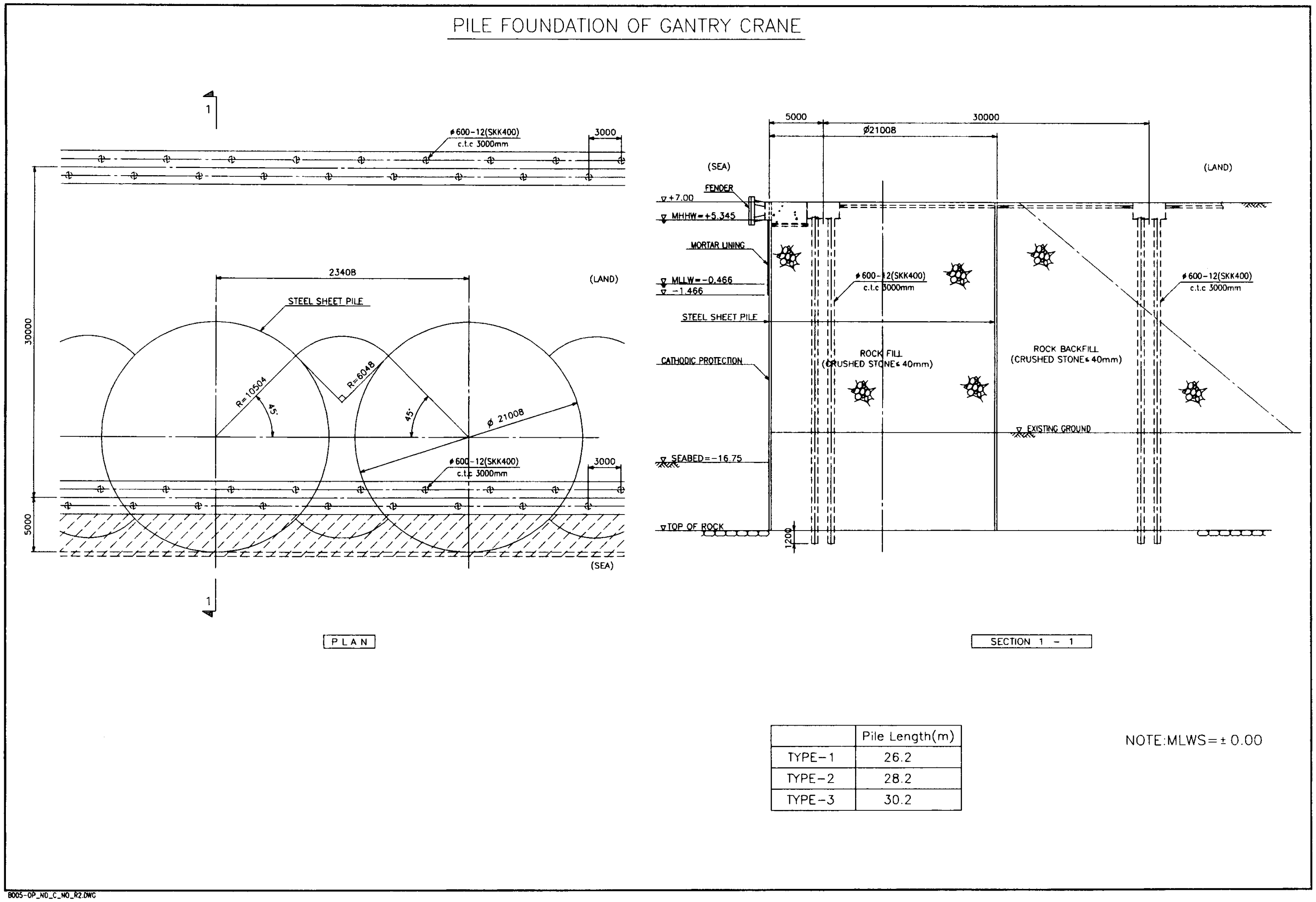
7.5 Design of Foundation of Gantry Crane

This Section explains briefly the design of gantry crane for quaywall side as berth facility. The loading condition of gantry crane (carrying capacity of 80ton) is assumed as **Table 7.5-1**. Span of crane legs is planned as 30m.

Table 7.5.1 Loading Condition for Gantry Crane

	Sea Side		Land Side	
No. of Legs	2		2	
Travel Weels	8wheels per leg		8 wheels per leg	
Loading Condition	Vertical Load	Horizontal Load	Vertical Load	Horizontal Load
In Working	446kN	—	377kN	—
Storm	637kN	73.5kN	539kN	63.7kN
Earthquake	353kN	—	348kN	—

Gantry crane is sustained by pile foundation. The steel pile (ϕ600×12, L =26.2~30.2m) is used as the pile material. The details of design method and design values are omitted in this report. The designed drawing of pile foundation is shown in **Figure 7.5.1**.



	Pile Length(m)
TYPE-1	26.2
TYPE-2	28.2
TYPE-3	30.2

Figure 7.5.1 Pile Foundation of Gantry Crane in Quaywall Side

CHAPTER 8 CONSTRUCTION PLAN OF ARTIFICIAL ISLAND

8.1 General

Panama Artificial Island is planned by reclamation within the sheet pile cellular cofferdam using excavated materials from the new Panama Canal construction. Construction workflow for construction of artificial island is shown in Figure 8.1.1.

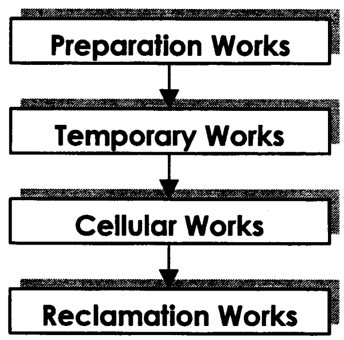
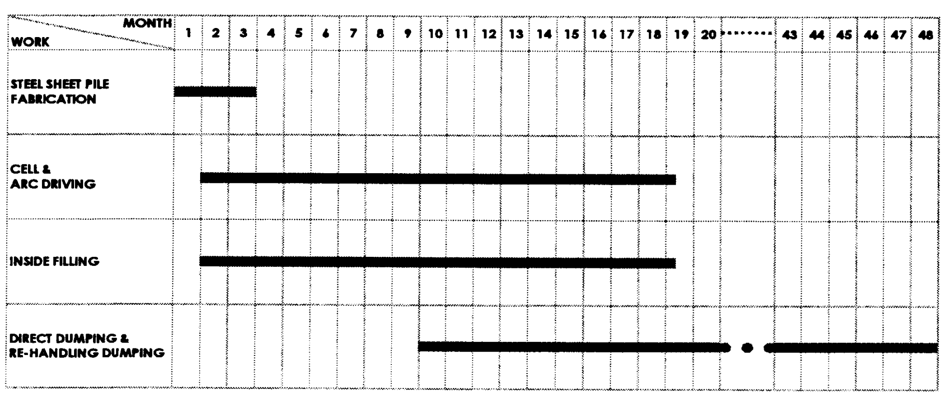


Figure 8.1.1 Workflow for Construction of Artificial Island

8.2 Construction Schedule

Construction schedule for Panama Artificial Island is shown in Table 8.2.1.

Table 8.2.1 Construction Schedule



8.3Preparation Work

8.3.1 Pre-construction Survey

The location area shall be surveyed to determine the seabed level by multi-beam system or echo sounder prior to the artificial island construction work. Multi-beam system transmits and receives fan-shaped multi-frequencies sound waves simultaneously. Therefore, seabed will be surveyed by certain width at the same time and survey work for the extensive area will be more efficient. The survey boat is positioned by the Differential Global Positioning System (DGPS), which receives the signals from plural satellites, and position data are combined and recorded with water depth data. Such data will be used as the input for the reclamation and dredging volume calculation. Method of sounding using multi-beam is shown in Figure 8.3.1.1.

In addition, magnetometer survey will be carried out to detect artificial obstructions such as sunken wrecks.

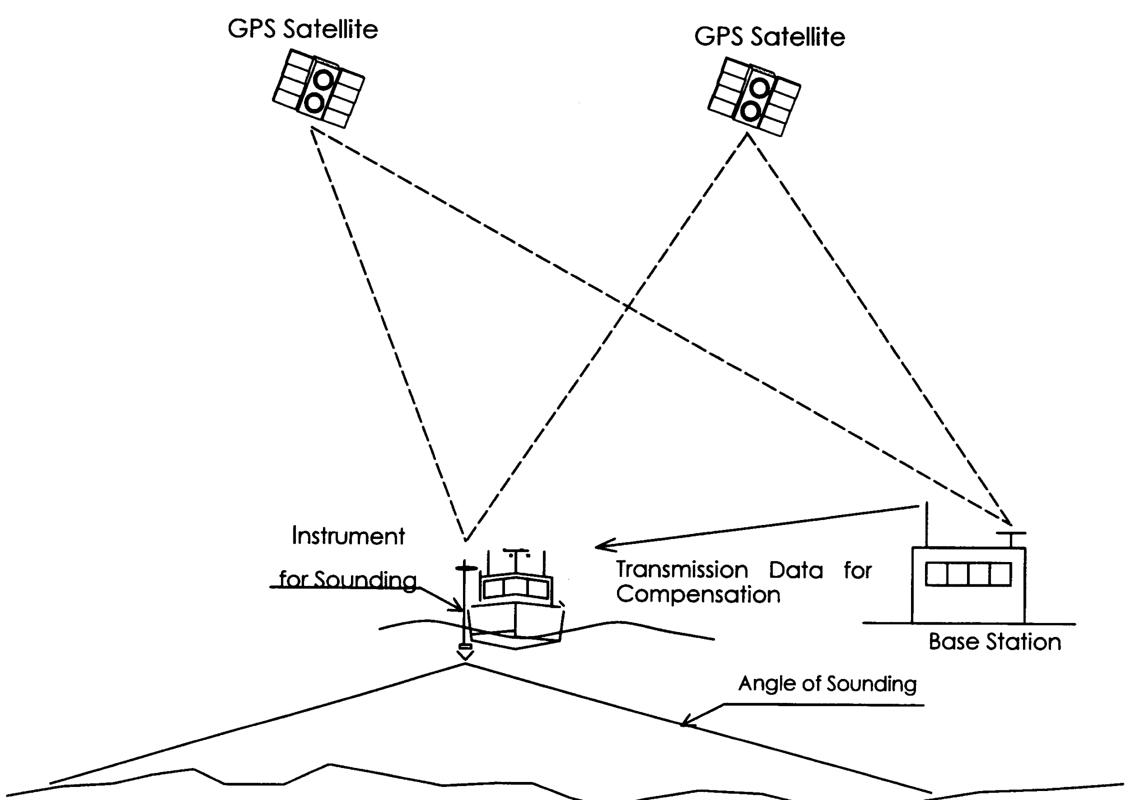


Figure 8.3.1.1 Sounding Using Multi-Beam

8.3.2 Soil Investigation Work

Soil investigation will be carried out in order to determine the detailed subsoil conditions. Marine boring will be conducted using the jack-up platform. DGPS will be used for the positioning of the boring location. In-situ test such as, Standard Penetration Test and the laboratory test for grain-size analysis, compressive strength test etc., will also be carried out. Obtained soil data will be utilized for the detailed designing and construction planning. Soil investigation is shown in Figure 8.3.2.1.

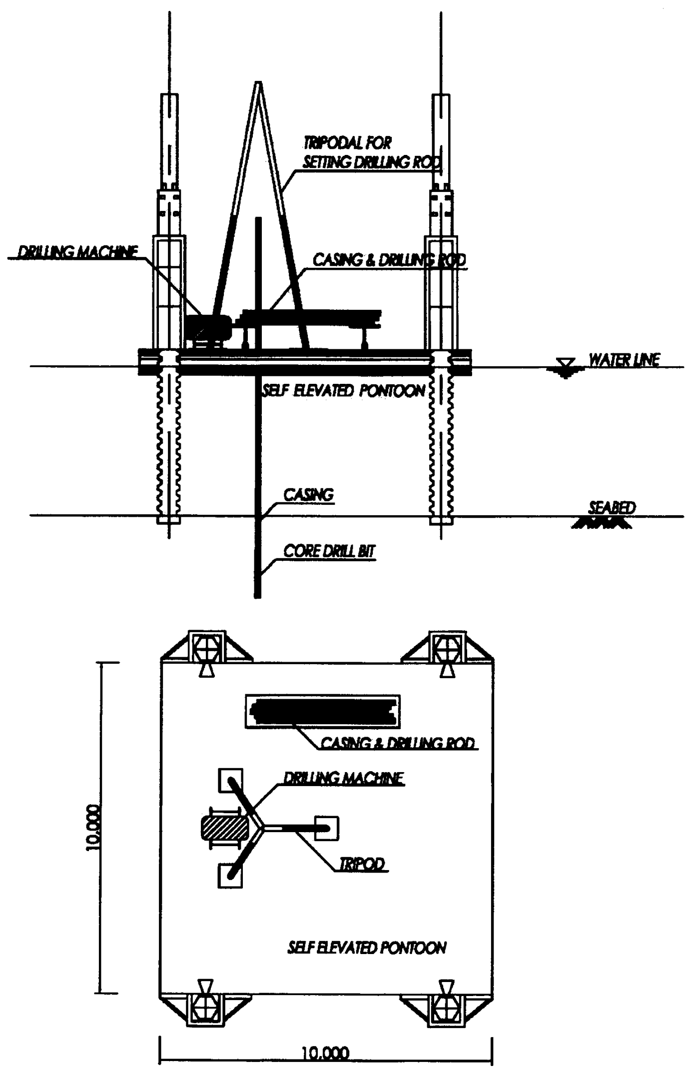


Figure 8.3.2.1 Soil Investigation

8.4 Temporary Work

8.4.1 Temporary Loading Jetty

Temporary loading jetty for the filling material is planned in the vicinity of the New Lock Site. And its jetty head shall be located at the water depth deeper than -8m, and it shall not disturb the existing navigational traffic or other working vessels.

The jetty and trestle will be constructed with steel pipe pile foundations and steel beam super structures. Belt conveyor system, which conveys the filling material from stock yard, will be installed on the jetty. Temporary loading jetty is shown in <u>Figure 3.4.1.1~3</u>.

The capacity of the transport system is approximately 3,000m^3 per hour. Temporary navigation aids will be installed along the barge traffic route in accordance with the marine safety regulation.

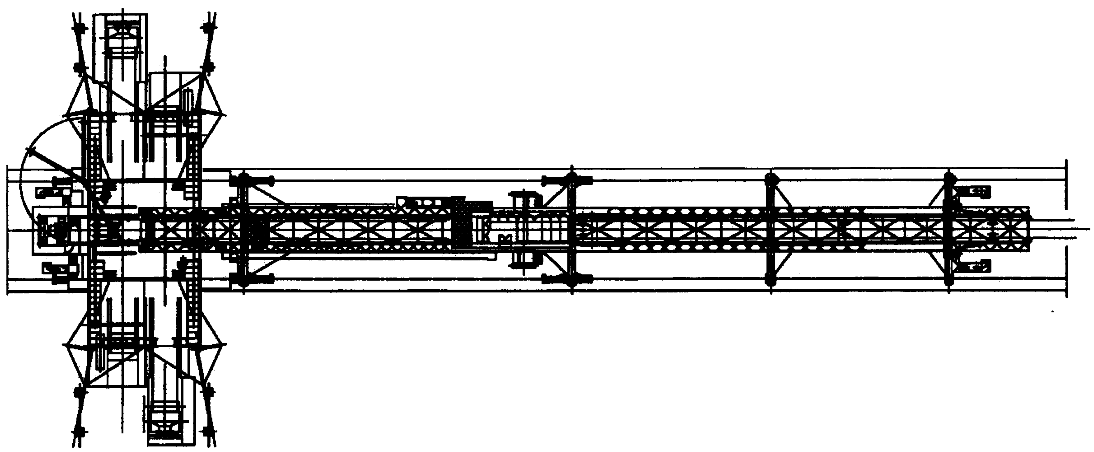
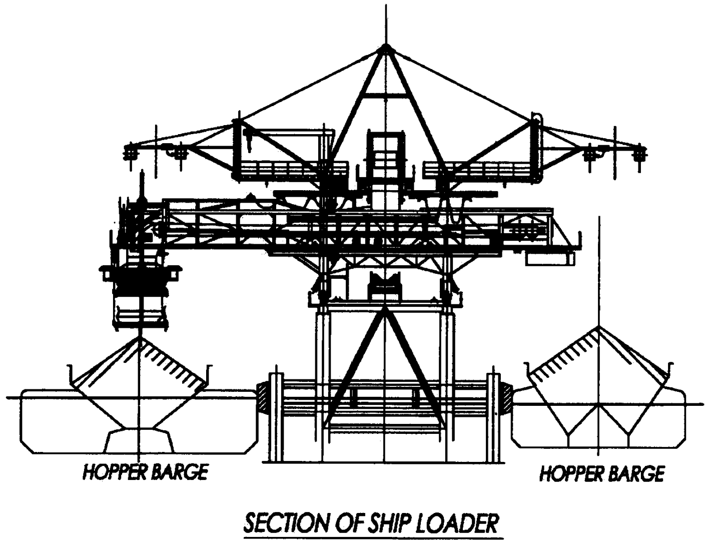


Figure 8.4.1.1 Plan of Loading Jetty

Figure 8.4.1.2 Section of Loading Jetty



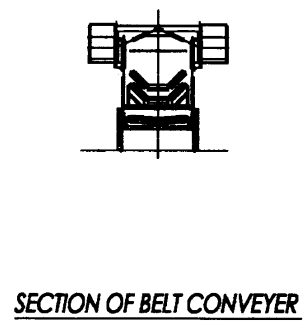


Figure 8.4.1.3 Section of Ship Loader and Belt Conveyer

8.4.2 Offshore Cell Fabrication Base

Offshore cell pre-fabrication base will be constructed. It has tower cranes and fabrication platform and shall be located at calm area having enough working space and water depth for the floating crane and sheet pile transport barge operation.

Tower crane has 4 nos. of pipe piles foundation with concrete coping, where the tower crane will be fixed on it.

Fabrication platform is consisting of lower frame and upper guide frame. Lower frame has steel pipe piles foundation with rounded steel sheet pile pedestal on the piles and the cradle of the upper guide frame. Prefabricated upper guide frame will be installed on the cradle by the floating crane. Sheet pile cellular will be prefabricated using upper guide frame.

Offshore cell fabrication base is shown in Figure 8.4.2.1.

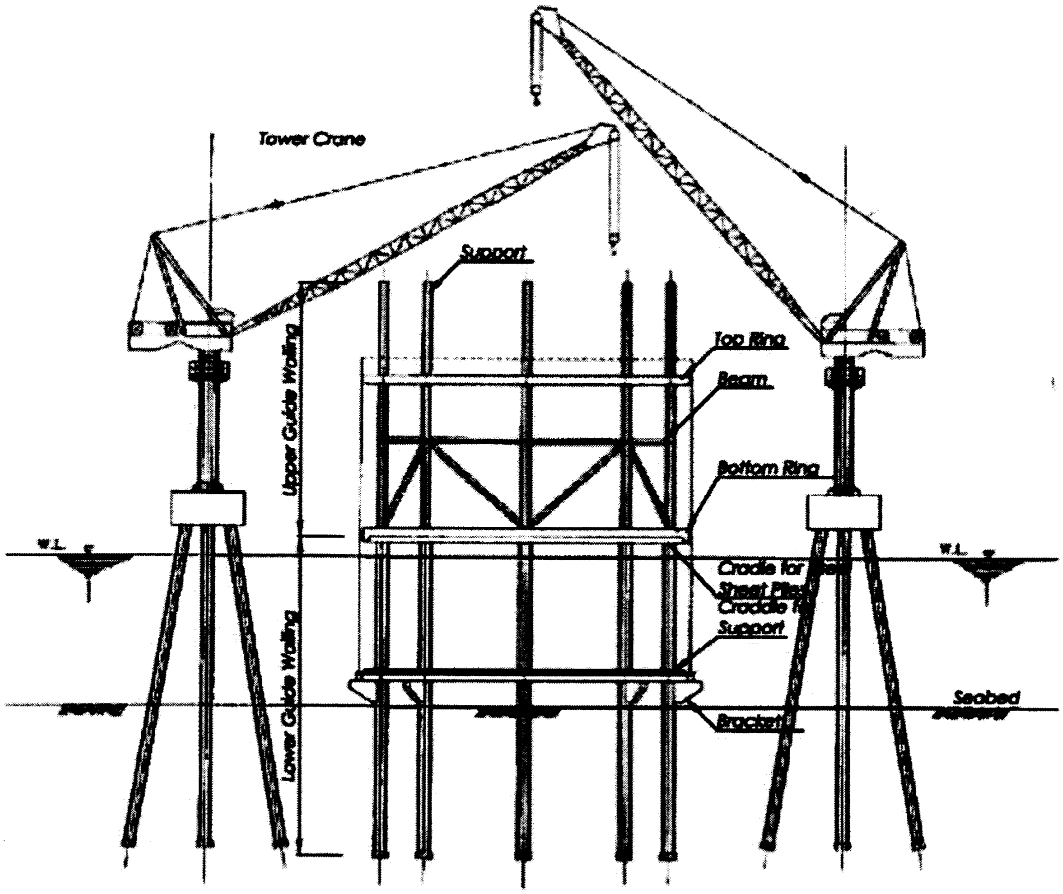


Figure 8.4.2.1 Offshore Cell Fabrication Base

8.5 Cellular Wall Construction Work

8.5.1 General

Steel sheet pile cell will be prefabricated at the fabrication yard, transported and installed at the proposed site, driven by vibro-hammer, then after the upper guide frame removal the cell will be filled. Each cell will be connected by the arc cells then the arc cell will also be filled.

Steel sheet pile cellular construction workflow is shown in Figure 8.5.1.1~2.

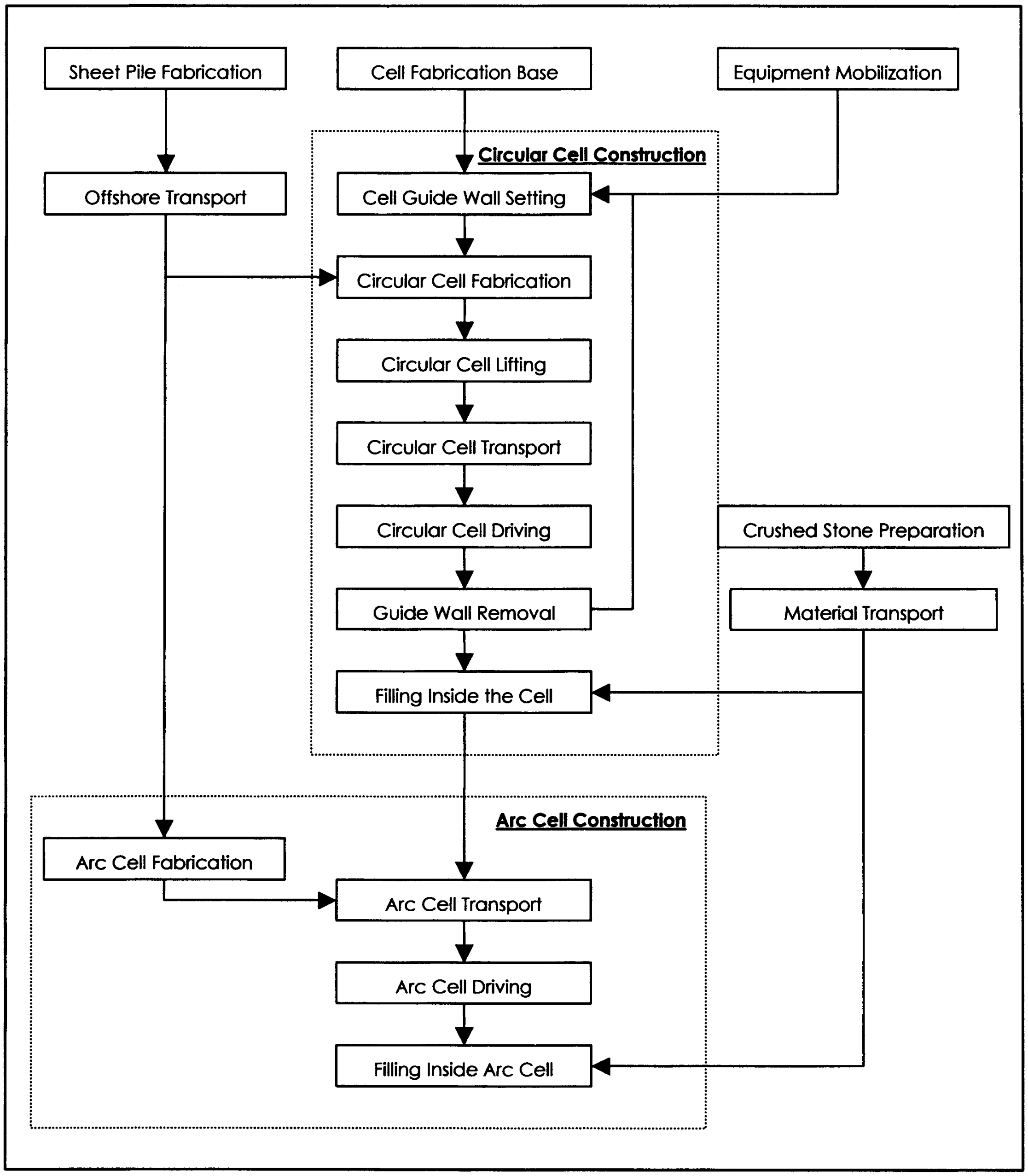


Figure 8.5.1.1 Workflow for Cellular Construction

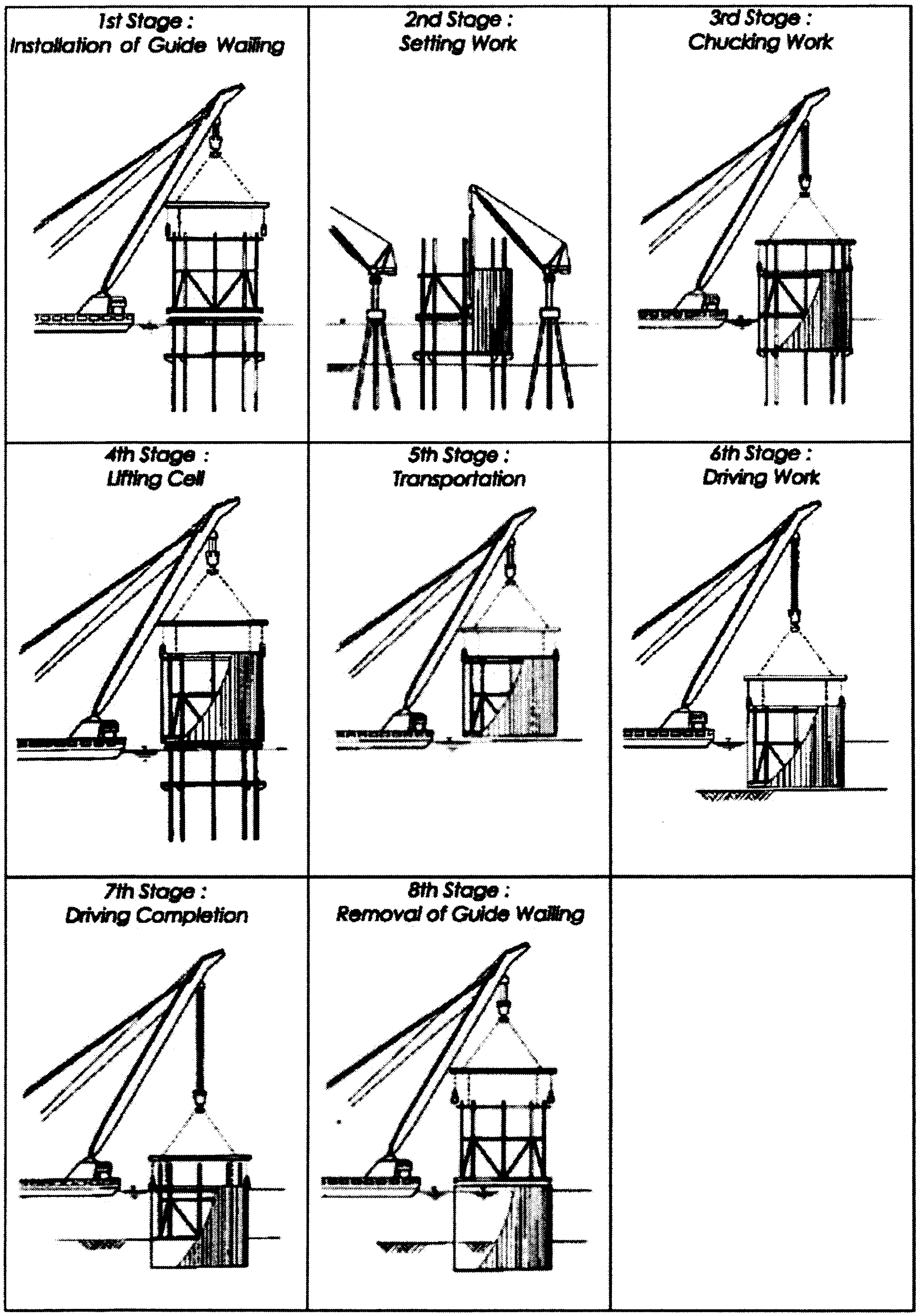


Figure 8.5.1.2 Workflow for Cellular Construction

8.5.2 Main Equipment List

Main equipment list for cellular construction is shown in Table 8.5.2.1~3.

(1) Fabrication of Cellular

Table 8.5.2.1 Equipment List for Fabrication of Cellular

Equipment	Capacity	Quantity
Tower Crane	60 ton-m	5 nos.
Floating Crane	50 ton	2 nos.
Launch	60 ps	2 nos.
Floating Barge	500 ton	2 nos.
Trailer	20 ton	2 nos.
Generator	100 kVA	2 nos.

(2) Transportation and Driving Cellular

Table 8.5.2.2 Equipment List for Transportation and Driving Cellular

Equipment	Capacity	Quantity
Floating Crane	2050 ton	1 nos.
Generator Barge	3500 kVA	2 nos.
Anchor Boat	50 ton	2 nos.
Tug Boat	2500 ps	2 nos.
Survey Boat	200 ps	2 nos.
Launch	200 ps	2 nos.
Generator	100 kVA	2 nos.
Vibro-Hammer	60 / 90 kW	24 nos.
Vibration Chuck	42 ton	132 nos.
Admission Device	-	1 Ls
Operation Board	-	1 Ls
Cab Tyre Cable	-	1 Ls
Hydraulic Unit / Hose	-	1 Ls
Hanging Wire	-	1 Ls

(3) Transportation and Driving for Arc Cell

Table 8.5.2.3 Equipment List for Transportation and Driving for Arc Cell

Equipment	Capacity	Quantity
Floating Crane	700 ton	1 nos.
Generator Barge	3500 kVA	1 nos.
Anchor Boat	25 ton	2 nos.
Tug Boat	2000 ps	2 nos.
Survey Boat	200 ps	2 nos.
Launch	200 ps	2 nos.
Vibro-Hammer	60 / 90 kW	4 nos.
Vibration Chuck	42 ton	18 nos.
Admission Device	-	1 Ls
Operation Board	-	1 Ls
Cab Tyre Cable	-	1 Ls
Hydraulic Unit / Hose	-	1 Ls
Hanging Wire	-	1 Ls

8.5.3 Fabrication of Circular Cell

(1) Steel Sheet Pile Installation on Circular Waller Guide Frame

The upper and lower rings of the upper guide frame will be marked with uniform pitch, which is the sheet pile width. Temporary guide sheet piles will be fixed on the exact position of the upper frame. Sheet piles will be installed starting from the next to the guide sheet piles in accordance with the marking, and it will proceed symmetrically against the center of the ring, then forming the circular cell. After the installation of several numbers, the installed piles shall be fixed on the upper guide frame by lever hoists in order to maintain the cellular verticality. The steel sheet pile shall be handled by 2 cranes to prevent its distortion. The cell circular will be closed by the prefabricated arc connection piles (T shaped pile). Each sheet pile joint and the overall figure shall be inspected.

Steel sheet pile installation on the circular waller guide flame is shown in Figure 8.5.3.1.

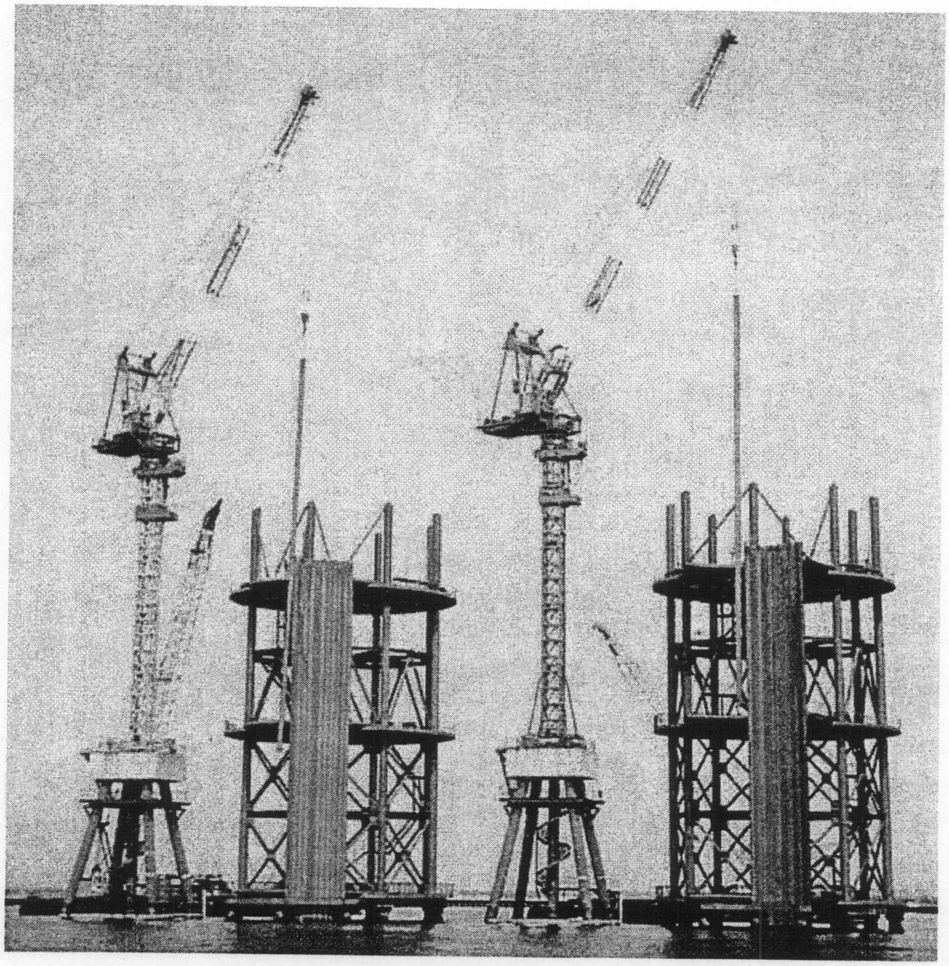


Figure 8.5.3.1 Fabrication of Cellular

(2) Special Equipment for Circular Cell

Special equipment with hanging rounded frame, the upper guide frame and almost 20 nos. of vibro hammers shall be utilized for the circular cell driving. Vibro-hammers and the upper guide frame are hanged from the hanging rounded frame, the chucks of vibro-hammers hang the steel sheet piles. Each vibro-hammer has the adapter having 3 to 6 numbers of chucks, which hang the same numbers of sheet piles. The sheet piles are temporarily fixed to the chucks by safety pins.

The equipment for driving cellular is shown in Figure 8.5.3.2. The vibro hammer with chuck for driving cellular is shown in Figure 8.5.3.3.

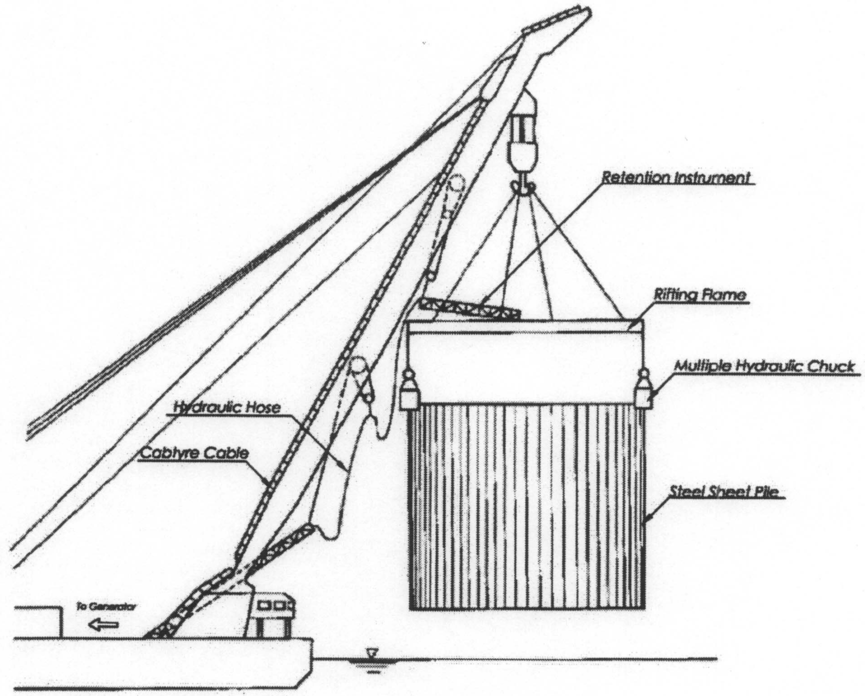


Figure 8.5.3.2 Equipment for Driving Cellular

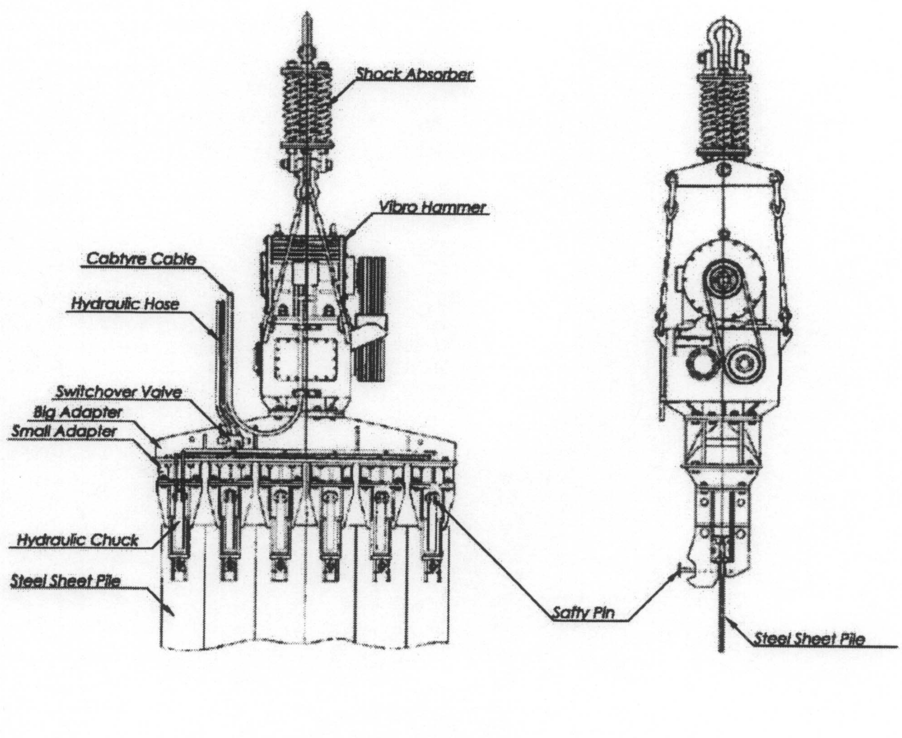


Figure 8.5.3.3 Vibro Hammer with Chuck

(3) Lifting and Towing Fabricated Circular Cell

The floating crane will be equipped with a hanging round frame and vibro-hammers. Each sheet pile will be chucked by vibro-hammers and fixed by the safety pins. Lifting wires will be set on the hooks of upper ring, dismantle the connection bolts between the upper guide frame and lower frame. Then prefabricated cellular will be lifted and transported to the installation location. Transportation of cellular is shown in Figure 8.5.3.4.

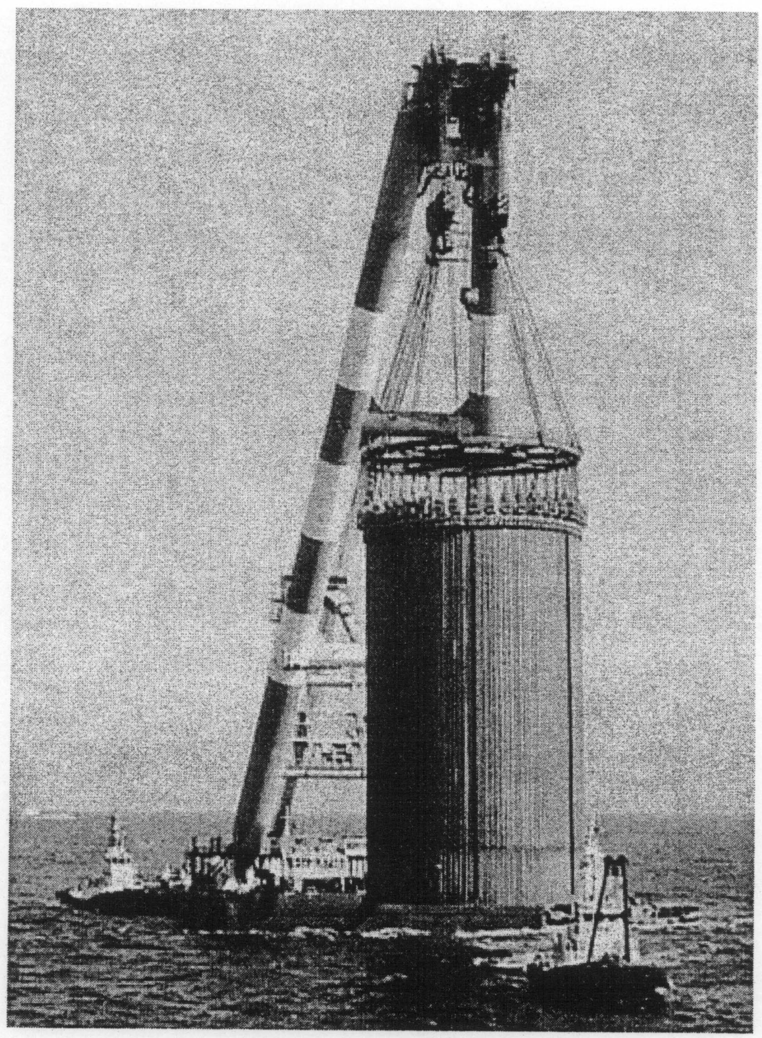


Figure 8.5.3.4 Transportation of Cellular

(4) Positioning and Driving Circular Cell

The cellular positioning will be guided using transits from 2 directions, one is in a line with the revetment and another in the right angle of it. Survey stages will be installed if necessary. After the cellular is guided close to the installed position, it will be lowered down close to the seabed. Then vibro-hammers will be operated, and driven into the seabed while monitoring its verticality, twisting and rotating condition.

The cellular will be driven and monitored by surveying the marks on the sheet piles until near to the design level, then stop the vibro-operation. Then the top elevation of sheet piles will be adjusted by operating 1 or 2 vibro-hammer one by one symmetrically while surveying the sheet pile level.

Cellular installation work is shown in Figure 8.5.3.5.

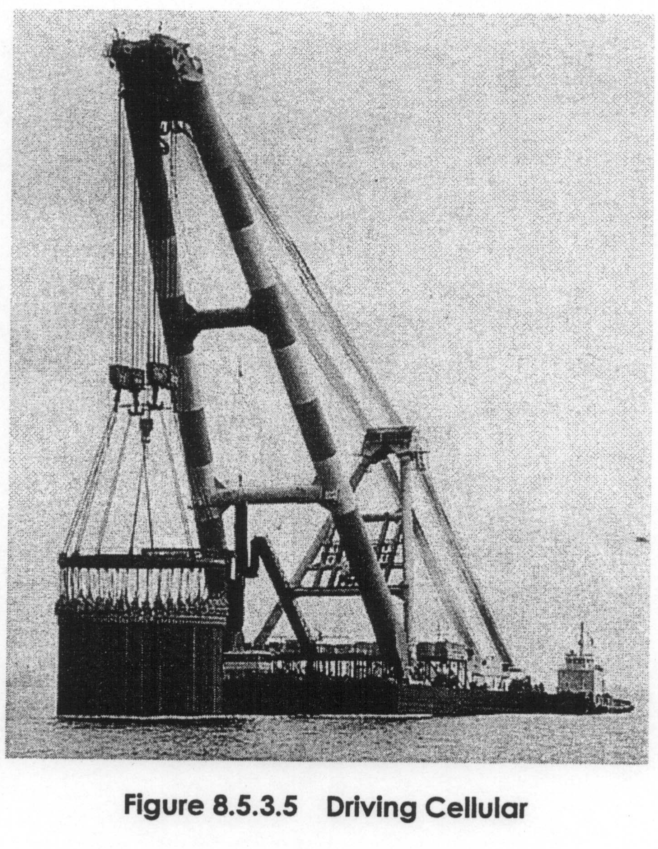


Figure 8.5.3.5 Driving Cellular

(5) Guide Frame Removal

After driving operation, the chucks and safety pins will be released then the upper guide frame will be lifted. The upper guide frame will be transported back to the cell fabrication yard and installed on the lower frame again for the next cell pre-fabrication.

Removal of guide flame is shown in Figure 8.5.3.6.

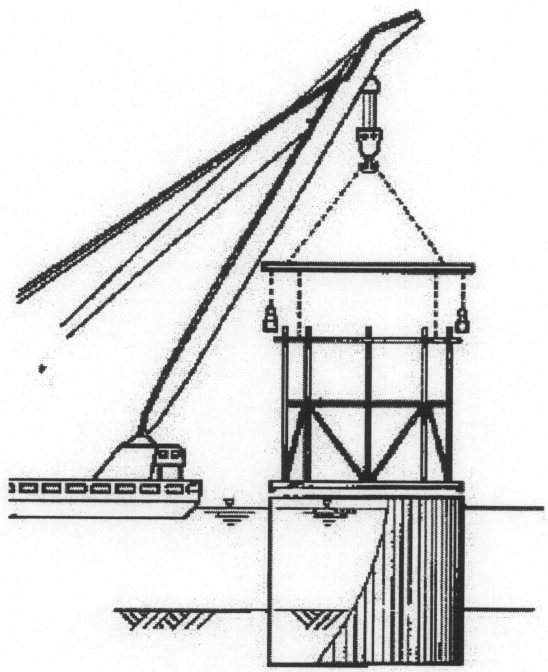


Figure 8.5.3.6 Removal of Guide Flame

(6) Circular Cell Inside Filling

Immediately after the circular cell installation, the cell will be filled by crusher run in order to secure the stability of single cell structure. The crusher run will be loaded on the hopper barge at the temporary loading jetty, then transported and it will be moored to the reclaimer barge, which has been anchored in front of the circular cell. The crusher run will be unloaded and filled into the cell by the conveyor system of the reclaimer barge.

Inside filling of crushed stone for cellular is shown in Figure 8.5.3.7.

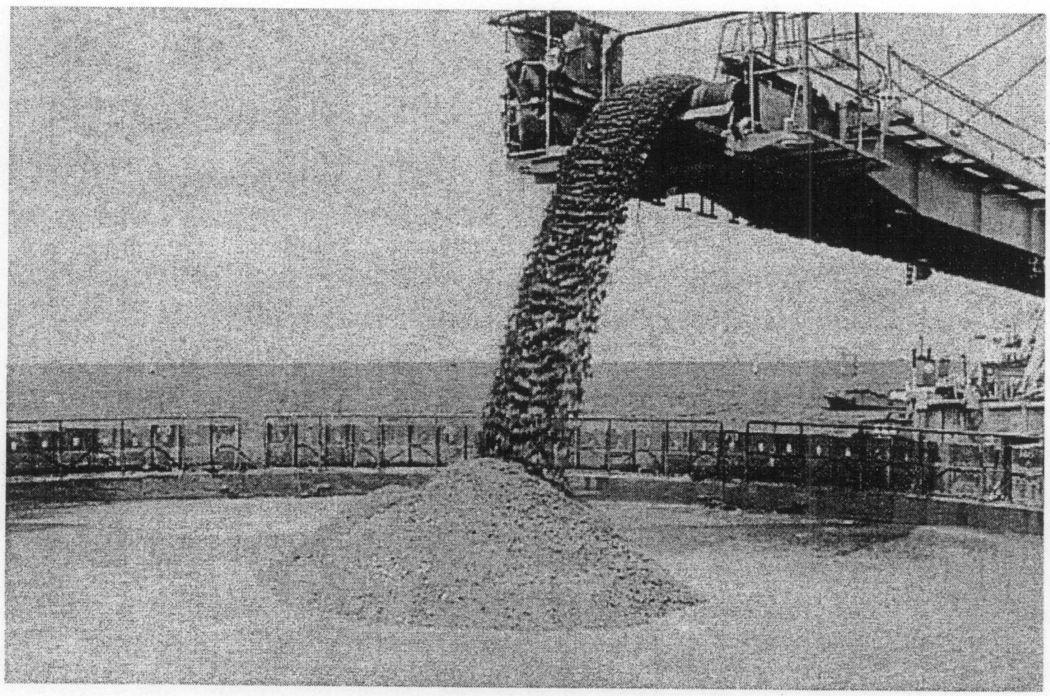


Figure 8.5.3.7 Inside Filling of Crusher Run for Cellular

8.5.4 Fabrication of Arc Cell

(1) Arc Cell Fabrication

The arc will be prefabricated at the fabrication yard similar to the circular cell fabrication. It will be fabricated using the guide frame and crane for the arc and it will be carried out simultaneously with circular cell fabrication.

(2) Arc Cell Installation

The arc will be driven as same procedure as circular cell. Prefabricated arc will be transported by the floating crane and driven by the vibro-hammers. The curved guide frame for arc shall be used for prefabrication, and the arc will be inserted in the connection sheet piles (T shaped sheet pile). In principle, the arcs shall be installed at both sides on the same day to secure their stability. Driving arc cell is shown in Figure 8.5.4.1.

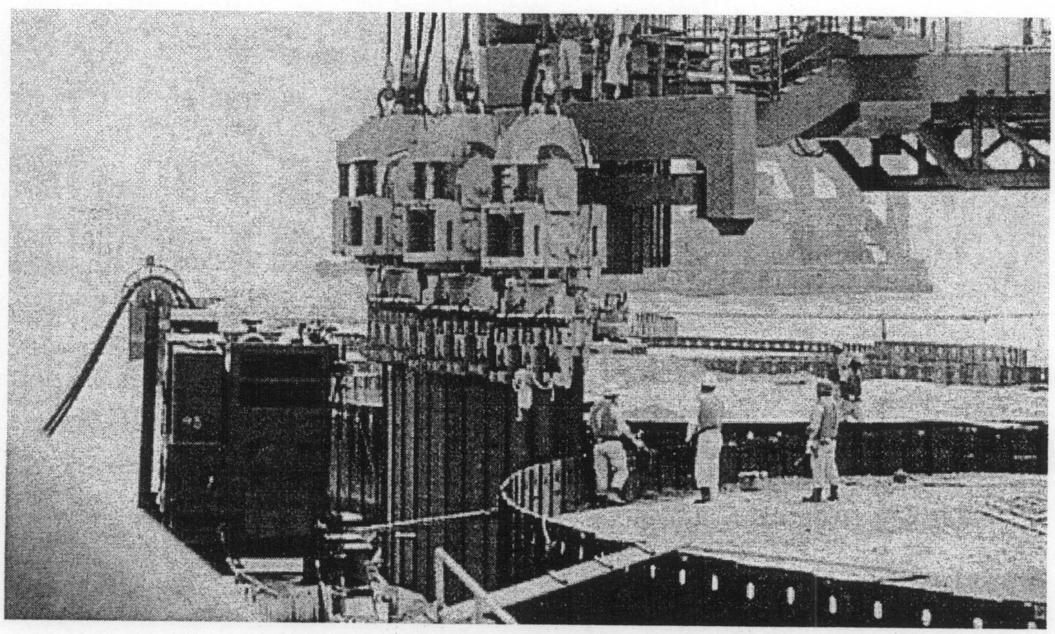


Figure 8.5.4.1 Driving Arc Cell

(3) Arc Cell Inside Filling

Immediately after the arc cell installation, its inside will be filled by crusher run in order to secure the stability of single arc cell structure. The filling work will be carried out by the same procedure as the circular cell. The overall filling quantity of both types of cell is approximately at 2,000,000m^3.

8.5.5 Cellular Cap Concrete

Cap concrete will be cast on the top of cell after the inside filling in order to prevent the fill material washed out by the waves. Cap concrete is plain concrete and it has 300mm thickness. Casting cap concrete is shown in <u>Figure 8.5.5.1</u>.

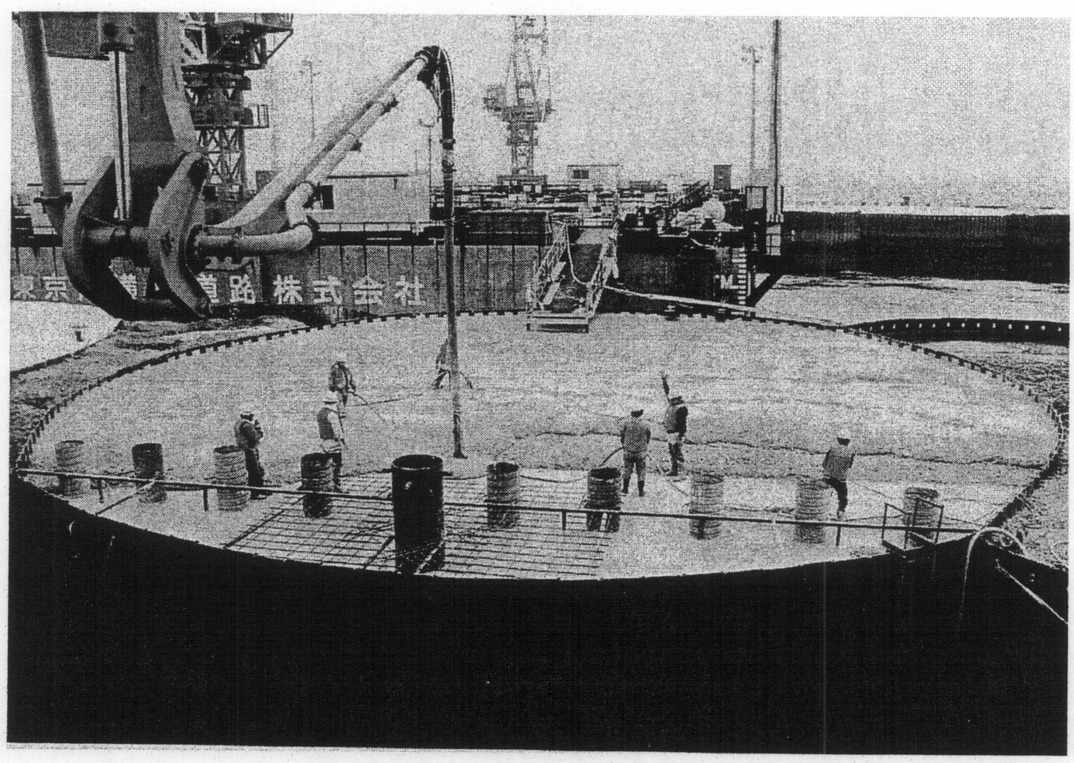


Figure 8.5.5.1 Casting Cap Concrete

8.5.6 Backfilling with Crusher Run

After the cell filling and capping concrete, the area behind the cellular will be backfilled with crusher run. The crusher run will be loaded on the hopper barge at the temporary loading jetty, then transported beside the reclaimer barge, which has been anchored in front of the circular cell. The crusher run will be unloaded and filled behind the cell by the reclaimer barge with the conveyor system. Typical section for quaywall and revetment is shown in Figure 8.5.6.1.

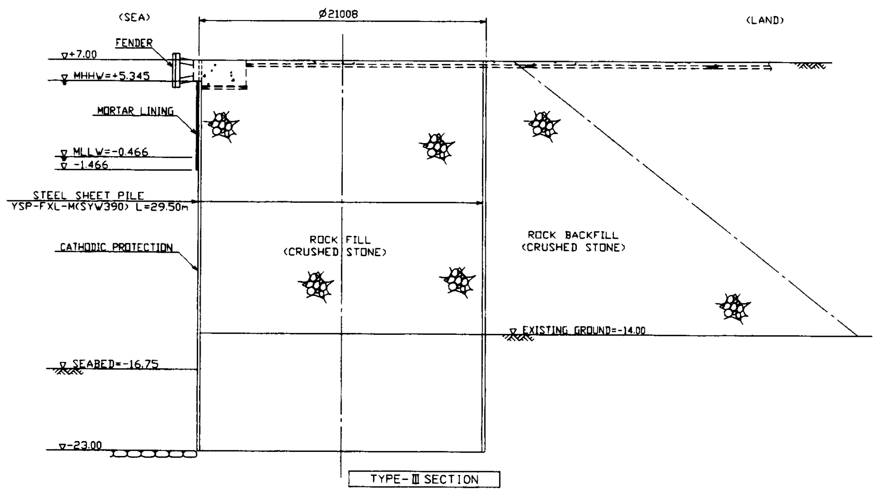


Figure 8.5.6.1 Typical Cross Section for Quaywall Side

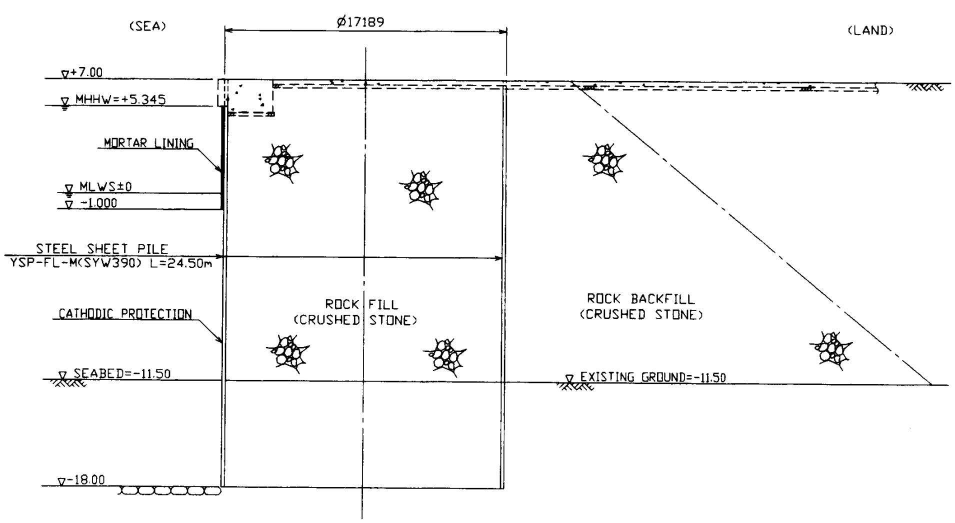


Figure 8.5.6.2 Typical Cross Section for Revetment Side

8.6 Reclamation Work

8.6.1 General

The artificial island shall be divided into sections for construction planning purpose, the section, which completed cell filling and backfilling behind it to secure cell stability, will start to reclaim. Prior to the reclamation work, the stability of revetment and original subsoil during the reclamation work will be analyzed using soil data obtained from soil investigation. Reclamation will be controlled layer by layer in order to prevent circular slipping and thickness of each layer and detailed sequence for each section will be planned based on the analysis results.

The reclamation work will be carried out in 2 stages. At the 1st stage, hopper barge direct dumping will fill the lower layer of the reclamation area. It will be continued up to the depth where the barge can no longer maneuver. At the 2nd stage the upper layer of the area will be filled by the conveyor system of the reclaimer barge.

Movement of the cellular revetment and ground will be monitored by inclinometers and settlement gauges.

8.6.2 Main Equipment List

Main equipment list is shown in Table 8.6.2.1.

Table 8.6.2.1 Main Equipment List

Equipment	Capacity	Quantity
Hopper Barge	8000 m^3	3 nos.
Pusher Boat	4000 ps	3 nos.
Reclaimer Barge	3500 m^3/h	1 nos.
Survey Boat	200 ps	1 nos.
Anchor Boat	15 ton	2 nos.
Bulldozer	21 ton	1 Ls
Grader	4 m	1 Ls
Compaction Roller	5 ton	1 Ls
Vibration Roller	10 ton	1 Ls
Dump Truck	10 ton	1 Ls
Excavator	2.0 m^3	1 Ls
Wheel Loader	2.0 m^3	1 Ls
Water Pump	4 inch	1 Ls

8.6.3 Methodology

(1) Material Loading and Transporting to Reclamation Site

Hopper barges transporting filling materials shall be a pusher type showing high safety performance during operation.

Filling materials will be auto-transported by the conveyor system from land stockyard to the loading jetty and loaded onto the hopper barge moored to the jetty.

(2) Direct Dumping Reclamation by Hopper Barge

Hopper barges will navigate on the proposed route for the filling site. Each dumping position shall be planned considering the dumped volume, width and length of the barge. The position of hopper barge shall be confirmed by DGPS prior to dumping operation. Tug boat may be arranged to assist the barge positioning if necessary. After dumping, the seabed level will be surveyed and the next dumping plan shall be reviewed based on it. Dumping work and route map for hopper barge is shown in Figure 8.6.3.1~2.

The sailing distance between the temporary loading jetty and artificial island is 12 miles. Each trip by 8,000 m^3 class hopper barge will take 2.6 hours for loading, 2.0 hours for sailing to the filling area, 0.5 hours for positioning and dumping and 2.0 hours for sailing to the loading jetty. Cycle time of each trip will be 7.1 hours. Monthly production by 3 numbers of barges on 24 hours basis will be approximately 1,200,000m^3.

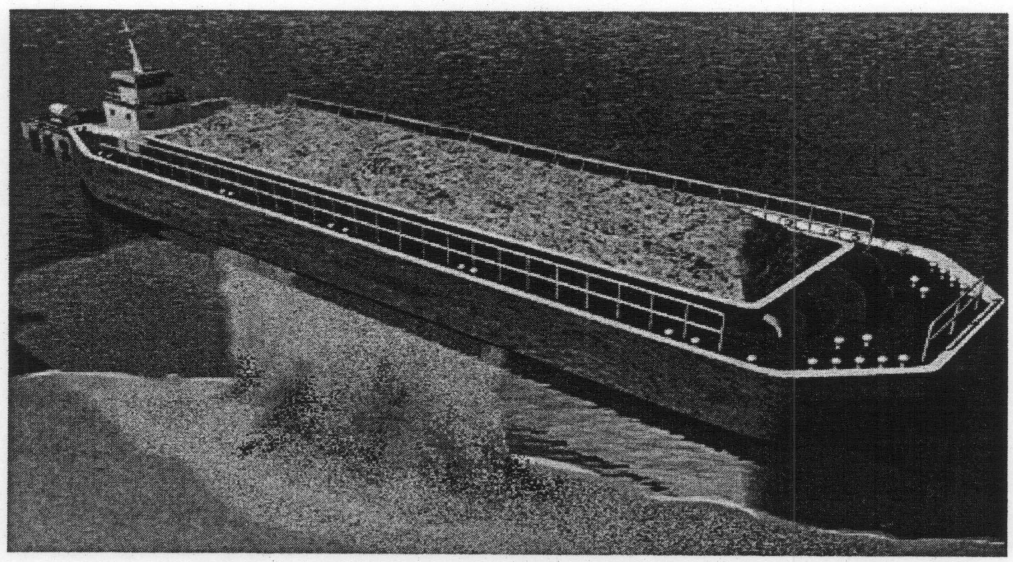


Figure 8.6.3.1 Dumping Work

Figure 8.6.3.2 Route Map for Hopper Barge

(3) Reclamation by Reclaimer Barge

The hopper barge will be moored to the reclaimer barge, which has been anchored in front of the cell revetment. The filling materials will be unloaded and conveyed to the filling area by the conveyor system of the reclaimer barge. The filling work shall be conducted layer by layer in accordance with the prior stability analysis results. Reclamation work using reclaimer barge is shown in Figure 8.6.3.3.

Under the reclaimer barge filling operation, each trip by 8,000 m^3 class hopper barges will take 2.6 hours for loading, 2.0 hours for sailing to the filling area, 4.1 hours for unloading and 2.0 hours for sailing to the loading jetty. Cycle time of each trip will be 10.7 hours. Monthly production by 3 numbers of barges on 24 hours basis will be approximately 1,200,000m^3.

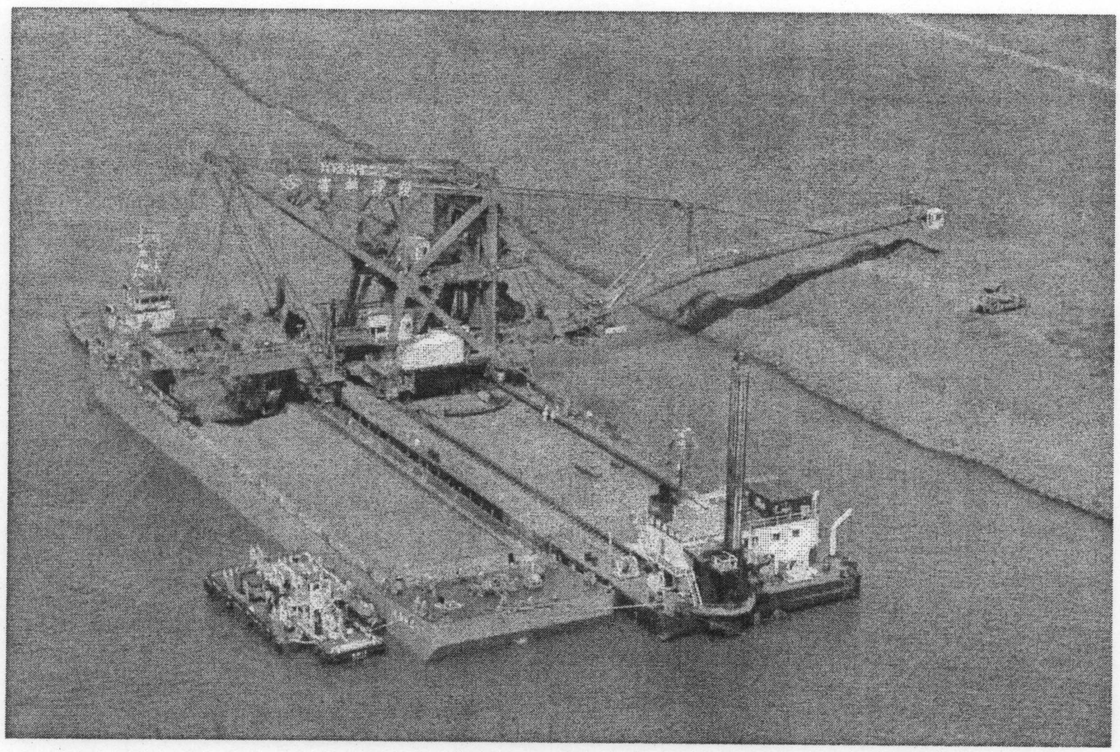


Figure 8.6.3.3 Reclamation Using Reclaimer Barge

(4) Leveling and Compaction

Inland heavy equipment will carry out the land transport of filling material, surface leveling and compaction work. Surface settlement shall be monitored periodically during leveling operation.

CHAPTER 9 COST ESTIMATE

9.1 Overall Project Cost Estimation

Estimated construction cost of the Panama Artificial Island and container terminal is summarized in Table 9.1-1.

Table 9.1-1 Summary Of Construction Cost – Plan B

(Million US$)

Component		Phase 1	Phase 2	Total
1	Island Construction	365.2	0.0	365.2
2	Accessway	99.3	0.0	99.3
3	Infrastructures	74.4	38.7	113.1
4	Container Terminal	216.5	102.8	319.3
Total		755.4	141.5	896.9

9.2 Artificial Island Construction Cost

Estimated Panama Artificial Island construction cost is shown in Table 9.2-1.

Table 9.2-1 Artificial Island Construction Cost

(Price in US$)

Description	Unit	Q'ty	U. Price	Price
Mobilization and Demobilization	ls	1	10,000,000.00	10,000,000
Cell Driving Work				
Island Revetment	m	5,800	34,284.75	198,851,547
Inside Filling				
Inside Fill in Cell with Crushed Stone	m3	1,984,102	2.73	5,416,598
Rock Crushing Plant	ls	1	1,000,000.00	1,000,000
Backfilling behind Cell				
Backfill behind Cell with Crushed Stone	m3	2,029,344	2.73	5,540,110
Reclamation				
Reclamation by Direct Dumping and Re-handling	m3	34,662,945	1.79	62,046,672
Loading Facilities	ls	1	20,000,000.00	20,000,000
Cap Concrete				
Cap Concrete at Top of Cell, t=300mm	m3	30,979	172.50	5,343,843
Mortal Lining Corrosion Protection				
Mortar casting in air, MLWS+6.5~+2.63	m3	3,772	184.00	694,032
Mortar casting in water, MLWS+2.63~-1.466	m3	3,926	313.95	1,232,526
Stud dubel D13 x L80mm	nr	205,274	1.73	354,098
Wire mesh D6 x 200mm sq., 2.22kg/m2	m2	51,319	4.03	206,557
Form work	m2	51,319	115.00	5,901,633
Corrosion Protection				
Sacrificial Cathodic Protection, 3.0A/nr	nr	3,654	1,610.00	5,882,940
Access Road				
Trestle	m	350	32,490.00	11,371,500
Causeway	m	5,125	14,000.00	71,750,000
Bridge	m	50	36,090.00	1,804,500
Subtotal				407,396,556
Engineering and Construction Administration	%	4		16,295,862
Contingencies	%	10		40,739,656
Total Cost				464,432,073

9.3 Infrastructure Construction Cost

Estimated infrastructure construction cost (Phase 1, Phase 2) is shown in Table 9.3-1 and 9.3-2.

Table 9.3-1 Infrastructures (Phase 1) Construction Cost (Price in US$)

Description	Unit	Q'ty	U. Price	Price
Mobilization and Demobilization	ls	1	3,000,000.00	3,000,000
Dredging	m3	4,500,000	5.75	25,875,000
Roads and Paved Areas				
Completion of Access road on Causeway	m3	121,325	22.50	2,729,813
Road Pavement within Island	m2	45,500	40.25	1,831,375
Utilities	ls	1	22,400,000.00	22,400,000
Public Access Areas	ls	1	3,065,000.00	3,065,000
Security and Fencing				
Fencing	m	3,000	35.00	105,000
Control Station & CC Systems	ls	1	550,000.00	550,000
Subtotal				59,556,188
Engineering and Construction Administration	%	5		2,977,809
Contingencies	%	20		11,911,238
Total Cost				74,445,235

Table 9.3-2 Infrastructures (Phase 2) Construction Cost (Price in US$)

Description	Unit	Q'ty	U. Price	Price
Mobilization and Demobilization	ls	1	3,000,000.00	3,000,000
Dredging	m3	4,500,000	5.75	25,875,000
Utilities	ls	1	1,950,000.00	1,950,000
Public Access Areas	ls	1	45,000.00	45,000
Security and Fencing				
Fencing	m	550	35.00	19,250
Control Station & CC Systems	ls	1	100,000.00	100,000
Subtotal				30,989,250
Engineering and Construction Administration	%	5		1,549,463
Contingencies	%	20		6,197,850
Total Cost				38,736,563

9.4 Container Terminal Construction Cost

Estimated container terminal construction cost (Phase 1, Phase 2) is shown in Table 9.4-1 and 9.4-2.

Table 9.4-1 Container Terminal (Phase 1) Construction Cost

(Price in US$)

Description	Unit	Q'ty	U. Price	Price
Mobilization and Demobilization	ls	1	1,500,000.00	1,500,000
Site Work				
Container Yard (Concrete Paving)	m2	900,000	69.00	62,100,000
Others	ls	1	13,876,000.00	13,876,000
Entrance Complex	ls	1	2,240,000.00	2,240,000
Buildings				
Maintenance & Repair shop, 1500m2 x 2nr	m2	3,000	1,250.00	3,750,000
Operation Bldg, 30m x 50m x 4 floors	m2	6,000	1,750.00	10,500,000
Marine Structures				
Quaywall				
Form work: Bottom	m2	6,728	86.25	580,260
Form work: Side	m2	15,467	57.50	889,333
Concrete work	m3	30,933	172.50	5,336,000
Re-bar work	t	4,640	1,725.00	8,004,000
Accessory				
Fender for Small Vessel	nr	180	9,200.00	1,656,000
Fender for Big Vessel	nr	90	20,700.00	1,863,000
Bollard	nr	72	11,500.00	828,000
Bitte	nr	8	5,750.00	46,000
Navigation Aid				
Channel Entrance Buoy	nr	2	46,000.00	92,000
Channel Marker Buoy	nr	2	39,100.00	78,200
Basin Marker Buoy	nr	5	36,800.00	184,000
Light Beacon	nr	4	11,500.00	46,000
Gantry Crane Foundation				
Pile driving work	m	32,640	115.00	3,753,600
Pile material	t	5,679	1,370.00	7,780,723
Concrete work	m3	16,200	172.50	2,794,500
Re-bar work	t	2,430	1,725.00	4,191,750
Form work	m2	11,340	57.50	652,050
Crane rail	m	3,600	264.50	952,200
Gantry Crane	nr	8	5,000,000.00	40,000,000
Subtotal				173,693,616
Engineering and Construction Administration/1	%	6		8,021,617
Contingencies/2	%	20		34,738,723
Total Cost				216,453,956

Note: /1 - Does not apply to gantry crane

/2-Excludes Yard equipment and inventory control systems

Table 9.4-2 Container Terminal (Phase 2) Construction Cost (Price in US$)

Description	Unit	Q'ty	U. Price	Price
Mobilization and Demobilization	ls	1	1,500,000.00	1,500,000
Site Work				
Container Yard (Concrete Paving)	m2	450,000	69.00	31,050,000
Others	ls	1	6,938,000.00	6,938,000
Entrance Complex	ls	1	1,120,000.00	1,120,000
Buildings				
Maintenance & Repair shop, 1500m2 x 1nr	m2	1,500	1,250.00	1,875,000
Marine Structures				
Quaywall				
Form work: Bottom	m2	3,364	86.25	290,130
Form work: Side	m2	7,733	57.50	444,667
Concrete work	m3	15,467	172.50	2,668,000
Re-bar work	t	2,320	1,725.00	4,002,000
Accessory				
Fender for Small Vessel	nr	90	9,200.00	828,000
Fender for Big Vessel	nr	45	20,700.00	931,500
Bollard	nr	36	11,500.00	414,000
Bitte	nr	4	5,750.00	23,000
Gantry Crane Foundation				
Pile driving work	m	17,453	115.00	2,007,133
Pile material	t	3,037	1,370.00	4,160,526
Concrete work	m3	8,100	172.50	1,397,250
Re-bar work	t	1,215	1,725.00	2,095,875
Form work	m2	5,670	57.50	326,025
Crane rail	m	1,800	264.50	476,100
Gantry Crane	nr	4	5,000,000.00	20,000,000
Subtotal				82,547,206
Engineering and Construction Administration/1	%	6		3,752,832
Contingencies/2	%	20		16,509,441
Total Cost				102,809,479

Note: /1-Does not apply to gantry crane

/2-Excludes Yard equipment and inventory control systems

CHAPTER 10 ENVIRONMENTAL ASPECTS

10.1 Introduction

This document together with the Draft Environmental Management and Monitoring Plan (EMMP) is intended to serve as a draft of the considerations initially identified to be taken care of on the construction of an artificial Island at the Pacific Entrance to the Panama Canal. The technical and economic justifications of such project are subject of study by other disciplines part of the current feasibility study.

The request for approval of an environmental permit for construction will involve further study such as a full fledge environmental impact assessment considering at least all measures established herein to properly account for the areas identified that require either management or monitoring.

The EMMP proposes 21 Management and Mitigation Measures which are the product of field visits to the project site, experience in similar project and the corresponding environmental checklist for ports and harbours from the April 2002 version of the Japan Bank for International Cooperation (JBIC) Guidelines for confirmation of environmental and social consideration, and describes in detail:

- The description of the measure, its objectives, rationale, main elements and monitoring (in a summary table);
- The approach, that is how the measure will be engineered;
- Action taken to include the mitigation in the port design, and action required in the future, together with the agencies responsible.

10.2 Social Aspect

It is clearly not foreseen that the project would have an adverse effect on the living and livelihood of the inhabitants of the nearby settlement ie. Veracruz. The proposed project is an offshore structure therefore its impact on the social and natural environment is limited to the location of the access point to the main land.

If any, the living and livelihood conditions of the inhabitant of Veracruz could be improved since additional work places would be available at the new development. Additionally basic services installed to service the port area could also be extended to the inhabitants of the nearby settlements as a social benefit.

The landscape of the bay area will mostly be affected by the construction of the access way rather than by the island construction itself, however all the proposed structure types studied to minimized the barrier effect would have the same impact on the landscape, therefore options to mitigate such effect would have to be proposed in the Environmental Impact Assessment if any is found suitable.

10.3 Environmental Aspect

Environmentally the proposed project location does not pose a significant threat to the environment for many reasons, such as:

Sea bed is sandy not rocky (according to the geotechnical investigation by the JETRO Study Team);

No loss of inter-tidal habitat (depending on the structure of Accessway) ;

No loss of vegetative protected species (except for at the connecting road to be constructed in the future);

Dumping of excavated material will be done in a contained environment thus greatly minimizing environmental impact which is normally associated with open sea dumping;

Location is nearby island formations, therefore environment is thus adapted to the existing velocity variations of the currents; and

Recommended access way structure provides a feasible and suitable solution since it minimizes the barrier effect.

It was identified that one of the few irreversible impact of the implementation of the project, nevertheless mitigable, is the location of the access point of the access way. This point falls in the border of a naturally protected area, such area lost would have to be compensated by a revegetation measured as proposed in the Draft Environmental Management and Monitoring Plan.

It is implied that all other conditions regarding the operations, local regulations and international agreements would be fully complied with, therefore having a negligible impact as long as the regulation are met.

It is expected that a full fledge Environmental Impact Assessment will be carried out to obtain approval by the Autoridad Nacional de Ambiente (ANAM) once a decision is reach on the detail design of the infrastructure.

It was learned from an interview by a member of the JETRO Study Team that the project area is not visited by artisanal fishermen; therefore, little impact is expected by the project construction in such industry.

The alternative to dump the material from the works of the excavation of the third set of locks in a contained environment is definitely a better environmental option than reclamation near the shore since it implies loss of inter tidal habitat and the need for a larger area to accommodate the same volume of material.

The greatest impact of the proposed island construction comes from the construction of the access way and not the island construction itself. The proposed use of the island as a container terminal is the cleanest potential use of the development as manageable levels of waste a generated and can be treated as proposed in the EMMP.

10.4 JBIC Guidelines

The Japan Bank for International Cooperation (JBIC) on April 1st, 2002 established new guidelines for confirmation of Environmental and Social Considerations; these guidelines came into effect on October 1st, 2003.

Particularly, for the proposed project, JBIC considers five classes which in turn are subdivided into other categories; these are shown in Table 10.1 with one category "impact during operation" being added into the class "others" by the consultant.

Class	Items	Ports and Harbors
1 Permits and Explanation	(1) EIA and Environmental Permits	○
	(2) Explanation to the Public	○
2 Mitigation Measures	(1) Air Quality	○
	(2) Water Quality	○
	(3) Waste	○
	(5) Noise and Vibration	○
	(7) Odor	○
	(8) Sediment	○
3 Natural Environment	(1) Protected Areas	○
	(2) Ecosystem	○
	(3) Hydrology	○
	(4) Topography and Geology	○
4 Social Environment	(1) Resettlement	○
	(2) Living and Livelihood	○
	(3) Heritage	○
	(4) Landscape	○
	(5) Ethnic Minorities and Indigenous Peoples	○
5 Others	(1) Impact during construction	○
	(2) Impact during operation	○
	(3) Monitoring	○

Table 10.1 Summary of Environmental Checklist

Based on the field visits, it was determined in the current feasibility that the following aspects are of no concern in the current project as their impact is either non existent or minimal; Odor, Resettlement, Heritage, Ethnic Minorities and Indigenous People.

Table 10.2 Environmental Checklist (1/3)

Category	Environmental Item	Main Check Items
1 Permits and Explanation	(1) EIA and Environmental Permits	① Have EIA reports been officially completed? ② Have EIA reports been approved by authorities of the host country's government? ③ Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? ④ In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?
	(2) Explanation to the Public	① Are contents of the project and the potential impacts adequately explained to the public based on appropriate procedures, including information disclosure? Is understanding obtained from the public? ② Are proper responses made to comments from the public and regulatory authorities?
2 Mitigation Measures	(1) Air Quality	① Do air pollutants, such as sulfur oxides (SOx), nitrogen oxides (NOx), and soot and dust emitted from various sources, such as ships, vehicles, and the ancillary facilities comply with the country's emission standards and ambient air quality standards?
	(2) Water Quality	① Do general effluents from the related facilities comply with the country's effluent standards and ambient water quality standards? ② Do effluents from ships and ancillary facilities (e.g., dock) comply with the country's effluent standards and ambient water quality standards? ③ Are adequate measures taken to prevent spills and discharges of materials, such as oils and hazardous materials to the surrounding water areas? ④ Is there a possibility that oceanographic changes, such as alteration of ocean currents, and reduction in seawater exchange rates (deterioration of seawater circulation) due to modification of water areas, such as shoreline modifications, reduction in water areas, and creation of new water areas will cause changes in water temperature and water quality? ⑤ In the case of the projects including land reclamation, are adequate measures taken to prevent contamination of surface water, seawater, and groundwater by leachates from the reclamation areas?
	(3) Wastes	① Are wastes from ships and the related facilities properly treated and disposed of in accordance with the country's standards? ② Is offshore dumping of dredged materials and soils properly performed in accordance with the country's standards to prevent impacts on the surrounding waters? ③ Are adequate measures taken to prevent discharge or dumping of hazardous materials to the surrounding water areas?
	(4) Noise and Vibration	① Do noise and vibrations comply with the country's standards?
	(5) Odor	① Are there any odor sources? Are adequate odor control measures taken?
	(6) Sediment	① Are adequate measures taken to prevent contamination of sediments by discharges or dumping of materials, such as hazardous materials from ships and the related facilities?

Table 10.2 Environmental Checklist (2/3)

Category	Environmental Item	Main Check Items
3 Natural Environment	(1) Protected Areas	① Is the project site located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?
	(2) Ecosystem	① Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? ② Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? ③ If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem? ④ Is there a possibility that the project will adversely affect aquatic organisms? If significant impacts are anticipated, are adequate protection measures taken to reduce the impacts on aquatic organisms? ⑤ Is there a possibility that the project will adversely affect vegetation and wildlife of coastal zones? If significant impacts are anticipated, are adequate measures taken to reduce the impacts on vegetation and wildlife?
	(3) Hydrology	① Is there a possibility that installation of port and harbor facilities will cause oceanographic changes? Is there a possibility that installation of the facilities will adversely affect oceanographic conditions, such as induced currents, waves, and tidal currents?
	(4) Topography and Geology	① Is there a possibility that installation of port and harbor facilities will cause a large-scale alteration of topographic and geologic features in the surrounding areas or elimination of natural beaches?

Table 10.2 Environmental Checklist (3/3)

Category	Environmental Item	Main Check Items
4 Social Environment	(1) Resettlement	① Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? ② Is adequate explanation on relocation and compensation given to affected persons prior to resettlement? ③ Is the resettlement plan, including proper compensation, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? ④ Does the resettlement plan pay particular attention to vulnerable groups or persons, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? ⑤ Are agreements with the affected persons obtained prior to resettlement? ⑥ Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? ⑦ Is a plan developed to monitor the impacts of resettlement?
	(2) Living and Livelihood	① Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary? ② Is there a possibility that changes in water uses (including fisheries and recreational uses) in the surrounding areas due to project will adversely affect the livelihoods of inhabitants? ③ Is there a possibility that port and harbor facilities will adversely affect the existing water traffic and road traffic in the surrounding areas? ④ Is there a possibility that diseases, including communicable diseases, such as HIV will be introduced due to immigration of workers associated with the project? Are considerations given to public health, if necessary?
	(3) Heritage	① Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage sites? Are adequate measures considered to protect these sites in accordance with the country's laws?
	(4) Landscape	① Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?
	(5) Ethnic Minorities and Indigenous Peoples	① Does the project comply with the country's laws for rights of ethnic minorities and indigenous peoples? ② Are considerations given to reduce the impacts on culture and lifestyle of ethnic minorities and indigenous peoples?
5 Others	(1) Impacts during Construction	① Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? ② If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts? ③ If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts? ④ If necessary, is health and safety education (e.g., traffic safety, public health) provided for project personnel, including workers?
	(3) Impacts during Operation	① Are adequate measures considered to reduce impacts during operation (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? ② If operation activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts? ③ If operation activities adversely affect the social environment, are adequate measures considered to reduce impacts? ④ If necessary, is health and safety education (e.g., traffic safety, public health) provided for project personnel, including workers?
	(3) Monitoring	① Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? ② Are the items, methods and frequencies included in the monitoring program judged to be appropriate? ③ Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? ④ Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?

CHAPTER 11 DRAFT ENVIRONMENTAL MANAGEMENT and MONITORING PLAN

This document is the Draft Environmental Management and Monitoring Plan (EMMP) based on the site visits and the information gathered through the Study, which is the main output from the feasibility environmental assessment. The EMMP contains elements that indicate the minimum considerations to be used for the study to obtain the environmental permit based on the further study of the EIA. Such possible impacts shall be determined by a further EIA since they greatly depend on the defined implementation approach. This is the document that describes how the mitigation will be achieved, and in practical terms how each measure shall be included in the island design, together with any remaining action that needs to be taken in the future. It also describes the monitoring that would be carried out to ensure that the mitigation is implemented and that it reduces the environmental impacts of the project as intended. It thus contains all of the information describing how the environment is to be managed and protected during both construction and operation of the port island, and should be referred to by all parties throughout the project, whenever issues related to the environment are considered. The current EMMP does not limit itself to the construction of the artificial island itself but endeavors in some degree to raise awareness of the other impacts of the project implementation as a whole.

11.1 Approach

The work to develop the Draft Environmental Management and Monitoring Plan for the project involved several visits to the project site and the collection of information related to the nature of the proposed sites possibly affected by the project implementation.

The Management Plan is open for discussion in view of existing Environmental Regulations, Special Regulations or Decrees, Solid Waste Management norms and technical norms for Environmental Quality.

It is normal practice for environmental monitoring to be carried out in relation to major construction projects, and frequently this will be done in all phases, including the period before the project is built, during the construction process, and after completion when the development is in operation. The purpose of the monitoring is to:

- Collect data describing the environment at the project site before the development is constructed. This provides the baseline of existing conditions before any disturbance, with which any future monitoring can be compared;
- Observe the construction methods to ensure that all activities are carried out in the manner prescribed in the Specifications, and elsewhere in the Contract Documents. These documents include measures aimed at protecting the environment, so this monitoring ensures that these are adhered to;
- Record environmental conditions during the period in which the development is being built, which are compared with the baseline to determine the environmental effects of the construction process. This reveals whether mitigation measures aimed at reducing the impact of construction are having the desired effect;
- Record environmental conditions when the completed project is operating, to determine the impact of the operation of the development, and again to reveal whether mitigation measures to reduce its impact are proving successful.

Monitoring may thus confirm that the outcome of the project is as was predicted by the Environmental Impact Assessment Report (EIA) and that its environmental impacts are acceptable, or it may indicate certain areas where impacts are more adverse than expected, or where the mitigation measures are not sufficiently effective. This is one of the most important aspects of monitoring as it enables additional actions to be taken to further reduce the impact of the development if the monitoring shows this to be necessary.

The approach to the Monitoring Plan is similar to that of the Environmental

Management Plan. It takes the Mitigation Measures and explains the monitoring that will be carried out in relation to each. In each case the account commences with a table summarizing the Mitigation Measure and its objectives, and listing the action involved in implementing the measure. The table then indicates the monitoring necessary to ensure that the actions are implemented and that the mitigation is effective, and indicates who will be responsible for each activity. There is then a text explaining the reasons for specifying the monitoring measures and responsibilities, and explaining how the monitoring should be conducted. Each account then closes with a summary of what each monitoring measure should involve.

11.2 Proposed project characteristics

The recommended location of the artificial island was determined based on two factors; depth required for the berthing of the target ship and condition of sea bed. Based on the above, the recommended location of the North-East corner of the rectangular shape island is N978000 and E656800, about 5km south of the shore and 3.5km north of Taboga Island.

The recommended size of the artificial island was determined based on transshipment cargo forecast to be handled at the island and the size of the target ship. The rectangular shape island has a north-south length of 1,800m and the east-west length of 1,100m for an equivalent of 198 ha.

11.3 Considerations in view of project characteristics

It is understood that the currently proposed project is an alternative for the disposal of the excavated material from the potential construction of the third set of locks to the Panama Canal. Therefore a full fledge EIA would be warranted only if ACP considers the island construction alternative more advantageous vis-à-vis the other alternatives under consideration.

The proposed measures of the EMMP have been developed based on the nature of the proposed project and the experience in other project in similar environments. Following are the main aspects considered in the preparation of the proposed EMMP:

1) The borrow area will be subject of a separate study to evaluate its impacts on the land area, thus the impacts and measures of the borrow area have not been considered herewith, any mentioning of environmental considerations for the borrow area does not necessarily imply incorporation of such activity within the scope of this study.
2) All material suitable for fill will be used in the island construction; however a dump area must be identified for unsuitable material.
3) The foreseen environmental impacts of island and access way construction have been assessed using data on existing conditions from reports by others, site visits and assisted by numerical modeling of the impact on currents due to the construction.
4) A significant gain in terrestrial habitat at the island construction site (198 ha) will be obtained;
5) This project vis-à-vis other port construction project does not imply a significant loss of intertidal/subtidal habitat since the only affected area in the sea shore is the access point to the island which is a protected area but the impact will be minimal for the extend of the project.
6) Areas near the access point has both a social, economic and environmental value, monitoring and mitigation is being proposed to address these impacts.

11.4 Environmental Management and Mitigation Measures

11.4.1 Environmental Protection during the Construction Period

(1) Mitigation Measure and its Objectives

Table 11.4.1 Mitigation Measure No. 1:Re-vegetation and Wildlife Rescue

DESCRIPTION OF MEASURE

1. Plant trees proportionally to the affected area in the land side environment specially from the protected areas
2. Collect wildlife from the borrow area, access point and affected islands and release in suitable habitats nearby.

OBJECTIVE:

1 Plant trees to compensate for those lost during the borrow operation and during the construction of the access point at Punta Bruja.

2. Conserve wildlife living in the borrow area by collecting and re-locating to an undisturbed area nearby.

RATIONALE:

1. Re-vegetation:
   It is essential to re-vegetate twice the area which currently supports vegetation in any of the affected areas of the construction. It is proposed that the revegetation takes place using a density of 625 per hectare. A natural vegetation belt of 50m as minimum shall be retained along the alignment of the new access way. Indigenous trees shall be planted at all locations, It is not expected that the protected mangroves specie be affected therefore compensations for such specie is not needed. Mangrove was observed further West from the access point. The access point to the main land lies in a protected areas therefore it is desirable to minimize the land requirements when crossing this area.
2. Wildlife rescue:
   Wildlife at the borrow site and affected areas shall be carried out to relocate species both protected/unprotected and relocate them to nearby undamaged areas of similar habitat. This will include mammals, reptiles and amphibians.

MAIN ELEMENTS

Re-vegetation	D	C	O	Responsibility
1. Contract Drawings shall show a belt of 50m of vegetation.				Consultant
3. Identify based on the area deforested an equivalent of two(2) the affected area for re-vegetation.				Consultant
4. Prepare planting specification, appoint contractor				Consultant
5. Plant trees, maintain planted areas				Contractor
Wildlife Rescue				
1. Prepare specification for animal rescue				ACP
2. Appoint contractor, carry out rescue and release				ACP
MONITORING				
1. Monitor onsite and offsite planting as specified				ECW/ACP
2. Tree survival, watering, clearing of competing vegetation				ECW*/ACP
3. Supervise wildlife capture and release				ACP/ACP

Note: * ECW: Environmental Clerk of Works

(2) Monitoring Rationale

1) Environmental Clerk of Works (ECW)

As project proponent, ACP will appoint a Contractor to construct the Island Port and a Consultant to supervise the process. The Supervising Consultant will be required to provide a Environmental Clerk of Works (ECW) to be on site during the construction period to ensure that all environmental measures are implemented as prescribed in the documents and drawings that comprise the Construction Contract. Some of the environmental monitoring during the construction phase will be the responsibility of the Island Port Contractor, and the ECW will oversee this work to ensure that it is carried out as specified.

2) Island Port Environmental Unit (PEU)

ACP themselves will be responsible for monitoring during Island Port operations, and this will be implemented primarily by the Island Port Environmental Unit (PEU) described in Chapter 2, which ACP will establish towards the end of the construction period.

3) Re-vegetation

ACP will request assistance from the ANAM in developing a specification for the tree planting they will carry out in areas outside the Island Port, and in establishing the appropriate maintenance regime (watering, fertilizing, weeding and re-planting dead or ill-growing specimens).

During the construction period, the ECW will monitor the planted areas to ensure that they are planted and maintained according to the Specifications. Once the Island Port is operating ACP will continue maintaining the green areas.

4) Wildlife Rescue

ACP will also seek assistance from Autoridad Nacional del Ambiente (ANAM) in determining the groups of animals to be rescued from the borrow area, and in specifying how the capture and release operation will be carried out. ACP will use this information to prepare a Specification for the operation, after which they will appoint a suitable contractor or specialist. ACP will be requested to approve the persons identified by the contractor to handle the animals (who must be properly qualified and experienced in order to prevent undue distress to the animals), and to supervise the capture and release operation.

Capture and release is likely to involve a variety of well-recognized techniques appropriate for the species present, including net capture and capture under cover boards for amphibians, and the use of baited non-lethal traps for mammals and reptiles. The operation will be conducted three times in the two months before construction is due to commence, to prevent excessive re-colonization as will happen if the area is left undisturbed.

11.4.2 Conservation of Rocky Areas and Biota

(1) Mitigation Measure and its Objectives

Table 11.4.2 Mitigation Measure No. 2: Conservation of Rocky Areas and Biota

DESCRIPTION OF MEASURE				
The access structure type from the new island to the firm land shall be design as not to alter the tide fluctuations east of the access point.				
OBJECTIVE: Conservation of the rocky habitat and the organisms that live on it. Conservation of natural flow of water to prevent garbage accumulation.				
RATIONALE: There are few areas of hard substrate nearby the access point which required the tide fluctuation and the natural flow of the water. A cause-way will most likely alter this habitat also having a minimal socio-economic impact, however its structure could be chosen such that a minimal impact is cause in order to assure the sustainability of this type of barnacles, oyster and other epifauna.				
MAIN ELEMENTS				
	D	C	O	Responsibility
1. Structure type not to affect existing environment or ensure sustainability by the provision of similar environment.				Consultant
MONITORING				

The importance of the conservation of the rocky area is mainly due to the socio-economic impact since it was observed that locals use this as a source of income by the collection of the oyster which they in turn sell to the local restaurants in Playa Veracruz. However hard substrate was also observed in bigger quantities west of Veracruz at distances not so unreasonable as to change the collection point by the locals.

Figure 11.4.1 Hard Sustrate West of Veracruz Beach (Oeste de Playa Veracruz)

(2) Monitoring Rationale

Monitoring shall be carried out at Veracruz beach to evaluate the impact of the construction on the colonization of barnacles, oysters and other epifauna due to the construction of the access way to the Island Port Project.

11.4.3 Environmental Management During the Borrow Operation

(1) Mitigation Measure and its Objectives

Table 11.4.3 Mitigation Measure No. 3:

Environmental Management during the Borrow Operation

DESCRIPTION OF MEASURE

1. Water exposed soil at the borrow area during the dry season and retain drainage in a lagoon to reduce suspended solids.
2. Reduce vehicular emissions by adequate maintenance of construction site vehicles and machinery.
3. Minimize the impact of disposing of waste material

OBJECTIVE: Avoid air pollution from dust and vehicular emissions, and water pollution from runoff high in suspended solids.

RATIONALE:

1. Reduce dust and water pollution
   The borrow operation will remove vegetation, after which soil and rocks will be dug and dumped into the reclamation area. This could produce dust in dry weather, which could affect plants, animals and people in the vicinity, including site workers. The borrow area shall therefore be maintain wet enough to prevent dust generation during dry season. Drainage shall not be allowed to directly discharge into any water body as it shall be directed first to settlement lagoons before the water is discharged.
2. Vehicle maintenance
   The use of old and poorly maintained vehicles and machinery would add to the air pollution, so all such equipment will be kept in a good state of repair and maintained regularly.
3. The borrow operation will generate excess vegetation and topsoil which is biodegradable and thus unsuitable for use for reclamation. Topsoil will be provided for other projects if uses can be identified, and remaining material will be buried at a municipal landfill.

MAIN ELEMENTS	D	C	O	Responsability
1. Contract Docs require watering, drainage	■			Consultant
2. Contract Docs require vehicle maintenance	■			Consultant
3. Construct fence around borrow site		■		Consultant
4. Implement watering program		■		Contractor
5. Implement vehicle and equipment maintenance		■		Contractor
6. Contract Docs specify reuse of topsoil if possible		■		Consultant
7. Contract Docs specify landfilling of waste		■		Consultant
8. Transport and dispose of waste as appropriate		■		Consultant
MONITORING				
1. Correct watering and vehicle maintenance		■		ECW
2. Turbidity in water outside reclamation area		■		Contractor
3. Transport and disposal of waste as specified		■		ECW

(2) Approach

1) The Borrow Operation

The borrow operation will commence with the cutting of all trees and vegetation, using chain saws and other hand-held equipment. Roots will then be removed using mechanical diggers, and all of the vegetation will be collected into piles at one side of the area using bulldozers. The vegetation will be disposed of at a landfill operated by the Municipality of Panama City.

2) Reduction of Dust

As required by this Mitigation Measure, the Contract Documents state that all bare soil at the borrow site is to be watered during the dry season or any other time as required to prevent dust. This will probably be done using water tankers and/or piped water in the areas of flat terrain, with areas of undulating topography being watered by hand using hoses.

3) Vehicle Maintenance

A program for the maintenance of machinery and equipment, to prevent air pollution from exhaust gases is also required. The Contract Documents shall state therefore that all vehicles and equipment must be maintained according to manufacturers' specifications.

4) Construction of a Perimeter Fence

A construction of a perimeter fence around the reclamation site and construction site is also required to prevent entry by people, vehicles or animals.

(3) Monitoring Rationale

The ECW will monitor the correct implementation of the requirements of the Specification, the main elements of which are:

- Correct disposal of vegetation into approved landfill;
- Prevent dust generation by maintaining a wet surface in the work areas;
- Drainage of all water into settlement ponds before final discharge;
- Implementation of regular vehicle maintenance to avoid contamination by oil

leakage or excessive exhaust fumes.

The Contractor shall monitor suspended sediment 500 m from the overflow from the reclamation area. This shall be part of an extensive program of turbidity monitoring throughout the project. The ECW shall supervise this monitoring and review the results to determine whether further action is necessary.

11.4.4 Social and Environmental Protection During Dredging

(1) Mitigation Measure and its Objectives

Table 11.4.4 Mitigation Measure No. 4: Social and Environmental Protection during Dredging

DESCRIPTION OF MEASURE

1. Reduce the spread of suspended sediment around the dredger and at the disposal site, by monitoring turbidity and setting trigger levels that require operations to cease if exceeded.
2. Set up warning signs at the dredging and dumping sites to prevent vessels entering; train personnel in the environmental effects of dredging to raise awareness; carry booms and skimmers on the dredger to deal with spills of any hazardous liquids on board.

OBJECTIVE: Reduce water pollution from the spread of suspended solids (SS) produced by dredging and disposal, and the spread of oil from accidental fuel spillages.

RATIONALE:

1. Reducing the spread of suspended sediment
   Dredging the approach channel to the artificial island and turning basin will remove sediment. Also the construction of the Artificial Island will suppose an overflow of water from within the Island Boundaries which will carry sediments from the construction. Both operations will generate suspended sediment, which could reduce phytoplankton productivity, irritate gills of fish and cause them to avoid affected areas, and smother and kill the benthos on the seabed. Precautions such as surrounding the dredger and dumpsite with silt reduction curtains might be necessary to minimize the impact of such operations. Turbidity will then be monitored throughout the dredging, converted to SS, and if trigger levels are reached, dredging will cease until levels return to background. Maximum trigger level (increases above ambient) is 200 mg/l.

2. Other pollution control measures
   Warning signs will be placed at the dredging and disposal sites to prevent entry by vessels which could impede the operation and cause accidents. Workers will be trained in the environmental effects of dredging to raise awareness, and the contractor will develop an oilspill contingency plan and carry booms and skimmers to deal with any fuel spillage.

MAIN ELEMENTS

	D	C	O	Responsability
1. Contract Docs require daily turbidity monitoring				Consultant
2. Contract Docs: operations cease if trigger levels reached				Consultant
3. Contract Docs: train workers in effects of dredging				Consultant
4. Contract Docs: oilspill contingency plan and equipment				Consultant
5. Dredging, disposal, monitoring as specified				Contractor
6. Training, oilspill plan, equipment provided				Contractor
7. Set up signs at dredging and dump sites				ACP

MONITORING

	D	C	O	Responsability
1. Review SS results, decide when dredging should cease				ACP
2. Ensure operations and monitoring are as specified				ECW

(2) Approach

1) Dredging the access channel and the turning basin

The type of dredger to be used for the operation will not be specified in the Contract Documents as it is the responsibility of the Contractor to choose the most economical method(s). However it is very likely that a trailer suction dredger will be used.

The trailing suction hopper dredger sucks the seabed material through the trailing pipe into the hold of the dredger (Figure 11.4.2). The vessel is not anchored, and moves slowly across the area, and the operation is controlled by GPS to ensure highly accurate positioning at both dredging and disposal sites. Excess water is normally allowed to overflow from the top or bottom of the dredger for a period after the hold fills, to allow more sediment to settle in the hold, thus maximizing the amount of material carried to the disposal site. This is the part of the operation that generates the most turbidity, as the overflow water contains high levels of suspended sediment.

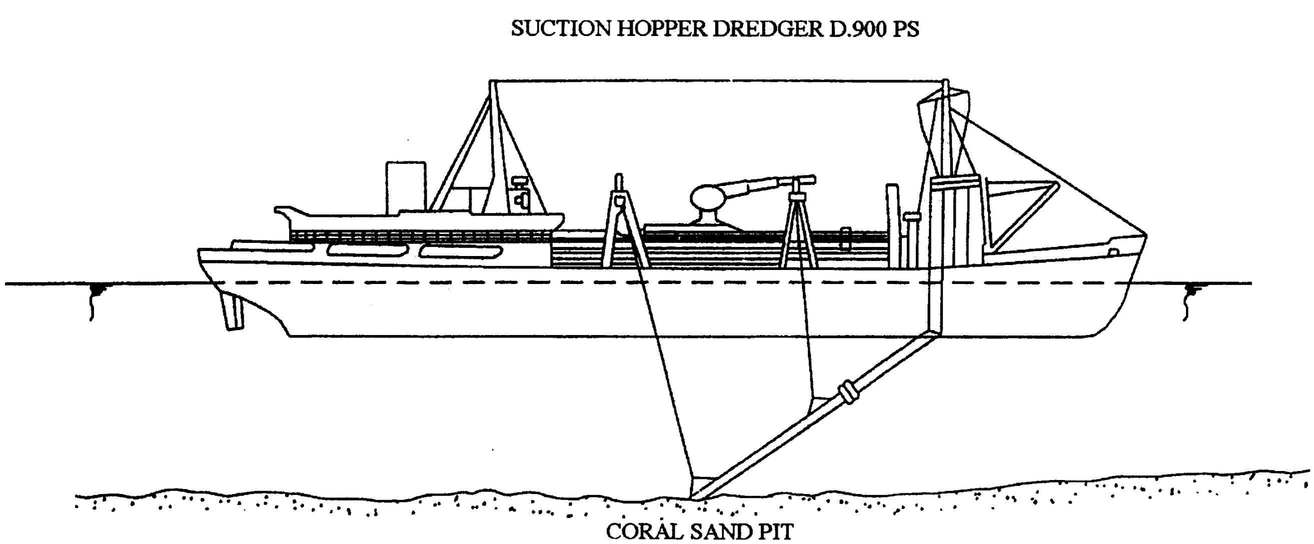


Figure 11.4.2 Trailing Suction Hopper Dredger

2) Offshore Disposal

The dredge material from the access channel and the turning basing will need to be disposed off in an offshore disposal area unless a suitable on land reclamation area is available. The disposal site shall have a soft bottom not rocky.

Dredging and disposal produces suspended sediment, but this can only be measured in the laboratory following vacuum filtration of a water sample, so there is a delay in obtaining the data. Turbidity can be measured instantaneously using a hand held meter, but measurements are based on the scattering of light, which is done by all particles in the water (including plankton, decaying organic matter, etc), not just suspended sediment. However a standard relationship between the two parameters can be deduced allowing immediate access to SS levels from turbidity readings. It is therefore proposed to require the Contractor to measure turbidity and SS at all stations every day for at least a month before dredging begins, to determine background levels and the relationship between the parameters. Turbidity would then be measured every 24 hours throughout the dredging and Island construction period, and the data supplied to ACP, who would decide when the contingency plan of ceasing dredging should be applied.

(3) Monitoring Rationale

Dredging, disposal and reclamation will be carried out in defined areas only, these shall be specified in the Contract Documents and Design Drawings. The operations shall also be controlled by GPS to ensure accurate positioning of all equipment. The Documents shall require the Contractor to monitor Turbidity and Suspended Sediment daily at several stations for at least a month before dredging begins, and to use the data to determine the relationship between the two parameters, and background (average) values of SS at each station. Turbidity will then be monitored daily at the same stations throughout the dredging operation, and the Contractor shall report the results to ACP weekly, or immediately if any trigger level is exceeded. ACP will review the results and discuss with ACP to decide if the instruction to cease dredging should be given. If this occurs, operations will not re-commence until background levels are reached again.

The stations shall be chosen near the reclamation site, to prevent plumes moving inshore, back towards the dredged channel. Three station shall be located 500m from the overflow from the reclamation area to ensure that as much silt as possible is retained within the bunded area; and one station is north-east to prevent significant plumes traveling towards the existing Panama Canal access, one station shall be in the north-west side of the island to monitor plumes traveling toward Veracruz Beach and One station in the direction of the beaches in Taboga Island. Trigger levels at all of these stations shall be set at 200 mg/l above ambient as a reference.

The Contract documents shall also require the Contractor to develop an oilspill contingency plan and carry the necessary equipment to enable any hazardous liquids spilled from the dredger to be contained and dealt with rapidly and effectively. He is also required to provide training to all workers in the environmental effects of dredging.

The monitoring carried out by the ECW in relation to this measure will be essentially observations to ensure that dredging, disposal and reclamation are carried out as shall be described in the specifications in the correct areas, and that the turbidity monitoring is carried out as specified, at the correct stations and with the required frequency.

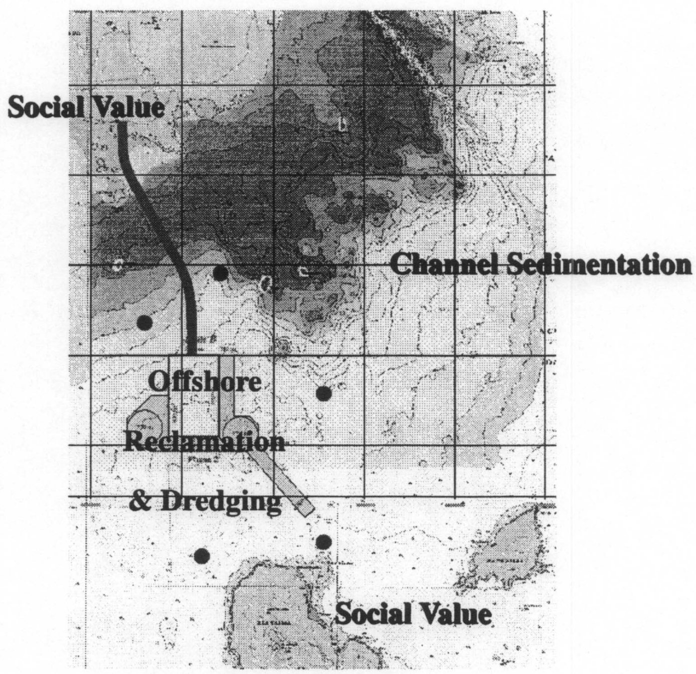


Figure 11.4.3 Monitoring Points during dredging

11.4.5 Sanitary Infrastructure for Construction Workers

(1) Mitigation Measure and its Objectives

Table 11.4.5 Mitigation Measure No. 5: Sanitary Infrastructure for Construction Workers

DESCRIPTION OF MEASURE				
Install and maintain adequate toilet, washing and safety facilities for the construction site workers.				
OBJECTIVE: Maintain worker health and safety and prevent sewage contamination of soil and water.				
RATIONALE: Construction will involve a large number of workers, who will be provided with adequate toilets, washing facilities, first aid kits, eyebaths and safety showers. Waste shall be treated to Panama standards by a portable plant or septic tanks.				
MAIN ELEMENTS				
	D	C	O	Responsibility
1. Contract Docs: provide sanitary facilities				Consultant
2. Contract Docs: treat waste to Panama standard				Consultant
3. Install/maintain toilets, washrooms, treat waste				Consultant
MONITORING				
1. Coliform bacteria in water around site				Consultant
2. Provision, usage of facilities, treatment of waste				ECW

(2) Approach

The number of workers required for the construction operation will vary depending on the stage of the process. It is important that facilities for workers are adequate to protect their health, and to prevent the environmental pollution associated with sites where toilet facilities are inadequate. First aid kits and safety showers will also be required. A clause shall be included in the Contract Documents requiring the Contractor to provide these facilities, and to ensure that they are used, and that the contents are disposed of appropriately, according to Panama discharge standards.

11.4.6 Project Promotion

(1) Mitigation Measure and its Objectives

Table 11.4.6 Mitigation Measure No. 6: Project Promotion

DESCRIPTION OF MEASURE				
Conduct a publicity campaign, via information boards and public meetings, to inform the population about the project and gain public support.				
OBJECTIVE: Prevent social unrest and protest regarding the project.				
RATIONALE: Some inhabitants could oppose the project either for environmental or social reasons. ACP shall conduct a campaign to inform the public about the economic and social benefits of the construction of this infrastructure. This shall involve public meetings and information boards.				
MAIN ELEMENTS				
	D	C	O	Responsibility
1 Erect billboards at the access location site and in Panama City near the Americas Bridge				ACP
2. Hold at least three (3) meetings to promote the project				ACP
MONITORING				
No monitoring required				

(2) Approach

As part of a final Environmental Permit for the construction of projects, is normally required that public meetings be held to account for the social impact or to account for environmental issues which might have not been identified in an Environmental Impact Assessment (EIA).

(3) Monitoring Rationale

Monitoring shall be carried out to ensure that meetings are held with the public and that their concerns and fears are addressed properly.

11.4.7 Construction of Additional Access Road Ways to Handle Additional Traffic

(1) Mitigation Measure and its Objectives

Table 11.4.7 Mitigation Measure No. 7:

Construction of additional Access Roads

DESCRIPTION OF MEASURE				
Construction traffic will use existing roads to the access point near Punta Bruja.				
OBJECTIVE: Prevent heavy machinery and equipment passing through the narrow streets that lead to the access location near Punta Bruja at the East End of the Veracruz Beach				
RATIONALE: It was observed in the visits to the project site that, the streets that lead to the access location of the new artificial island from the Americas Bridge is a narrow street not suitable for large numbers of heavy trucks. The additional traffic specially trucks would create a hazards for the existing light traffic that uses the existing road.				
MAIN ELEMENTS				
	D	C	O	Responsibility
1. Contract Documents specify alternative transport route				Consultant
2. Agree mechanism for traffic to use existing infrastructure such as America's Bridge				ACP/Consultant/Transportation Ministry
3. Construction traffic use of alternative transport route				Supervisor
MONITORING				
1. No monitoring necessary				

(2) Approach

The additional Access Road way shall be ready for the construction of the Artificial Island to haul the material to be used for the construction of the causeway and also for the construction of the infrastructure on the island. Additionally once the island is in operation and with all the expected transshipment traffic by trucks or rail it would generate additional heavy traffic volumes which could not be possibly handled with the existing network without posing a peril to the road users.

(3) Monitoring Rationale

The additional access road shall be used by all heavy traffic and monitoring shall be carried out to ensure that it does not make use of the existing narrow roads.

11.4.8 Control Development of Improvised Canteens

(1) Mitigation Measure and its Objectives

Table 11.4.8 Mitigation Measure No. 8:

Control Development of Improvised Canteens

DESCRIPTION OF MEASURE				
Prevent the illegal development of food stalls and other premises nearby the access road to the artificial island				
OBJECTIVE: Maintain a safe and clean appearance around the access point and specially Veracruz Beach prevent the accumulation of refuse.				
RATIONALE: The workforce engaged on a construction site and those employed in the subsequent new development represent a potential source of income for the local community, which frequently results in the establishment of improvised canteens and other stalls selling provisions near the site. Should these develop in an unplanned and unauthorized manner, without the basic services such as electricity, water and waste collection, they will easily become unsightly, generating waste which is not properly contained and removed. This shall be prevented to maintain the modern and clean appearance of the island development, and to avoid the health hazards associated with discarded uncollected piles of garbage. This will require legal measures, the provision of adequate canteens, and the provision of basic services with proper facilities nearby, where vendors can be licensed to establish canteens and other premises.				
MAIN ELEMENTS				
	D	C	O	Responsibility
1. Contract Docs: provide canteens at construction site				Consultant
2. Pass laws making stalls illegal outside site				ACP/ Panama City
3. Police remove any illegal premises				ACP/ Panama City
4. Provide suitable site nearby, license vendors				ACP/ Panama City
MONITORING				
1. Report any premises outside port to police				ECW, ACP

(2) Approach

The workforce employed on a construction site represents a potential source of income for the local community, and as a result, stalls selling food and other provisions normally proliferate outside construction sites. These premises then frequently remain in place after construction has been completed, providing the same kind of service to employees of the new facility. The premises are usually unplanned and unauthorized, and not provided with facilities such as water, electricity and a waste collection service, so rubbish accumulates and they often become unsightly and can be a risk to human health.

To prevent such an occurrence around Island Construction and to maintain the appearance of the site both during construction and operation, five actions will be taken as follows:

- Contract Documents shall require the Contractor to provide clean inexpensive canteen facilities for the construction site workforce;
- The issue of improvised canteens will be discussed with Panama Municipality to ensure that laws are in place making it illegal to erect and maintain stalls and any other premises in the vicinity of the site;
- Action will be requested by Panama Police Force to remove immediately any such stalls that develop;
- A request will be made for Panama Municipality or ACP to provide a suitable area near the port with an adequate structure, running water and electricity, and with a proper waste management service, where persons from the local community could be licensed to provide canteen services and other facilities;
- ACP will also provide suitable canteen facilities within the port during the operational phase.

(3) Monitoring Rationale

ACP will liase with Panama Municipality and Police Department to ensure that laws are passed and enforced preventing stallholders from establishing premises outside the Island Port access so that they will not detract from the appearance of the site. The Contract Documents shall require the contractor to provide inexpensive canteens on site where workers can obtain food, and ACP will do the same when the Island Port is operating. ACP will also request Panama Municipality to license food vendors to set stalls.

11.4.9 Worker Safety and Wildlife Conservation

(1) Mitigation Measure and its Objectives

Table 11.4.9 Mitigation Measure No. 9:

Worker Safety and Wildlife Conservation

DESCRIPTION OF MEASURE				
Provide medication for treatment of snake bites, and train workers in how to avoid and treat snake bites, and how to deal with any wildlife found on site.				
OBJECTIVE: Protect workers from snake bites, protect wildlife from damage by workers.				
RATIONALE: The areas of the new access road to the access location of the new artificial island near punta bruja and the borrow area might be inhabited by a variety of wildlife including venomous snakes. Although wildlife will be captured and relocated before construction begins, it is likely that some will remain, and others may enter the site from outside. Measures to protect both workers and wildlife shall therefore be taken. Antiserum will be provided on site and workers will be trained in avoiding and treating snakebites, and conserving any wildlife found on site.				
MAIN ELEMENTS				
	D	C	O	Responsibility
1. Contract Docs: train workers, provide antiserum	■			Consultant
2. Training and medical care during construction		■		Contractor
3. Training and medical care during port operations			■	ACP
4. Include wildlife conservation measures in EMS			■	PEU
MONITORING				
1. Training and antiserum provided		■		ECW

(2) Approach

Although the noise, and visual and physical disturbance that occurs at the start of the borrow operation should cause most un-captured animals to leave the site, it is possible that some may be encountered by workers during this period. Most of the surface of the completed island project will be concrete, asphalt or block and therefore inhospitable to wildlife, additionally such access to this area will be controlled by a single road way.

(3) Monitoring Rationale

This measure shall mainly be monitored during the time the new access roadway is built and during the borrow operation since it is highly unlikely that snakes or other wildlife will be present at the offshore reclamation site.

11.4.10 Comply with Relevant Laws

(1) Mitigation Measure and its Objectives

Table 11.4.10 Mitigation Measure No. 10: Comply with Relevant Laws

DESCRIPTION OF MEASURE				
The port island and its activities must comply with relevant laws throughout all stages.				
OBJECTIVE: Ensure that island final design and all construction and operation activities comply with all relevant national laws.				
RATIONALE: The construction process and the operating port involve many activities which could be hazardous if equipment, machinery and operations are not designed and implemented to the strictest standards and specifications, and if laws are not upheld. A port is also a place where illegal activities could occur, including handling prohibited goods. Designs have been prepared following established national, and where relevant, international standards, and the Port Contractor will be required to operate in compliance with all national laws. As the project proponent and the legal authority for the operating port, ACP will also ensure that all applicable laws are upheld by port operators and users at all times.				
MAIN ELEMENTS				
	D	C	O	Responsibility
1. Port island designs comply with standards and laws				Consultant
2. Contract Docs: Contractor to comply with laws				Consultant
3. Port Island built according to standards and laws				Consultant
4. Port Island Manual checked for legal compliance				ACP
5. Port Island Manual and procedures comply with laws				ACP
6. ACP enforce compliance with procedures, law				ACP/Port Mgr
MONITORING				
1. Construction carried out according to contract				Consultant
2. Port operations according to POM				ACP/Port Mgr

(2) Approach

1) Port Planning

Engineering designs are developed by reference to standards and criteria set down in design manuals, which have been used over many years to produce designs of quality and safety, that comply with relevant laws. For the present port, international standards were used, specifically those of the Japanese Standards. This, plus quality checks carried out as part of routine engineering procedure, have ensured that the designs comply with the relevant laws.

2) Construction Process

As far as the construction process is concerned, the Contract Documents require the Contractor to obtain information on the appropriate laws and to ensure that all activities are in compliance. The construction process will be supervised by a civil engineering Consultant, who will engage local consultants familiar with the legislative environment of Panama, to ensure that any illegal or non-compliant practices are recognized and corrected.

3) Port Operations

All of the activities within the port will be prescribed by procedures contained in a Port Operations Manual. ACP shall ensure that their Legal Department review all procedures in the draft and final versions of the manual to ensure that the approaches specified are in compliance with all appropriate laws. Adherence to the procedures will then be monitored by the Port Management Team, and they will report transgressions to ACP, who will have the ability to apply appropriate sanctions.

Ports normally house officials from the government customs and immigration departments who operate to detect illegal cargoes or immigrants. Officers from Customs and Immigration will thus be provided with offices in the port from where they will implement their activities. These will include routine checking of baggage and passports plus targeted searches of specific vessels, vehicles and containers.

(3) Monitoring Rationale

The designs, drawings, reports and other documents that will be produced for the project shall referred to national and international standards, and be subject to rigorous Quality Assurance checks, ensuring that the highest standards are met. The Contract Documents require the Contractor to be familiar with all relevant Panamanian laws and to ensure that all activities are in full compliance. This will be monitored by the Consultant supervising construction, who will also need to be fully conversant with national laws relating to construction to detect any incidences of bad practice.

During the operational phase ACP will design a Island Port Operations Manual (POM) specifying how all activities in the functioning Island Port are to be conducted, and they will ensure that these all comply with the relevant laws by subjecting both draft and final versions to careful scrutiny by the ACP Legal Department. It will then be the responsibility of the ACP Manager of the Island Port (which he may delegate) to ensure that all operations follow the procedures in the manual explicitly and thus maintain legal compliance. This will be observed during routine site inspections and subject to an annual formal audit.

Finally illegal immigration and the handling of prohibited cargoes and materials will be detected and prevented by the activities of the Government Immigration and Customs officials, who will be housed in the Island Port.

11.4.11 Environmental Protection During the Operational Period

(1) Mitigation Measure and its Objectives

Table 11.4.11 Mitigation Measure No. 11: Solid Waste Management

DESCRIPTION OF MEASURE				
Collection and disposal of solid waste produced during port operations.				
OBJECTIVE: Maintain a clean site, prevent odor and contamination of soil and water.				
RATIONALE: In the functioning port, solid waste from vessels will be dealt with by Shipping Agents, who normally employ a contractor to carry material to landfill. The remaining waste is the responsibility of the Port Authority, and ACP will require all companies operating within the port to develop and apply Waste Management Plans (WMP) to deal with their waste. ACP will prepare an overall Plan for the port, to provide the framework within which the plans of each company must fit. They will also provide trash containers, a central disposal point, and a garbage truck, and will arrange for Panama Municipality to collect the waste from outside the port. The Port Waste Management Plan will be included in the Port Operations Manual (POM), which contains procedures describing how all the activities in the port are to be conducted.				
MAIN ELEMENTS				
	D	C	O	Responsibility
1. Request Panama City to collect port waste				ACP
2. Require firms to prepare Waste Management Plan				ACP
3. Prepare Port Operations Manual				ACP
4. Prepare Port Waste Management Plan				ACP
5. Provide trash containers and collection truck				ACP
6. Waste managed according to plans				ACP
MONITORING				
1. Correct deposition, collection, disposal of waste				PEU

(2) Approach

1) Port Management

ACP will have overall authority over the port on behalf of the government, and will thus take major decisions regarding matters of policy. They will appoint a Port Manager who will be responsible for the day-to-day business and operation of the port, and he will head a management team including managers of other departments (such as Administration, Operations and Maintenance), each of whom will be responsible for their aspect of the operation.

2) Port Operations Manual

ACP will prepare an Operations Manual, containing procedures that have to be followed within the port. This will cover all activities, and will be provided to all concessionaires, to all vessels visiting the port, and to all container and haulage companies. The Port Management Team will monitor the application of the procedures, and will take action in cases of repeated violation.

3) Solid Waste Management

Solid waste will be generated by most of the activities in the port when it is operational, including the administration buildings, the facilities provided for workers (canteens and washrooms), the activities of the various companies operating on site, and the ships that visit the port.

(3) Monitoring Rationale

The Island Port Operations Manual will contain a Island Port Waste Management Plan, and ACP will require all companies operating in the Island Port adhere to the WMP, and to develop and apply their own Plans. It is likely that ACP will appoint a local company to provide waste management services for the Island Port, which will include the provision of closable steel bins to all companies, and the collection of waste. ACP shall arrange for Panama Municipality to collect waste from outside the Island Port, which they will report to the municipal landfill.

The Island Port Environmental Unit will monitor the application of the waste management plans, during the course of their routine site inspections, and by annual audits.

11.4.12 Liquid Waste Management

(1) Mitigation Measure and its Objectives

Table 11.4.12 Mitigation Measure No. 12: Liquid Waste Management

DESCRIPTION OF MEASURE				
Include in the port design, measures to collect, treat and dispose of any spills of hazardous liquids.				
OBJECTIVE: Prevent pollution of soil and water by spilled liquids.				
RATIONALE: It is not expected that the completed port will handle liquid cargoes in bulk, so the only area in which hazardous liquids will be handled is in the vehicle maintenance workshop. The drainage system shall been designed to collect all drainage from this area and pass to an oil-water separator, designed to treat the waste to Panama discharge standards.				
MAIN ELEMENTS				
	D	C	O	Responsibility
1. Port Design: includes oil-water separator				Consultant
2. Port Design: workshop drainage to separator				Consultant
3. Prepare port oilspill contingency plan				ACP
4. Provide booms, skimmers, absorbents				ACP
MONITORING				
1. Oil/grease in separator effluent (weekly)				PEU

(3) Monitoring Rationale

The Island Port drainage system shall be designed to collect and transport all runoff from the area of the vehicle maintenance workshop to an oil-water separator, which shall be designed to treat waste to Panama discharge standards. The Supervising Consultant shall ensure that the separator and drainage system are constructed as specified.

During the operational phase ACP will appoint qualified personnel to prepare an oilspill contingency plan for the Island Port, provide the necessary equipment and train staff in implementing the oil containment and treatment measures. This will then be applied to deal with any spillages in the vicinity, whether from the Island Port, visiting vessels or other sources. The Island Port Environmental Unit will check the correct functioning of the oil-water separator by taking a sample of effluent every week and sending it to an accredited laboratory for analysis of oil and grease.

11.4.13 Occupational Health and Safety

(1) Mitigation Measure and its Objectives

Table 11.4.13 Mitigation Measure No. 13: Occupational Health and Safety

DESCRIPTION OF MEASURE				
Operate Occupational Health and Safety (OHS) Plans and provide safety equipment for workers during port construction and operation.				
OBJECTIVE: Protect health and safety of workers and maintain occupational hygiene.				
RATIONALE: To protect the health and safety of workers, the Port Contractor will be required to produce and operate an OHS plan covering construction site activities, and to provide safety equipment including clothing, footwear, head and eye protection, gloves, harnesses, etc. ACP will produce an OHS plan for the operating port, and provide safety equipment for those activities that are their responsibility.				
MAIN ELEMENTS				
	D	C	O	Responsibility
1. Contract Docs: Operate OHS Plan (construction)	■			Consultant
2. Contract Docs: Provide safety equipment	■			Consultant
3. Construction activities conducted as in Plan		■		Contractor
4. OHS Plan and equipment for operating port			■	ACP
5. Operational activities conducted as in Plan			■	ACP
MONITORING				
1. Construction activities conducted as in Plan		■		Consultant
2. Operational activities conducted as in Plan			■	Port Manager

(2) Approach

1) Occupational Health and Safety

Most of the activities performed at a construction site carry a degree of risk to the safety of workers, with those of most risk being activities involving demolition, or where vehicles are involved (such as at the borrow site), or when workers are working above ground on scaffolding. Similarly in an operating port many of the activities involve complex machinery or vehicles (container handling), or hazardous materials (in cargoes).

It is normal practice for construction sites and industrial premises to operate OHS Plans, and provide safety equipment to protect workers. This will be achieved in the present project as follows:

- Contract Documents require the Port Contractor to prepare and operate an OHS Plan at the construction site and provide safety equipment for workers;
- ACP will prepare an OHS Plan for the operating port, will provide equipment and

facilities for operations that are their responsibility, and will audit performance and keep a record of accidents.

(3) Monitoring Rationale

The Contract Documents require the Island Port Contractor to prepare and submit as part of his tender an OHS plan for the construction process, and this will be scrutinized by ACP as one of the conditions used for selecting the preferred bidder. The Construction Supervisor will then ensure that this is followed throughout the construction period.

ACP themselves will prepare an OHS plan for the Island Port operations, which will be an annex to the Island Port Operations Manual. All concessionary companies, visiting vessels, haulage and container handling companies and their employees will be required to comply, as will all ACP employees. Equipment will be provided by the companies, and by ACP for their own staff, and usage will be mandatory. Monitoring the application of the procedures and provision and usage of the equipment will be the responsibility of the Island Port Manager, who may delegate this to member(s) of his staff.

11.4.14 Port Environmental Unit

(1) Mitigation Measure and its Objectives

Table 11.4.14 Mitigation Measure No. 14: Port Environmental Unit

DESCRIPTION OF MEASURE				
Form a group of experts to be responsible for environmental matters within the port.				
OBJECTIVE: Minimize the environmental impacts of port operations				
RATIONALE: Most of the activities of the port could damage the environment if mitigation measures are not implemented properly, if operational procedures are not followed, and if accidents occur. A small Unit of experts will be established, to determine whether procedures are being implemented, and to carry out monitoring to assess whether agreed conditions are being met and to determine how the port is affecting the environment. This will comprise a qualified Manager, a Mechanical Engineer and a Water Quality Scientist.				
MAIN ELEMENTS				
	D	C	O	Responsibility
1. Establish Port Environment Unit (PEU)				ACP
2. PEU carry out ambient and effluent monitoring				PEU
MONITORING BY ENVIRONMENTAL UNIT				
1. Daily observations for pollution evidence				PEU
2. Oil Separator effluent: Oil/grease				PEU
3. WWTP: BOD, COD, TSS, Coliform				PEU
4. Ambient air, soil, water quality				PEU
5. Report results to ACP				PEU

(2) Approach

Most modern ports now have some kind of Environmental Unit, with facilities on site where they can carry out basic tests of water quality and other environmental parameters. These tests, and other observations are very important in monitoring the effects of the port on the environment, and providing early indications of potential problems. Such a Unit will be established at Panama Island Port, to carry out the following activities:

- *Ad hoc* observations and annual audits of the compliance of port operators, staff and visitors, with procedures set down in the Port Operations Manual relating to environmental matters;
- Monthly monitoring of ambient water, air and soil quality within the port, and the concentrations of key parameters in wastewater discharges and atmospheric emissions from port operations and processes;
- Review of the monitoring results, comparing ambient values with national standards and baseline conditions established before the port was constructed,

and comparing the quality of discharges and emissions with national standards and permit conditions specific to particular operations;

- Assessment of the impact of the port on the environment on the basis of the above comparisons, and early identification of any exceeding of standards, or other potential environmental problems;
- Regular reporting of the results of such analyses to ACP, with recommendations regarding appropriate remedial action.

(3) Monitoring Rationale

ACP will establish a Island Port Environmental Unit comprising a qualified Manager and Specialist, and will provide equipment and facilities necessary for the Unit to carry out the various monitoring activities allocated to it in this Monitoring Plan. The PEU will reIsland Port their findings to ACP on a monthly basis, and more frequently if environmental problems are detected. They will also work with consultants or Specialist appointed by ACP to develop an Environmental Management System (EMS) for the Island Port, comprising procedures which all Island Port concessionary companies will be required to follow to minimize their impacts on the environment.

External monitoring of the activities of the PEU will be provided by ACP, who will be requested for assistance in the appointment of staff and specification of equipment when the PEU is established. They will also be consulted regarding the data collected by the PEU during the course of their activities.

11.4.15 Environmental Measures in Port Operations Manual

(1) Mitigation Measure and its Objectives

Table 11.4.15 Mitigation Measure No 15:

Environmental Measures in Port Operations Manual

DESCRIPTION OF MEASURE				
Prepare and include environmental measures in the Operations Manual for the port.				
OBJECTIVE: Raise awareness of environmental risks/impacts, reduce pollution incidents and the impact of the port on the environment.				
RATIONALE: The Port Environmental Unit will establish an Environmental Management System with procedures specifying how the port and it's various operations will manage and minimize their effects on the environment.				
MAIN ELEMENTS				
	D	C	O	Responsibility
1. Set up Port Environmental Management System				PEU
MONITORING				
1. *Ad hoc* observation of working practices				PEU
2. Annual audit: compliance with EMS procedures				PEU

(2) Approach

The procedures of the Port Operations Manual should prevent accidents during port operations and thus avoid environmental damage. However given that most activities in the port could affect the environment, it is important that the port also takes positive action to manage and minimize its impacts, in addition to these preventative measures. This is the function of an Environmental Management System (EMS), which covers such actions as recycling of paper and other waste, reducing the use of fuels and energy, etc, but also examines the direct impact of the port on the environment through the materials it uses, the products it makes, and the way materials are handled. The PEU will design and implement an EMS for the port, which will become an integral part of the POM, and will apply to all port activities.

(3) Monitoring Rationale

The procedures of the Island Port Operations Manual (POM) will be mandatory for all companies operating in the Island Port and their employees, including those of ACP. The PEU will develop an Environmental Management System for the Island Port (EMS), the manual for which will be part of the POM. This will contain procedures designed to reduce the environmental impact of the Island Port, and these will also be mandatory. The PEU will observe the activities of the Island Port to monitor compliance with the EMS procedures and will report transgressions to ACP. Once per year they will formally audit the compliance of all concessionaires with the EMS;

11.4.16 Operation of Liquid Treatment Plants

(1) Mitigation Measure and its Objectives

Table 11.4.16 Mitigation Measure No 16:

Operation of Liquid Treatment Plants

DESCRIPTION OF MEASURE				
Employ a qualified technician to operate the port water treatment plants and monitor effluent discharges.				
OBJECTIVE: Maintain WWTP and oil-water separator in full working order, and ensure that discharges meet Panama standards.				
RATIONALE: Measures to control water pollution in the port shall comprise an oil-water separator and a sewage treatment plant. These shall be designed to treat pollutants so that water released to the environment meets Panama discharge standards. The Contractor will prepare an Operation and Maintenance Manual for the plants specifying procedures to be followed, and ACP will hire a qualified technician to operate the plants and measure basic parameters of the effluent.				
MAIN ELEMENTS				
	D	C	O	Responsibility
1. WWTP designed to treat to discharge standard				Consultant
2. Separator designed to treat to discharge standard				Consultant
3. Contract Docs: Contractor supply O&M manual				Contractor
4. Plants built as specified				Contractor
5. Hire technical operator for treatment plants				ACP
6. Provide basic monitoring equipment				ACP
7. Technician maintains plants, monitors effluent				PEU
MONITORING				
1. Plants built as specified				Consultant
2. Monthly: flow, pH, temperature, visual quality				Technician
3. Monthly: oil/grease, BOD, COD, TSS, bacteria				PEU

(2) Approach

1) Oil Treatment

The oil-water separator will receive drainage from the vehicle maintenance workshops, and shall designed to treat the liquids to Panama discharge standards, before effluent is released to the sea at the container berths. Contract Documents require the

Contractor to provide an Operation and Maintenance (O&M) Manual describing the procedures that need to be followed to maintain the plant in working order. ACP will employ a qualified technician to operate the separator, following the procedures set down in the O&M manual, and to record basic parameters of the effluent.

2) Wastewater Treatment

A sewage treatment plant shall be provided to treat waste from on site toilets and washrooms, and this shall also be designed to treat the material to Panama discharge standards. Again the Contractor will provide an O&M Manual and the technician will operate the plant and monitor basic effluent parameters.

3) Effluent Analysis

The Port Environmental Unit will take samples of both effluents every month for analysis of the more complex determinants. These are oil and grease in the separator discharges, and BOD, COD, Total Suspended Solids and total and faecal coliforms in the WWTP effluent. These will be carried out by an external laboratory, and the Environmental Unit will report to ACP on the results.

(3) Monitoring Rationale

The oil-water separator and the WWTP plants shall be designed to treat the waste material producing effluents that meet Panama discharge standards. The Construction Supervisor will ensure that both are built as specified, and that as required by the Contract Documents, the Contractor produces Manuals describing in detail the operation and maintenance of both plants.

ACP will operate the plants, and be responsible for keeping the plants in full working order, following the procedures set down in the O&M Manuals. Samples of effluent for more detailed analysis (WWTP: BOD_5, COD, TSS and total and fecal coliforms; Oil-water separator: total oil and grease) will be taken every month by the PEU and sent to an external laboratory for analysis.

11.4.17 Maintenance of Treatment Plants

(1) Mitigation Measure and its Objectives

Table 11.4.17 Mitigation Measure No 17: Maintenance of Treatment Plants

DESCRIPTION OF MEASURE				
Maintain port pollution treatment facilities and remove and dispose of waste material.				
OBJECTIVE: Prevent discharge of polluting effluents.				
RATIONALE: The various oil-water separator and wastewater treatment plant require regular maintenance and removal of waste to maintain optimum performance. ACP will appoint a contractor to remove and dispose of sludge in an approved manner.				
MAIN ELEMENTS				
	D	C	O	Responsibility
1. Determine appropriate means of sludge disposal		■		ACP
2. Appoint Contractor to remove, dispose sludge			■	ACP
3. Sludge removed and disposed of			■	ACP
MONITORING				
1. Removal and disposal of sludge as specified			■	PEU

(2) Monitoring Rationale

The measures necessary to maintain the oil separator and WWTP will be included in the O&M Manuals for the plants, and the maintenance will be conducted by the technician. The PEU will monitor the implementation of the necessary maintenance in the course of their activities on site.

ACP will liase with Panama Municipality to determine the appropriate means of disposal of oil and sewage sludge, and will then prepare contracts and engage a local company to remove and dispose of the waste as agreed. The PEU will also observe these activities to ensure that procedures set down in the contract are followed.

11.4.18 Prevent Rodents Entering the Port from Ships

(1) Mitigation Measure and its Objectives

Table 11.4.18 Mitigation Measure No 18:

Prevent Rodents Entering the Port from Ships

DESCRIPTION OF MEASURE				
Prevent rats and other rodents entering the port from visiting ships.				
OBJECTIVE: Prevent proliferation of pests in the port damaging cargoes, and the introduction of alien species.				
RATIONALE: Poorly controlled loading and pest control procedures at other ports could mean that the holds of ships that visit the Panama Island Port could be inhabited by rats and other rodents, feeding on the loose and bagged cargoes. These could be species alien to the Americas if ships visit from far afield, so to prevent the proliferation of pests in the port and the introduction of alien species that could upset the balance of natural ecosystems, these animals need to be prevented from entering the port. This is routinely done in ports by the use of metal barriers on the mooring ropes. This topic should not be foreign to Panama being the international port it is.				
MAIN ELEMENTS				
	D	C	O	Responsibility
1. POM: require ships to use anti rodent barriers				ACP
2. Control pests throughout port				ACP
MONITORING				
1. Monitor use of discs, pests in port				PEU

(2) Approach

It is expected that many of the ships that will visit Panama Island Port will container carries, however there might be in some cases ships carrying cargoes that attract rats and other rodents. This applies particularly to materials handled in bulk, such as the grains, and maize and soybean flours, but also break-bulk cargoes carried in bags. Rodents will need to be prevented from entering the port where they could cause serious damage to cargoes being stored. Pests could also bring wider ecological problems if they were species alien to the Americas, because they could upset the balance of natural ecosystems if they escaped from the port and proliferated in the surrounding habitats.

This is a problem that has been solved in ports by a very simple yet effective way. Rats normally leave the hold of ships is by running down the mooring ropes, and they can be prevented from doing this by installing metal barriers along the ropes, which are large enough to prevent the rats from climbing over. Most vessels now carry their own devices to prevent rats entering their holds, and a procedure will be added to the Port Operations

Manual requiring ships to use these devices on all mooring ropes at all times when in the port.

The port will apply its own pest control procedures to keep down the populations of rodents attracted by the cargoes, and this will involve:

- General good housekeeping measures as prescribed by the Operational Procedures, including preventing spillage of solids and storing bulks in hygienic conditions in closed containers;
- Specific pest control measures when required.

(3) Monitoring Rationale

ACP shall include in the Island Port Operations Manual a procedure making the usage of anti rat discs mandatory at all times when a vessel is moored, and the PEU will observe the usage of the discs during their activities in the Island Port. ACP will also appoint a local company to control rats and other pests in the Island Port and the PEU will observe the actions they take and will monitor the presence of pests in the Island Port to ensure that the control measures are effective.

11.4.19 Air Quality

(1) Mitigation Measure and its Objectives

Table 11.4.19 Mitigation Measure No 19: Air Quality Monitoring

DESCRIPTION OF MEASURE				
Employ a qualified consultant to measure air contaminants concentrations near the new port development and near the new access way specially near populations or recreational locations.				
OBJECTIVE: Air contaminant concentrations such as Sulfur Oxides and Nitrogen Oxides below the acceptable limits according to local regulations or internationally accepted regulations.				
RATIONALE: Measures to monitor air contaminant concentrations shall be obtained prior to project execution to be taken as background concentration in order to assess the impact of the new project on the air quality. These monitoring stations shall be located in the downward direction of the wind from the project site and only if a population exist within the reach of such contaminant. Until the access route access the access point if fully defines is would be recommended only to use two control points; one at Veracruz beach and one at Taboga island. The Contractor shall then ensure constant monitor during operations and ACP by PEU shall follow with monitoring during the operation by hiring a qualified firm to take measurements.				
MAIN ELEMENTS				
	D	C	O	Responsibility
1. Determine background contaminant concentration and compare with limits				Consultant
2. Contract Docs: Contractor to monitor during construction				Contractor
3. Technician maintains monitoring equipment and take readings during the first year of operation to compare with background and limits. Determine if further monitoring is warranted.				PEU
MONITORING				
1. Monitor contaminant concentrations during constructions and determine based on wind directions any potential effect.				Consultant
2. Weekley: Contaminant Concentrations				PEU

(2) Approach

1) Calling Ships

Calling ships approaching or leaving the island will have air contaminant emission, their concentrations in the monitoring points shall be establish and compared with the limiting values for human exposure. A decision could be made after one year of operation (dependant on percent occupancy of berths) if further monitoring is warranted. Monitoring could cease if mathematical modelling or field data demonstrate negligible risk of harmful contaminants reaching trigger levels.

2) Land Transportation

The access way to the island will be connected to a highway to mobilize the containers in and out of the island towards other facilities, as the volumes of containers to be transported increases the volume of contaminants generated by all the potential truck traffic could adversely affect the air quality near existing human settlements. Background levels and monitoring stations shall be established once the alignment of the new road is defined. Control or mitigation measures shall be established once the impacts are known with more certainty.

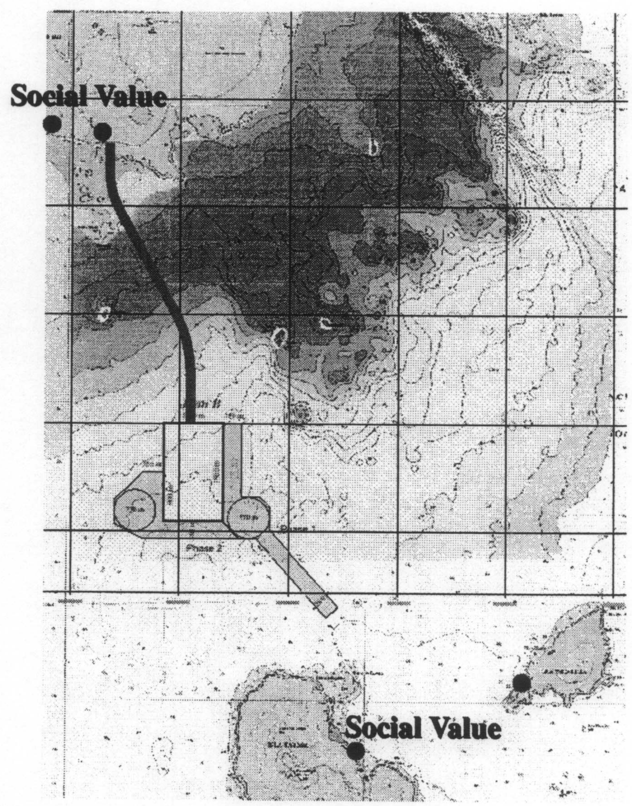


Figure 11.4.4 Monitoring Points for air quality

11.4.20 Protected Areas

(1) Mitigation Measure and its Objectives

Table 11.4.20 Mitigation Measure No 20: Protected Area

DESCRIPTION OF MEASURE				
The connection of the access way to the island to the main land lies in an area that belong to a protected zone, the amount of deforestation shall be minimized and the impact mitigated by assigning more protected areas nearby and replanting trees.				
OBJECTIVE: Air contaminant concentrations such as Sulfur Oxides and Nitrogen Oxides below the acceptable limits according to local regulations or internationally accepted regulations.				
RATIONALE: Measures to monitor air contaminant concentrations shall be obtained prior to project execution to be taken as background concentration in order to assess the impact of the new project on the air quality. These monitoring stations shall be located in the downward direction of the wind from the project site and only if a population exist within the reach of such contaminant. Until the access route access the access point if fully defines is would be recommended only to use two control points; one at Veracruz beach and one at Taboga island. The Contractor shall then ensure constant monitor during operations and ACP by PEU shall follow with monitoring during the operation by hiring a qualified firm to take measurements.				
MAIN ELEMENTS				
	D	C	O	Responsibility
1. Determine background contaminant concentration and compare with limits	■			Consultant
2. Contract Docs: Contractor to monitor during construction		■		Contractor
3. Technician maintains monitoring equipment and take readings during the first year of operation to compare with background and limits. Determine if further monitoring is warranted.			■	PEU
MONITORING				
1. Monitor contaminant concentrations during constructions and determine based on wind directions any potential effect.		■		Consultant
2. Weekley: Contaminant Concentrations			■	PEU

(2) Approach

1) Calling Ships

Calling ships approaching or leaving the island will have air contaminant emission, their concentrations in the monitoring points shall be establish and compared with the limiting values for human exposure. A decision could be made after one year of operation (dependant on percent occupancy of berths) if further monitoring is warranted. Monitoring could cease if mathematical modelling or field data demonstrate negligible risk of harmful contaminants reaching trigger levels.

2) Land Transportation

The access way to the island will be connected to a highway to mobilize the containers in and out of the island towards other facilities, as the volumes of containers to be transported increases the volume of contaminants generated by all the potential truck traffic could adversely affect the air quality near existing human settlements. Background levels and monitoring stations shall be established once the alignment of the new road is defined. Control or mitigation measures shall be established once the impacts are known with more certainty.

11.4.21 Hydrology

Table 11.4.21 Mitigation Measure No 21: Hydrology

DESCRIPTION OF MEASURE				
As a new structure is placed on the path of the currents, it has an effect on the currents behavior and it results in effects on the environment, the extend of the effect is dependant on the natural conditions and the extend of the impact from the structure.				
OBJECTIVE: By the mathematical modeling make recommendations on the proposed design to have the minimum impact on the hydrology due to the construction of the island and the access way.				
RATIONALE: Two structures will be built which will have an impact on the hydrology of the influence zone; Artificial Island and Access Way.				
MAIN ELEMENTS				
	D	C	O	Responsibility
1. Jointly determine from the mathematical modeling the least damaging structure and access way type in view of the environment.	■			Consultant
MONITORING				
2. Monthly: Monitoring after construction the effect on the currents or shoreline changes.			■	PEU

(2) Approach

1) Artificial Island

Mathematical modelling were carried out to determine the effects of the construction of the artificial island on the currents of the influence area north of Taboga Island and towards the shore. Is was observed that, given that two natural islands of considerable size exist at close distance south of the proposed artificial island, the impacts of the new structure are not different from the impacts of the two existing island. Therefore, and assuming that the natural habitat is already adapted to such conditions, the impact of the construction of the island itself either on the natural habitat or the currents is not expected to be significant.

2) Access Way

The access way to the island will be connected to a highway to mobilize the containers in and out of the island towards other facilities; the type of structure is a key element on the determination of the impact of the project on the hydrology, bigger than the island itself. Mathematical modeling were made by three different structures and combination of structures as shown in Current Analysis (Chapter 5). The structure recommended is a hybrid of two structures which proved to be environmentally acceptable and economically feasible. Near the shore it was recommended to use a combination of bridge and culverts not to impede the natural flow of water, specially in the flood tide, a causeway similar to Amador's is then used for about 3.5 km with a bridge at mid distance to allow the passage of the currents not to fully block the two sides and minimize the barrier effect. In terms of the Environment and the Hydrology it is obviously more desirable to allow the fully unimpeded passage of the flows, however the proposed solution is not expected to pose significant treat to the bay environment when looking at the entire Panama Bay dynamic.

CHAPTER 12 PROJECT EVALUATION

The Project for the Construction of an Artificial Island at the Pacific Entrance to the Panama Canal was derived from effective utilization of excavated material to be generated from the proposed construction of the Third Locks, which is still under studies by ACP. This Chapter deals with project evaluation by calculating economic and financial internal rates of return and preparing a financial statement, provided that a container terminal is constructed in the Artificial Island to be created from the excavated material. Financial evaluation has been conducted to appraise financial soundness of the port management entity. It must be noted that management and operation system would be studied in the succeeding stage.

12.1 Economic Evaluation

12.1.1 Purposes and Methodology of Economic Analysis

The purpose of economic analysis is to appraise the economic feasibility of the Project from the viewpoint of the national economy. This focuses on whether the benefits of the Project exceed those that could be derived from other investment opportunities in Panama.

12.1.2 Prerequisites for Economic Analysis

12.1.2.1 Base Year

Costs and benefits estimated in the economic analysis were expressed in the prices applicable in the fixed "Base Year" and throughout the "Project Life" mentioned below. In this analysis, the year 2003 was adopted as the "Base Year" since the costs of the Project were estimated on the basis of current prices in the same year.

12.1.2.2 Project Life

Taking account of the sum of construction period and probable concession period relating to the Project the period of 50 years was adopted as the "Project Life".

12.1.2.3 "With-the-project" Case and "Without-the-project" Case

A cost-benefit analysis was conducted on the difference between the "With-the-project" case in which an investment is made and the "Without-the-project" case in which no investment is made, that is the benefits and costs arising from the investment for the Project were compared.

(1) "With-the-Project" Case

Excavated material generated from the Third Locks Project will be effectively utilized as reclamation material and finally an Artificial Island will be created for handing transshipment container cargoes related to the Canal and non-related the Canal.

(2) "Without-the-Project" Case

Excavated material generated from the Third Locks Project will be disposed of some places which ACP designates. Transshipment cargoes will be destined to others ports.

12.1.3 Benefits of the Project

12.1.3.1 Benefit Items

As benefits to be brought about by a port project, the following items are normally identified:

(1) Savings in cost of ship staying at berths

(2) Savings in cost of ship waiting in an offshore anchorage

(3) Savings in sea transportation cost

(4) Savings in land transportation cost

(5) Earnings of port tariff from the handling of foreign cargo to be transited via the New Port

(6) Promotion of regional economic development

(7) Increase in job opportunity in the region.

12.1.3.2 Estimated Benefits by the Project

In this JETRO F/S, the following benefits are anticipated.

(1) Savings in Sea Transportation Cost

Capitalizing on mass transportation by large vessels (post Panamax vessels) would be effective and such a trend of enlargement of vessels contribute to reducing cargo transportation costs. In this case, savings in sea transportation cost will be generated with the employment of larger container vessels to be brought by the investment at the New Port. In this F/S, saving in sea transportation of 15 (fifteen) United States dollars per TEU is roughly applied to quantify the savings.

(2) Earnings from Handling Transshipment Cargo at the New Port

Earnings of currencies will be brought by attracting transshipment cargoes at the New Port. In this Study, the tariff of 100 United States dollars per TEU including container handling charge and vessel service charge can be applied to simplify the analysis.

(3) Savings in Effective Utilization of Excavated Material

Excavated material generated from the Third Locks Project is effectively utilized as reclamation material for an artificial island that would be a transshipment container hub port in the Pacific side of Panama. According to the Final Report of the Preliminary Study of Island Development prepared in December 2001, a cost of 5.20 United States dollars per cubic meter for excavated material can be saved if excavated material is disposed of in the Artificial Island.

12.1.4 Costs of the Project

12.1.4.1 Initial Investment Costs

Table 12.1-1 summarizes the project cost phase-wisely allocated.

Table 12.1-1 Project Cost

(Million US$)

Component		Phase 1	Phase 2	Total
1	Island Construction	365.2	0.0	365.2
2	Accessway	99.3	0.0	99.3
3	Infrastructures	74.4	38.7	113.1
4	Container Terminal	216.5	102.8	319.3
Total		755.4	141.5	896.9

12.1.4.2 Management/Operation and Maintenance Costs

Cost items for management/operation and maintenance are listed below:

(1) Maintenance Cost for Infrastructures

This cost was assumed to be one percent (1%) of initial investment costs of depreciable infrastructures. Thus, reclamation costs, etc. were excluded.

(2) Maintenance Cost for Equipment

This cost was assumed to be four percent (4%) of initial investment costs of equipment (gantry cranes).

(3) Administrative Cost

The administrative cost, most of which is personnel expense was assumed.

(4) Renewal Investment Costs

From the start of operation and throughout the project life, the equipment that is procured in the initial stage will be renewed when its useful life expires. Individual useful lives were assumed to be in the range of 5 to 25 years. A longer life (25 years) was assumed for quayside gantry cranes.

(5) Total Costs

The total project costs comprising those of initial investment, yearly management/operation and maintenance, and renewal of equipment from time to time during the project life are summarized in Table 12.1-2 together with benefits to be generated from the Project.

12.1.5 Evaluation of the Project

12.1.5.1 Calculation of EIRR (Base Case)

The economic internal rate of return (EIRR) based on a cost-benefit analysis was used to appraise the economic feasibility of the Project. The EIRR is the discount rate that makes the costs and benefits of a project equal during the project life. The following formula was used to calculation of EIRR:

$$\sum_{i=1} \frac{Bi - Ci}{(1+r)^{i-1}} = 0$$

Where,

n: Period of economic calculation (project life)

i: Year

Bi:Benefits in the i-th year

Ci:Costs in the i-th year

r: Discount rate

The resulting EIRR of the Project is 12.4% (see Table 12.1-2).

12.1.5.2 Sensitivity Analysis

In order to see if the Project is still feasible when some factors vary, the following cases were examined in a sensitivity analysis:

Case A : Total costs increase by 5% and benefits decrease by 10%

Case B : Total costs increase by 10% and benefits decrease by 10%

Case C : Total costs increase by 10% and benefits decrease by 15%

The EIRRs in Cases A, B and C in the above sensitivity analysis are 10.9%, 10.5% and 10.0%, respectively (See Table 12.1-3, 12.1-4, 12.1-5).

Table 12.1-2 Summary of EIRR Caluculation (Base Case)

Unit: US$

No.	Year	Container (TEU)	Initial Investment	Management/Operations and Maintenance Costs			Cost Saving in Transportation	Cost Saving in Disposal	Renewal Cost	Cost Total (E)	Benefit Total (B)	B-E
				Maintenance for Infrastructure	Maintenance for Equipment	Administrative Costs						
1	2005		6,300,000							6,300,000	0	-6,300,000
2	2006		6,500,000							6,500,000	0	-6,500,000
3	2007		500,000							500,000	0	-500,000
4	2008		201,000,000							201,000,000	0	-201,000,000
5	2009		173,900,000					67,039,078		173,900,000	67,039,078	-106,860,922
6	2010		190,400,000					67,039,078		190,400,000	67,039,078	-123,360,922
7	2011		183,100,000					67,039,078		183,100,000	67,039,078	-116,060,922
8	2012	530,500		5,156,940	1,600,000	4,200,000	7,957,500			10,956,940	61,007,500	50,050,560
9	2013	557,025		5,156,940	1,600,000	4,200,000	8,355,375			10,956,940	64,057,875	53,100,935
10	2014	584,876		5,156,940	1,600,000	4,200,000	8,773,144			10,956,940	67,260,769	56,303,829
11	2015	614,120		5,156,940	1,600,000	4,200,000	9,211,801			10,956,940	70,623,807	59,666,867
12	2016	644,826		5,156,940	1,600,000	4,200,000	9,672,391			10,956,940	74,154,998	63,198,058
13	2017	677,067		5,156,940	1,600,000	4,200,000	10,156,011			10,956,940	77,862,747	66,905,807
14	2018	710,921		5,156,940	1,600,000	4,200,000	10,663,811			10,956,940	81,755,885	70,798,945
15	2019	746,467		5,156,940	1,600,000	4,200,000	11,197,002			10,956,940	85,843,679	74,886,739
16	2020	783,790		5,156,940	1,600,000	4,200,000	11,756,852			10,956,940	90,135,863	79,178,923
17	2021	822,980		5,156,940	1,600,000	4,200,000	12,344,694			10,956,940	94,642,656	83,685,716
18	2022	864,129		5,156,940	1,600,000	4,200,000	12,961,929			10,956,940	99,374,789	88,417,849
19	2023	907,335		5,156,940	1,600,000	4,200,000	13,610,025			10,956,940	104,343,528	93,386,588
20	2024	952,702		5,156,940	1,600,000	4,200,000	14,290,527			10,956,940	109,560,705	98,603,765
21	2025	1,000,337		5,156,940	1,600,000	4,200,000	15,005,053			10,956,940	115,038,740	104,081,800
22	2026	1,050,354		5,156,940	1,600,000	4,200,000	15,755,306			10,956,940	120,790,677	109,833,737
23	2027	1,102,871		5,156,940	1,600,000	4,200,000	16,543,071			10,956,940	126,830,211	115,873,271
24	2028	1,158,015		5,156,940	1,600,000	4,200,000	17,370,225			10,956,940	133,171,721	122,214,781
25	2029	1,215,916		5,156,940	1,600,000	4,200,000	18,238,736			10,956,940	139,830,308	128,873,368
26	2030	1,276,712		5,156,940	1,600,000	4,200,000	19,150,673			10,956,940	146,821,823	135,864,883
27	2031	1,340,547		5,156,940	1,600,000	4,200,000	20,108,206			10,956,940	154,162,914	143,205,974
28	2032	1,407,574		5,156,940	1,600,000	4,200,000	21,113,616			10,956,940	161,871,060	150,914,120
29	2033	1,477,953	45,200,000	5,156,940	1,600,000	4,200,000	22,169,297			56,156,940	169,964,613	113,807,673
30	2034	1,551,851	90,000,000	5,156,940	1,600,000	4,200,000	23,277,762			100,956,940	178,462,843	77,505,903
31	2035	1,629,443		6,292,300	2,400,000	4,200,000	24,441,650		40,000,000	52,892,300	187,385,986	134,493,686
32	2036	1,710,916		6,292,300	2,400,000	4,200,000	25,663,733			12,892,300	196,755,285	183,862,985
33	2037	1,796,461		6,292,300	2,400,000	4,200,000	26,946,919			12,892,300	206,593,049	193,700,749
34	2038	1,886,284		6,292,300	2,400,000	4,200,000	28,294,265			12,892,300	216,922,702	204,030,402
35	2039	1,980,599		6,292,300	2,400,000	4,200,000	29,708,979			12,892,300	227,768,837	214,876,537
36	2040	2,079,629		6,292,300	2,400,000	4,200,000	31,194,428			12,892,300	239,157,278	226,264,978
37	2041	2,183,610		6,292,300	2,400,000	4,200,000	32,754,149			12,892,300	251,115,142	238,222,842
38	2042	2,292,790		6,292,300	2,400,000	4,200,000	34,391,856			12,892,300	263,670,899	250,778,599
39	2043	2,407,430		6,292,300	2,400,000	4,200,000	36,111,449			12,892,300	276,854,444	263,962,144
40	2044	2,527,801		6,292,300	2,400,000	4,200,000	37,917,022			12,892,300	290,697,167	277,804,867
41	2045	2,654,192		6,292,300	2,400,000	4,200,000	39,812,873			12,892,300	305,232,025	292,339,725
42	2046	2,786,901		6,292,300	2,400,000	4,200,000	41,803,516			12,892,300	320,493,626	307,601,326
43	2047	2,926,246		6,292,300	2,400,000	4,200,000	43,893,692			12,892,300	336,518,308	323,626,008
44	2048	3,072,558		6,292,300	2,400,000	4,200,000	46,088,377			12,892,300	353,344,223	340,451,923
45	2049	3,226,186		6,292,300	2,400,000	4,200,000	48,392,796			12,892,300	371,011,434	358,119,134
46	2050	3,387,496		6,292,300	2,400,000	4,200,000	50,812,436			12,892,300	389,562,006	376,669,706
47	2051	3,556,870		6,292,300	2,400,000	4,200,000	53,353,057			12,892,300	409,040,106	396,147,806
48	2052	3,734,714		6,292,300	2,400,000	4,200,000	56,020,710			12,892,300	429,492,111	416,599,811
49	2053	3,921,450		6,292,300	2,400,000	4,200,000	58,821,746			12,892,300	450,966,717	438,074,417
50	2054	4,117,522		6,292,300	2,400,000	4,200,000	61,762,833			12,892,300	473,515,053	460,622,753
51	2055	4,323,398		6,292,300	2,400,000	4,200,000	64,850,975			12,892,300	497,190,805	484,298,505
52	2056	4,539,568		6,292,300	2,400,000	4,200,000	68,093,523			12,892,300	522,050,346	509,158,046
53	2057	4,766,547		6,292,300	2,400,000	4,200,000	71,498,200			12,892,300	548,152,863	535,260,563
54	2058	5,004,874		6,292,300	2,400,000	4,200,000	75,073,109			12,892,300	575,560,506	562,668,206
55	2059	5,255,118		6,292,300	2,400,000	4,200,000	78,826,765			12,892,300	604,338,531	591,446,231
56	2060	5,517,874		6,292,300	2,400,000	4,200,000	82,768,103			12,892,300	634,555,458	621,663,158
57	2060	5,517,874		6,292,300	2,400,000	4,200,000	82,768,103			12,892,300	634,555,458	621,663,158
Total			896,900,000	288,501,720	101,600,000	210,000,000	1,661,748,271	201,117,233	40,000,000	1,537,001,720	12,941,187,309	11,404,185,589
											EIRR=	12.35%

Table 12.1-3 Sensitivity Analysis in EIRR Caluculation (5 % Increase in Costs and 10 % Decrease in Revenues) (Case A)

Unit: US$

No.	Year	Container (TEU)	Initial Investment	Management/Operations and Maintenance Costs			Cost Saving in Transportation	Cost Saving in Disposal	Renewal Cost	Cost Total (E)	Benefit Total (B)	B-E
				Maintenance for Infrastructure	Maintenance for Equipment	Administrative Costs						
1	2005		6,615,000							6,615,000	0	-6,615,000
2	2006		6,825,000							6,825,000	0	-6,825,000
3	2007		525,000							525,000	0	-525,000
4	2008		211,050,000							211,050,000	0	-211,050,000
5	2009		182,595,000					60,335,170		182,595,000	60,335,170	-122,259,830
6	2010		199,920,000					60,335,170		199,920,000	60,335,170	-139,584,830
7	2011		192,255,000					60,335,170		192,255,000	60,335,170	-131,919,830
8	2012	530,500		5,414,787	1,680,000	4,410,000	7,161,750			11,504,787	54,906,750	43,401,963
9	2013	557,025		5,414,787	1,680,000	4,410,000	7,519,838			11,504,787	57,652,088	46,147,301
10	2014	584,876		5,414,787	1,680,000	4,410,000	7,895,829			11,504,787	60,534,692	49,029,905
11	2015	614,120		5,414,787	1,680,000	4,410,000	8,290,621			11,504,787	63,561,426	52,056,639
12	2016	644,826		5,414,787	1,680,000	4,410,000	8,705,152			11,504,787	66,739,498	55,234,711
13	2017	677,067		5,414,787	1,680,000	4,410,000	9,140,409			11,504,787	70,076,473	58,571,686
14	2018	710,921		5,414,787	1,680,000	4,410,000	9,597,430			11,504,787	73,580,296	62,075,509
15	2019	746,467		5,414,787	1,680,000	4,410,000	10,077,301			11,504,787	77,259,311	65,754,524
16	2020	783,790		5,414,787	1,680,000	4,410,000	10,581,167			11,504,787	81,122,277	69,617,490
17	2021	822,980		5,414,787	1,680,000	4,410,000	11,110,225			11,504,787	85,178,391	73,673,604
18	2022	864,129		5,414,787	1,680,000	4,410,000	11,665,736			11,504,787	89,437,310	77,932,523
19	2023	907,335		5,414,787	1,680,000	4,410,000	12,249,023			11,504,787	93,909,176	82,404,389
20	2024	952,702		5,414,787	1,680,000	4,410,000	12,861,474			11,504,787	98,604,634	87,099,847
21	2025	1,000,337		5,414,787	1,680,000	4,410,000	13,504,548			11,504,787	103,534,866	92,030,079
22	2026	1,050,354		5,414,787	1,680,000	4,410,000	14,179,775			11,504,787	108,711,609	97,206,822
23	2027	1,102,871		5,414,787	1,680,000	4,410,000	14,888,764			11,504,787	114,147,190	102,642,403
24	2028	1,158,015		5,414,787	1,680,000	4,410,000	15,633,202			11,504,787	119,854,549	108,349,762
25	2029	1,215,916		5,414,787	1,680,000	4,410,000	16,414,862			11,504,787	125,847,277	114,342,490
26	2030	1,276,712		5,414,787	1,680,000	4,410,000	17,235,605			11,504,787	132,139,641	120,634,854
27	2031	1,340,547		5,414,787	1,680,000	4,410,000	18,097,386			11,504,787	138,746,623	127,241,836
28	2032	1,407,574		5,414,787	1,680,000	4,410,000	19,002,255			11,504,787	145,683,954	134,179,167
29	2033	1,477,953	47,460,000	5,414,787	1,680,000	4,410,000	19,952,368			58,964,787	152,968,151	94,003,364
30	2034	1,551,851	94,500,000	5,414,787	1,680,000	4,410,000	20,949,986			106,004,787	160,616,559	54,611,772
31	2035	1,629,443		6,606,915	2,520,000	4,410,000	21,997,485		42,000,000	55,536,915	168,647,387	113,110,472
32	2036	1,710,916		6,606,915	2,520,000	4,410,000	23,097,360			13,536,915	177,079,756	163,542,841
33	2037	1,796,461		6,606,915	2,520,000	4,410,000	24,252,227			13,536,915	185,933,744	172,396,829
34	2038	1,886,284		6,606,915	2,520,000	4,410,000	25,464,839			13,536,915	195,230,431	181,693,516
35	2039	1,980,599		6,606,915	2,520,000	4,410,000	26,738,081			13,536,915	204,991,953	191,455,038
36	2040	2,079,629		6,606,915	2,520,000	4,410,000	28,074,985			13,536,915	215,241,551	201,704,636
37	2041	2,183,610		6,606,915	2,520,000	4,410,000	29,478,734			13,536,915	226,003,628	212,466,713
38	2042	2,292,790		6,606,915	2,520,000	4,410,000	30,952,671			13,536,915	237,303,810	223,766,895
39	2043	2,407,430		6,606,915	2,520,000	4,410,000	32,500,304			13,536,915	249,169,000	235,632,085
40	2044	2,527,801		6,606,915	2,520,000	4,410,000	34,125,320			13,536,915	261,627,450	248,090,535
41	2045	2,654,192		6,606,915	2,520,000	4,410,000	35,831,586			13,536,915	274,708,822	261,171,907
42	2046	2,786,901		6,606,915	2,520,000	4,410,000	37,623,165			13,536,915	288,444,264	274,907,349
43	2047	2,926,246		6,606,915	2,520,000	4,410,000	39,504,323			13,536,915	302,866,477	289,329,562
44	2048	3,072,558		6,606,915	2,520,000	4,410,000	41,479,539			13,536,915	318,009,801	304,472,886
45	2049	3,226,186		6,606,915	2,520,000	4,410,000	43,553,516			13,536,915	333,910,291	320,373,376
46	2050	3,387,496		6,606,915	2,520,000	4,410,000	45,731,192			13,536,915	350,605,805	337,068,890
47	2051	3,556,870		6,606,915	2,520,000	4,410,000	48,017,752			13,536,915	368,136,095	354,599,180
48	2052	3,734,714		6,606,915	2,520,000	4,410,000	50,418,639			13,536,915	386,542,900	373,005,985
49	2053	3,921,450		6,606,915	2,520,000	4,410,000	52,939,571			13,536,915	405,870,045	392,333,130
50	2054	4,117,522		6,606,915	2,520,000	4,410,000	55,586,550			13,536,915	426,163,547	412,626,632
51	2055	4,323,398		6,606,915	2,520,000	4,410,000	58,365,877			13,536,915	447,471,725	433,934,810
52	2056	4,539,568		6,606,915	2,520,000	4,410,000	61,284,171			13,536,915	469,845,311	456,308,396
53	2057	4,766,547		6,606,915	2,520,000	4,410,000	64,348,380			13,536,915	493,337,577	479,800,662
54	2058	5,004,874		6,606,915	2,520,000	4,410,000	67,565,799			13,536,915	518,004,455	504,467,540
55	2059	5,255,118		6,606,915	2,520,000	4,410,000	70,944,088			13,536,915	543,904,678	530,367,763
56	2060	5,517,874		6,606,915	2,520,000	4,410,000	74,491,293			13,536,915	571,099,912	557,562,997
57	2061	5,793,767		6,606,915	2,520,000	4,410,000	74,491,293			13,536,915	595,930,343	582,393,428
Total			941,745,000	302,926,806	106,680,000	220,500,000	1,495,573,444	181,005,510	42,000,000	1,613,851,806	11,671,899,009	10,058,047,203

EIRR= 10.87%

Table 12.1-4 Sensitivity Analysis in EIRR Caluculation (10 % Increase in Costs and 10 % Decrease in Revenues) (Case B)

Unit: US$

No.	Year	Container (TEU)	Initial Investment	Management/Operations and Maintenance Costs			Cost Saving in Transportation	Cost Saving in Disposal	Renewal Cost	Cost Total (E)	Benefit Total (B)	B-E
				Maintenance for Infrastructure	Maintenance for Equipment	Administrative Costs						
1	2005		6,930,000							6,930,000	0	-6,930,000
2	2006		7,150,000							7,150,000	0	-7,150,000
3	2007		550,000							550,000	0	-550,000
4	2008		221,100,000							221,100,000	0	-221,100,000
5	2009		191,290,000					60,335,170		191,290,000	60,335,170	-130,954,830
6	2010		209,440,000					60,335,170		209,440,000	60,335,170	-149,104,830
7	2011		201,410,000					60,335,170		201,410,000	60,335,170	-141,074,830
8	2012	530,500		5,672,634	1,760,000	4,620,000	7,161,750			12,052,634	54,906,750	42,854,116
9	2013	557,025		5,672,634	1,760,000	4,620,000	7,519,838			12,052,634	57,652,088	45,599,454
10	2014	584,876		5,672,634	1,760,000	4,620,000	7,895,829			12,052,634	60,534,692	48,482,058
11	2015	614,120		5,672,634	1,760,000	4,620,000	8,290,621			12,052,634	63,561,426	51,508,792
12	2016	644,826		5,672,634	1,760,000	4,620,000	8,705,152			12,052,634	66,739,498	54,686,864
13	2017	677,067		5,672,634	1,760,000	4,620,000	9,140,409			12,052,634	70,076,473	58,023,839
14	2018	710,921		5,672,634	1,760,000	4,620,000	9,597,430			12,052,634	73,580,296	61,527,662
15	2019	746,467		5,672,634	1,760,000	4,620,000	10,077,301			12,052,634	77,259,311	65,206,677
16	2020	783,790		5,672,634	1,760,000	4,620,000	10,581,167			12,052,634	81,122,277	69,069,643
17	2021	822,980		5,672,634	1,760,000	4,620,000	11,110,225			12,052,634	85,178,391	73,125,757
18	2022	864,129		5,672,634	1,760,000	4,620,000	11,665,736			12,052,634	89,437,310	77,384,676
19	2023	907,335		5,672,634	1,760,000	4,620,000	12,249,023			12,052,634	93,909,176	81,856,542
20	2024	952,702		5,672,634	1,760,000	4,620,000	12,861,474			12,052,634	98,604,634	86,552,000
21	2025	1,000,337		5,672,634	1,760,000	4,620,000	13,504,548			12,052,634	103,534,866	91,482,232
22	2026	1,050,354		5,672,634	1,760,000	4,620,000	14,179,775			12,052,634	108,711,609	96,658,975
23	2027	1,102,871		5,672,634	1,760,000	4,620,000	14,888,764			12,052,634	114,147,190	102,094,556
24	2028	1,158,015		5,672,634	1,760,000	4,620,000	15,633,202			12,052,634	119,854,549	107,801,915
25	2029	1,215,916		5,672,634	1,760,000	4,620,000	16,414,862			12,052,634	125,847,277	113,794,643
26	2030	1,276,712		5,672,634	1,760,000	4,620,000	17,235,605			12,052,634	132,139,641	120,087,007
27	2031	1,340,547		5,672,634	1,760,000	4,620,000	18,097,386			12,052,634	138,746,623	126,693,989
28	2032	1,407,574		5,672,634	1,760,000	4,620,000	19,002,255			12,052,634	145,683,954	133,631,320
29	2033	1,477,953	49,720,000	5,672,634	1,760,000	4,620,000	19,952,368			61,772,634	152,968,151	91,195,517
30	2034	1,551,851	99,000,000	5,672,634	1,760,000	4,620,000	20,949,986			111,052,634	160,616,559	49,563,925
31	2035	1,629,443		6,921,530	2,640,000	4,620,000	21,997,485		44,000,000	58,181,530	168,647,387	110,465,857
32	2036	1,710,916		6,921,530	2,640,000	4,620,000	23,097,360			14,181,530	177,079,756	162,898,226
33	2037	1,796,461		6,921,530	2,640,000	4,620,000	24,252,227			14,181,530	185,933,744	171,752,214
34	2038	1,886,284		6,921,530	2,640,000	4,620,000	25,464,839			14,181,530	195,230,431	181,048,901
35	2039	1,980,599		6,921,530	2,640,000	4,620,000	26,738,081			14,181,530	204,991,953	190,810,423
36	2040	2,079,629		6,921,530	2,640,000	4,620,000	28,074,985			14,181,530	215,241,551	201,060,021
37	2041	2,183,610		6,921,530	2,640,000	4,620,000	29,478,734			14,181,530	226,003,628	211,822,098
38	2042	2,292,790		6,921,530	2,640,000	4,620,000	30,952,671			14,181,530	237,303,810	223,122,280
39	2043	2,407,430		6,921,530	2,640,000	4,620,000	32,500,304			14,181,530	249,169,000	234,987,470
40	2044	2,527,801		6,921,530	2,640,000	4,620,000	34,125,320			14,181,530	261,627,450	247,445,920
41	2045	2,654,192		6,921,530	2,640,000	4,620,000	35,831,586			14,181,530	274,708,822	260,527,292
42	2046	2,786,901		6,921,530	2,640,000	4,620,000	37,623,165			14,181,530	288,444,264	274,262,734
43	2047	2,926,246		6,921,530	2,640,000	4,620,000	39,504,323			14,181,530	302,866,477	288,684,947
44	2048	3,072,558		6,921,530	2,640,000	4,620,000	41,479,539			14,181,530	318,009,801	303,828,271
45	2049	3,226,186		6,921,530	2,640,000	4,620,000	43,553,516			14,181,530	333,910,291	319,728,761
46	2050	3,387,496		6,921,530	2,640,000	4,620,000	45,731,192			14,181,530	350,605,805	336,424,275
47	2051	3,556,870		6,921,530	2,640,000	4,620,000	48,017,752			14,181,530	368,136,095	353,954,565
48	2052	3,734,714		6,921,530	2,640,000	4,620,000	50,418,639			14,181,530	386,542,900	372,361,370
49	2053	3,921,450		6,921,530	2,640,000	4,620,000	52,939,571			14,181,530	405,870,045	391,688,515
50	2054	4,117,522		6,921,530	2,640,000	4,620,000	55,586,550			14,181,530	426,163,547	411,982,017
51	2055	4,323,398		6,921,530	2,640,000	4,620,000	58,365,877			14,181,530	447,471,725	433,290,195
52	2056	4,539,568		6,921,530	2,640,000	4,620,000	61,284,171			14,181,530	469,845,311	455,663,781
53	2057	4,766,547		6,921,530	2,640,000	4,620,000	64,348,380			14,181,530	493,337,577	479,156,047
54	2058	5,004,874		6,921,530	2,640,000	4,620,000	67,565,799			14,181,530	518,004,455	503,822,925
55	2059	5,255,118		6,921,530	2,640,000	4,620,000	70,944,088			14,181,530	543,904,678	529,723,148
56	2060	5,517,874		6,921,530	2,640,000	4,620,000	74,491,293			14,181,530	571,099,912	556,918,382
57	2061	5,793,767		6,921,530	2,640,000	4,620,000	74,491,293			14,181,530	595,930,343	581,748,813
Total			986,590,000	317,351,892	111,760,000	231,000,000	1,495,573,444	181,005,510	44,000,000	1,690,701,892	11,671,899,009	9,981,197,117
											EIRR=	10.47%

Table 12.1-5 Sensitivity Analysis in EIRR Caluculation (10 % Increase in Costs and 15 % Decrease in Revenues) (Case C)

Unit: US$

No.	Year	Container (TEU)	Initial Investment	Management/Operations and Maintenance Costs			Cost Saving in Transportation	Cost Saving in Disposal	Renewal Cost	Cost Total (E)	Benefit Total (B)	B-E
				Maintenance for Infrastructure	Maintenance for Equipment	Administrative Costs						
1	2005		6,930,000							6,930,000	0	-6,930,000
2	2006		7,150,000							7,150,000	0	-7,150,000
3	2007		550,000							550,000	0	-550,000
4	2008		221,100,000							221,100,000	0	-221,100,000
5	2009		191,290,000					56,983,216		191,290,000	56,983,216	-134,306,784
6	2010		209,440,000					56,983,216		209,440,000	56,983,216	-152,456,784
7	2011		201,410,000					56,983,216		201,410,000	56,983,216	-144,426,784
8	2012	530,500		5,672,634	1,760,000	4,620,000	6,763,875			12,052,634	51,856,375	39,803,741
9	2013	557,025		5,672,634	1,760,000	4,620,000	7,102,069			12,052,634	54,449,194	42,396,560
10	2014	584,876		5,672,634	1,760,000	4,620,000	7,457,172			12,052,634	57,171,653	45,119,019
11	2015	614,120		5,672,634	1,760,000	4,620,000	7,830,031			12,052,634	60,030,236	47,977,602
12	2016	644,826		5,672,634	1,760,000	4,620,000	8,221,532			12,052,634	63,031,748	50,979,114
13	2017	677,067		5,672,634	1,760,000	4,620,000	8,632,609			12,052,634	66,183,335	54,130,701
14	2018	710,921		5,672,634	1,760,000	4,620,000	9,064,239			12,052,634	69,492,502	57,439,868
15	2019	746,467		5,672,634	1,760,000	4,620,000	9,517,451			12,052,634	72,967,127	60,914,493
16	2020	783,790		5,672,634	1,760,000	4,620,000	9,993,324			12,052,634	76,615,484	64,562,850
17	2021	822,980		5,672,634	1,760,000	4,620,000	10,492,990			12,052,634	80,446,258	68,393,624
18	2022	864,129		5,672,634	1,760,000	4,620,000	11,017,640			12,052,634	84,468,571	72,415,937
19	2023	907,335		5,672,634	1,760,000	4,620,000	11,568,522			12,052,634	88,691,999	76,639,365
20	2024	952,702		5,672,634	1,760,000	4,620,000	12,146,948			12,052,634	93,126,599	81,073,965
21	2025	1,000,337		5,672,634	1,760,000	4,620,000	12,754,295			12,052,634	97,782,929	85,730,295
22	2026	1,050,354		5,672,634	1,760,000	4,620,000	13,392,010			12,052,634	102,672,075	90,619,441
23	2027	1,102,871		5,672,634	1,760,000	4,620,000	14,061,610			12,052,634	107,805,679	95,753,045
24	2028	1,158,015		5,672,634	1,760,000	4,620,000	14,764,691			12,052,634	113,195,963	101,143,329
25	2029	1,215,916		5,672,634	1,760,000	4,620,000	15,502,925			12,052,634	118,855,761	106,803,127
26	2030	1,276,712		5,672,634	1,760,000	4,620,000	16,278,072			12,052,634	124,798,549	112,745,915
27	2031	1,340,547		5,672,634	1,760,000	4,620,000	17,091,975			12,052,634	131,038,477	118,985,843
28	2032	1,407,574		5,672,634	1,760,000	4,620,000	17,946,574			12,052,634	137,590,401	125,537,767
29	2033	1,477,953	49,720,000	5,672,634	1,760,000	4,620,000	18,843,903			61,772,634	144,469,921	82,697,287
30	2034	1,551,851	99,000,000	5,672,634	1,760,000	4,620,000	19,786,098			111,052,634	151,693,417	40,640,783
31	2035	1,629,443		6,921,530	2,640,000	4,620,000	20,775,403		44,000,000	58,181,530	159,278,088	101,096,558
32	2036	1,710,916		6,921,530	2,640,000	4,620,000	21,814,173			14,181,530	167,241,992	153,060,462
33	2037	1,796,461		6,921,530	2,640,000	4,620,000	22,904,882			14,181,530	175,604,092	161,422,562
34	2038	1,886,284		6,921,530	2,640,000	4,620,000	24,050,126			14,181,530	184,384,296	170,202,766
35	2039	1,980,599		6,921,530	2,640,000	4,620,000	25,252,632			14,181,530	193,603,511	179,421,981
36	2040	2,079,629		6,921,530	2,640,000	4,620,000	26,515,263			14,181,530	203,283,687	189,102,157
37	2041	2,183,610		6,921,530	2,640,000	4,620,000	27,841,027			14,181,530	213,447,871	199,266,341
38	2042	2,292,790		6,921,530	2,640,000	4,620,000	29,233,078			14,181,530	224,120,265	209,938,735
39	2043	2,407,430		6,921,530	2,640,000	4,620,000	30,694,732			14,181,530	235,326,278	221,144,748
40	2044	2,527,801		6,921,530	2,640,000	4,620,000	32,229,468			14,181,530	247,092,592	232,911,062
41	2045	2,654,192		6,921,530	2,640,000	4,620,000	33,840,942			14,181,530	259,447,221	245,265,691
42	2046	2,786,901		6,921,530	2,640,000	4,620,000	35,532,989			14,181,530	272,419,582	258,238,052
43	2047	2,926,246		6,921,530	2,640,000	4,620,000	37,309,638			14,181,530	286,040,561	271,859,031
44	2048	3,072,558		6,921,530	2,640,000	4,620,000	39,175,120			14,181,530	300,342,589	286,161,059
45	2049	3,226,186		6,921,530	2,640,000	4,620,000	41,133,876			14,181,530	315,359,719	301,178,189
46	2050	3,387,496		6,921,530	2,640,000	4,620,000	43,190,570			14,181,530	331,127,705	316,946,175
47	2051	3,556,870		6,921,530	2,640,000	4,620,000	45,350,099			14,181,530	347,684,090	333,502,560
48	2052	3,734,714		6,921,530	2,640,000	4,620,000	47,617,604			14,181,530	365,068,295	350,886,765
49	2053	3,921,450		6,921,530	2,640,000	4,620,000	49,998,484			14,181,530	383,321,709	369,140,179
50	2054	4,117,522		6,921,530	2,640,000	4,620,000	52,498,408			14,181,530	402,487,795	388,306,265
51	2055	4,323,398		6,921,530	2,640,000	4,620,000	55,123,328			14,181,530	422,612,185	408,430,655
52	2056	4,539,568		6,921,530	2,640,000	4,620,000	57,879,495			14,181,530	443,742,794	429,561,264
53	2057	4,766,547		6,921,530	2,640,000	4,620,000	60,773,470			14,181,530	465,929,934	451,748,404
54	2058	5,004,874		6,921,530	2,640,000	4,620,000	63,812,143			14,181,530	489,226,430	475,044,900
55	2059	5,255,118		6,921,530	2,640,000	4,620,000	67,002,750			14,181,530	513,687,752	499,506,222
56	2060	5,517,874		6,921,530	2,640,000	4,620,000	70,352,888			14,181,530	539,372,139	525,190,609
57	2061	5,793,767		6,921,530	2,640,000	4,620,000	70,352,888			14,181,530	562,823,102	548,641,572
Total			986,590,000	317,351,892	111,760,000	231,000,000	1,412,486,030	170,949,648	44,000,000	1,690,701,892	11,023,460,175	9,332,758,283

EIRR= 9.99%

12.2 Financial Evaluation

12.2.1 Purposes and Methodology of Financial Analysis

The purpose of financial analysis is to appraise the financial viability of the Project from the viewpoint of capital investment to confirm whether it could yield sufficient returns and the financial soundness of the port management entity. In this study, to measure the financial viability quantitatively, the Financial Internal Rate of Return (FIRR) on a gross capital basis was calculated and compared with the assumed average interest rate of the fund to be raised for the Project to confirm whether FIRR could exceed the interest rate.

12.2.2 Prerequisites for the Financial Analysis

12.2.2.1 Base Year

Incomes and expenses estimated in the financial analysis were expressed in the prices applicable in the fixed "Base Year" and throughout the "Project Life" mentioned below. In this analysis, the year 2003 was adopted as the "Base Year".

12.2.2.2 Project Life

Taking account of the sum of construction period and probable concession period relating to the Project, the period of 50 years was adopted as the "Project Life".

12.2.2.3 Financial Terms of Loans to be Raised for the Project

In this financial analysis, it is assumed that fund will be financed by the Japan Bank for International Cooperation (JBIC). The interest rate applied by the JBIC for upper-middle-income countries (Panama) is 1.20 percent if a preferential terms loan is adopted. According to JBIC's guidelines, the preferential terms loan can be applied for projects to cope with "Global Environmental Problems, Industrial Pollution," such as Marine Pollution, and this Artificial Island Project can be eligible to apply for such preferential terms. However, it should be noted that ACP is still contemplating the possible source of funds.

12.2.2.4 Volume of Container Cargo at New Port

Container handling operation at New Port is assumed to be started in 2012. Yearly cargo throughput from the starting year of the port operations through the expiry of the project life, viz. 2012 to 2061, is shown in Table 12.2-1

12.2.2.5 Port Tariff

Normally, to estimate incomes for the Project, almost the same tariff level as that of the existing neighboring ports is adopted. However, in this Study, the tariff of 100 United States dollars per TEU including container handling charge and vessel service charge can be applied to simplify the analysis.

12.2.3 Revenues

Revenues will be gained from providing port services to consignees/shippers and shipping lines. The amount of revenues is estimated by multiplying the port tariff and the volume of container cargo.

12.2.4 Expenses

12.2.4.1 Expenses for Initial Investment

Expenses for the initial investment for the Project are summarized in Chapter 12.1.4.1.

12.2.4.2 Management/Operations and Maintenance Expenses

Expense items for management/operation and maintenance are listed below:

(1) Maintenance Expense for Infrastructures

This expense was assumed to be one percent (1%) of initial investment expenses of depreciable infrastructures. Thus, reclamation expense, etc. were excluded.

(2) Maintenance Expense for Equipment

This expense was assumed to be four percent (4%) of initial investment expenses of equipment (gantry cranes).

(3) Administrative Expense

The administrative expense, most of which is personnel expense was assumed.

(4) Renewal Investment Expenses

From the start of operation and throughout the project life, the equipment that is procured in the initial stage will be renewed when its useful life expires. Individual useful lives were assumed to be in the range of 5 to 25 years. A longer life (25 years) was assumed for quayside gantry cranes.

(5) Total Expenses

The total project expenses comprising those of initial investment, yearly management/operation and maintenance, and renewal of equipment from time to time during the project life.

12.2.5 Evaluation of the Project

12.2.5.1 Viability of the Project

(1) Calculation of FIRR (Base Case)

The financial internal rate of return (FIRR) is used to appraise the financial viability of the Project. The FIRR is the discount rate that makes the net present value of cash inflow and outflow equal during the project life. The following formula was used to calculate FIRR:

$$\sum_{i=1}^{n} \frac{Ii - Oi}{(1+r)^{i-1}} = 0$$

Where;

n: Project life

i: Year

Ii: Cash inflow in the i-th year

Oi: Cash outflow in the i-th year

r: Discount rate

The resulting FIRR of the Project is 9.6% (see Table 12.2-1).

(2) Sensitivity Analysis

In order to see if the Project is still financially viable when some factors vary, the following cases were examined in a sensitivity analysis:

Case A: Total expenses increase by 5% and incomes decrease by 10%

Case B: Total expenses increase by 10% and incomes decrease by 10%

Case C: Total expenses increase by 10% and incomes decrease by 15%

The FIRRs in Cases A, B and C in the above sensitivity analysis are 8.6 %, 8.3 % and.8.0 %, respectively (See Table 12.2-2, 12.2-3, 12.2-4).

12.2.5.2 Financial Statement

Table 12.2-5 shows a financial statement of the project.

Table 12.2-1 Summary of FIRR Caluculation (Base Case)

Unit: US$

No.	Year	Container (TEU)	Initial Investment	Management/Operations and Maintenance Expenses: Maintenance for Infrastructure	Maintenance for Equipment	Administrative Expenses	Renewal Investment	Expense Total (E)	Revenue Total (R)	R-E
1	2005		6,300,000					6,300,000		-6,300,000
2	2006		6,500,000					6,500,000		-6,500,000
3	2007		500,000					500,000		-500,000
4	2008		201,000,000					201,000,000		-201,000,000
5	2009		173,900,000					173,900,000		-173,900,000
6	2010		190,400,000					190,400,000		-190,400,000
7	2011		183,100,000					183,100,000		-183,100,000
8	2012	530,500		5,156,940	1,600,000	4,200,000		10,956,940	53,050,000	42,093,060
9	2013	557,025		5,156,940	1,600,000	4,200,000		10,956,940	55,702,500	44,745,560
10	2014	584,876		5,156,940	1,600,000	4,200,000		10,956,940	58,487,625	47,530,685
11	2015	614,120		5,156,940	1,600,000	4,200,000		10,956,940	61,412,006	50,455,066
12	2016	644,826		5,156,940	1,600,000	4,200,000		10,956,940	64,482,607	53,525,667
13	2017	677,067		5,156,940	1,600,000	4,200,000		10,956,940	67,706,737	56,749,797
14	2018	710,921		5,156,940	1,600,000	4,200,000		10,956,940	71,092,074	60,135,134
15	2019	746,467		5,156,940	1,600,000	4,200,000		10,956,940	74,646,677	63,689,737
16	2020	783,790		5,156,940	1,600,000	4,200,000		10,956,940	78,379,011	67,422,071
17	2021	822,980		5,156,940	1,600,000	4,200,000		10,956,940	82,297,962	71,341,022
18	2022	864,129		5,156,940	1,600,000	4,200,000		10,956,940	86,412,860	75,455,920
19	2023	907,335		5,156,940	1,600,000	4,200,000		10,956,940	90,733,503	79,776,563
20	2024	952,702		5,156,940	1,600,000	4,200,000		10,956,940	95,270,178	84,313,238
21	2025	1,000,337		5,156,940	1,600,000	4,200,000		10,956,940	100,033,687	89,076,747
22	2026	1,050,354		5,156,940	1,600,000	4,200,000		10,956,940	105,035,371	94,078,431
23	2027	1,102,871		5,156,940	1,600,000	4,200,000		10,956,940	110,287,140	99,330,200
24	2028	1,158,015		5,156,940	1,600,000	4,200,000		10,956,940	115,801,497	104,844,557
25	2029	1,215,916		5,156,940	1,600,000	4,200,000		10,956,940	121,591,572	110,634,632
26	2030	1,276,712		5,156,940	1,600,000	4,200,000		10,956,940	127,671,150	116,714,210
27	2031	1,340,547		5,156,940	1,600,000	4,200,000		10,956,940	134,054,708	123,097,768
28	2032	1,407,574		5,156,940	1,600,000	4,200,000		10,956,940	140,757,443	129,800,503
29	2033	1,477,953	45,200,000	5,156,940	1,600,000	4,200,000		56,156,940	147,795,315	91,638,375
30	2034	1,551,851	90,000,000	5,156,940	1,600,000	4,200,000		100,956,940	155,185,081	54,228,141
31	2035	1,629,443		6,292,300	2,400,000	4,200,000	40,000,000	52,892,300	162,944,335	110,052,035
32	2036	1,710,916		6,292,300	2,400,000	4,200,000		12,892,300	171,091,552	158,199,252
33	2037	1,796,461		6,292,300	2,400,000	4,200,000		12,892,300	179,646,130	166,753,830
34	2038	1,886,284		6,292,300	2,400,000	4,200,000		12,892,300	188,628,436	175,736,136
35	2039	1,980,599		6,292,300	2,400,000	4,200,000		12,892,300	198,059,858	185,167,558
36	2040	2,079,629		6,292,300	2,400,000	4,200,000		12,892,300	207,962,851	195,070,551
37	2041	2,183,610		6,292,300	2,400,000	4,200,000		12,892,300	218,360,993	205,468,693
38	2042	2,292,790		6,292,300	2,400,000	4,200,000		12,892,300	229,279,043	216,386,743
39	2043	2,407,430		6,292,300	2,400,000	4,200,000		12,892,300	240,742,995	227,850,695
40	2044	2,527,801		6,292,300	2,400,000	4,200,000		12,892,300	252,780,145	239,887,845
41	2045	2,654,192		6,292,300	2,400,000	4,200,000		12,892,300	265,419,152	252,526,852
42	2046	2,786,901		6,292,300	2,400,000	4,200,000		12,892,300	278,690,110	265,797,810
43	2047	2,926,246		6,292,300	2,400,000	4,200,000		12,892,300	292,624,615	279,732,315
44	2048	3,072,558		6,292,300	2,400,000	4,200,000		12,892,300	307,255,846	294,363,546
45	2049	3,226,186		6,292,300	2,400,000	4,200,000		12,892,300	322,618,638	309,726,338
46	2050	3,387,496		6,292,300	2,400,000	4,200,000		12,892,300	338,749,570	325,857,270
47	2051	3,556,870		6,292,300	2,400,000	4,200,000		12,892,300	355,687,049	342,794,749
48	2052	3,734,714		6,292,300	2,400,000	4,200,000		12,892,300	373,471,401	360,579,101
49	2053	3,921,450		6,292,300	2,400,000	4,200,000		12,892,300	392,144,971	379,252,671
50	2054	4,117,522		6,292,300	2,400,000	4,200,000		12,892,300	411,752,220	398,859,920
51	2055	4,323,398		6,292,300	2,400,000	4,200,000		12,892,300	432,339,831	419,447,531
52	2056	4,539,568		6,292,300	2,400,000	4,200,000		12,892,300	453,956,822	441,064,522
53	2057	4,766,547		6,292,300	2,400,000	4,200,000		12,892,300	476,654,663	463,762,363
54	2058	5,004,874		6,292,300	2,400,000	4,200,000		12,892,300	500,487,397	487,595,097
55	2059	5,255,118		6,292,300	2,400,000	4,200,000		12,892,300	525,511,766	512,619,466
56	2060	5,517,874		6,292,300	2,400,000	4,200,000		12,892,300	551,787,355	538,895,055
57	2061	5,793,767		6,292,300	2,400,000	4,200,000		12,892,300	579,376,723	566,484,423
Total			896,900,000	288,501,720	101,600,000	210,000,000	40,000,000	1,537,001,720	11,105,911,173	9,568,909,453
									FIRR=	9.56%

Table 12.2-2 Sensitivity Analysis in FIRR Caluculation (5 % Increase in Expenses and 10 % Decrease in Revenues) (Case A)

Unit: US$

No.	Year	Container (TEU)	Initial Investment	Management/Operations and Maintenance Expenses			Renewal Investment	Expense Total (E)	Revenue Total (R)	R-E
				Maintenance for Infrastructure	Maintenance for Equipment	Administrative Expenses				
1	2005		6,615,000					6,615,000		-6,615,000
2	2006		6,825,000					6,825,000		-6,825,000
3	2007		525,000					525,000		-525,000
4	2008		211,050,000					211,050,000		-211,050,000
5	2009		182,595,000					182,595,000		-182,595,000
6	2010		199,920,000					199,920,000		-199,920,000
7	2011		192,255,000					192,255,000		-192,255,000
8	2012	530,500		5,414,787	1,680,000	4,410,000		11,504,787	47,745,000	36,240,213
9	2013	557,025		5,414,787	1,680,000	4,410,000		11,504,787	50,132,250	38,627,463
10	2014	584,876		5,414,787	1,680,000	4,410,000		11,504,787	52,638,863	41,134,076
11	2015	614,120		5,414,787	1,680,000	4,410,000		11,504,787	55,270,806	43,766,019
12	2016	644,826		5,414,787	1,680,000	4,410,000		11,504,787	58,034,346	46,529,559
13	2017	677,067		5,414,787	1,680,000	4,410,000		11,504,787	60,936,063	49,431,276
14	2018	710,921		5,414,787	1,680,000	4,410,000		11,504,787	63,982,866	52,478,079
15	2019	746,467		5,414,787	1,680,000	4,410,000		11,504,787	67,182,010	55,677,223
16	2020	783,790		5,414,787	1,680,000	4,410,000		11,504,787	70,541,110	59,036,323
17	2021	822,980		5,414,787	1,680,000	4,410,000		11,504,787	74,068,166	62,563,379
18	2022	864,129		5,414,787	1,680,000	4,410,000		11,504,787	77,771,574	66,266,787
19	2023	907,335		5,414,787	1,680,000	4,410,000		11,504,787	81,660,153	70,155,366
20	2024	952,702		5,414,787	1,680,000	4,410,000		11,504,787	85,743,160	74,238,373
21	2025	1,000,337		5,414,787	1,680,000	4,410,000		11,504,787	90,030,318	78,525,531
22	2026	1,050,354		5,414,787	1,680,000	4,410,000		11,504,787	94,531,834	83,027,047
23	2027	1,102,871		5,414,787	1,680,000	4,410,000		11,504,787	99,258,426	87,753,639
24	2028	1,158,015		5,414,787	1,680,000	4,410,000		11,504,787	104,221,347	92,716,560
25	2029	1,215,916		5,414,787	1,680,000	4,410,000		11,504,787	109,432,415	97,927,628
26	2030	1,276,712		5,414,787	1,680,000	4,410,000		11,504,787	114,904,035	103,399,248
27	2031	1,340,547		5,414,787	1,680,000	4,410,000		11,504,787	120,649,237	109,144,450
28	2032	1,407,574		5,414,787	1,680,000	4,410,000		11,504,787	126,681,699	115,176,912
29	2033	1,477,953	47,460,000	5,414,787	1,680,000	4,410,000		58,964,787	133,015,784	74,050,997
30	2034	1,551,851	94,500,000	5,414,787	1,680,000	4,410,000		106,004,787	139,666,573	33,661,786
31	2035	1,629,443		6,606,915	2,520,000	4,410,000	42,000,000	55,536,915	146,649,902	91,112,987
32	2036	1,710,916		6,606,915	2,520,000	4,410,000		13,536,915	153,982,397	140,445,482
33	2037	1,796,461		6,606,915	2,520,000	4,410,000		13,536,915	161,681,517	148,144,602
34	2038	1,886,284		6,606,915	2,520,000	4,410,000		13,536,915	169,765,592	156,228,677
35	2039	1,980,599		6,606,915	2,520,000	4,410,000		13,536,915	178,253,872	164,716,957
36	2040	2,079,629		6,606,915	2,520,000	4,410,000		13,536,915	187,166,566	173,629,651
37	2041	2,183,610		6,606,915	2,520,000	4,410,000		13,536,915	196,524,894	182,987,979
38	2042	2,292,790		6,606,915	2,520,000	4,410,000		13,536,915	206,351,139	192,814,224
39	2043	2,407,430		6,606,915	2,520,000	4,410,000		13,536,915	216,668,696	203,131,781
40	2044	2,527,801		6,606,915	2,520,000	4,410,000		13,536,915	227,502,130	213,965,215
41	2045	2,654,192		6,606,915	2,520,000	4,410,000		13,536,915	238,877,237	225,340,322
42	2046	2,786,901		6,606,915	2,520,000	4,410,000		13,536,915	250,821,099	237,284,184
43	2047	2,926,246		6,606,915	2,520,000	4,410,000		13,536,915	263,362,154	249,825,239
44	2048	3,072,558		6,606,915	2,520,000	4,410,000		13,536,915	276,530,261	262,993,346
45	2049	3,226,186		6,606,915	2,520,000	4,410,000		13,536,915	290,356,774	276,819,859
46	2050	3,387,496		6,606,915	2,520,000	4,410,000		13,536,915	304,874,613	291,337,698
47	2051	3,556,870		6,606,915	2,520,000	4,410,000		13,536,915	320,118,344	306,581,429
48	2052	3,734,714		6,606,915	2,520,000	4,410,000		13,536,915	336,124,261	322,587,346
49	2053	3,921,450		6,606,915	2,520,000	4,410,000		13,536,915	352,930,474	339,393,559
50	2054	4,117,522		6,606,915	2,520,000	4,410,000		13,536,915	370,576,998	357,040,083
51	2055	4,323,398		6,606,915	2,520,000	4,410,000		13,536,915	389,105,848	375,568,933
52	2056	4,539,568		6,606,915	2,520,000	4,410,000		13,536,915	408,561,140	395,024,225
53	2057	4,766,547		6,606,915	2,520,000	4,410,000		13,536,915	428,989,197	415,452,282
54	2058	5,004,874		6,606,915	2,520,000	4,410,000		13,536,915	450,438,657	436,901,742
55	2059	5,255,118		6,606,915	2,520,000	4,410,000		13,536,915	472,960,590	459,423,675
56	2060	5,517,874		6,606,915	2,520,000	4,410,000		13,536,915	496,608,619	483,071,704
57	2061	5,793,767		6,606,915	2,520,000	4,410,000		13,536,915	521,439,050	507,902,135
Total			941,745,000	302,926,806	106,680,000	220,500,000	42,000,000	1,613,851,806	9,995,320,055	8,381,468,249

FIRR= 8.61%

Table 12.2-3 Sensitivity Analysis in FIRR Caluculation (10 % Increase in Expenses and 10 % Decrease in Revenues) (Case B)

Unit: US$

No.	Year	Container (TEU)	Initial Investment	Management/Operations and Maintenance Expenses			Renewal Investment	Expense Total (E)	Revenue Total (R)	R-E
				Maintenance for Infrastructure	Maintenance for Equipment	Administrative Expenses				
1	2005		6,930,000					6,930,000		-6,930,000
2	2006		7,150,000					7,150,000		-7,150,000
3	2007		550,000					550,000		-550,000
4	2008		221,100,000					221,100,000		-221,100,000
5	2009		191,290,000					191,290,000		-191,290,000
6	2010		209,440,000					209,440,000		-209,440,000
7	2011		201,410,000					201,410,000		-201,410,000
8	2012	530,500		5,672,634	1,760,000	4,620,000		12,052,634	47,745,000	35,692,366
9	2013	557,025		5,672,634	1,760,000	4,620,000		12,052,634	50,132,250	38,079,616
10	2014	584,876		5,672,634	1,760,000	4,620,000		12,052,634	52,638,863	40,586,229
11	2015	614,120		5,672,634	1,760,000	4,620,000		12,052,634	55,270,806	43,218,172
12	2016	644,826		5,672,634	1,760,000	4,620,000		12,052,634	58,034,346	45,981,712
13	2017	677,067		5,672,634	1,760,000	4,620,000		12,052,634	60,936,063	48,883,429
14	2018	710,921		5,672,634	1,760,000	4,620,000		12,052,634	63,982,866	51,930,232
15	2019	746,467		5,672,634	1,760,000	4,620,000		12,052,634	67,182,010	55,129,376
16	2020	783,790		5,672,634	1,760,000	4,620,000		12,052,634	70,541,110	58,488,476
17	2021	822,980		5,672,634	1,760,000	4,620,000		12,052,634	74,068,166	62,015,532
18	2022	864,129		5,672,634	1,760,000	4,620,000		12,052,634	77,771,574	65,718,940
19	2023	907,335		5,672,634	1,760,000	4,620,000		12,052,634	81,660,153	69,607,519
20	2024	952,702		5,672,634	1,760,000	4,620,000		12,052,634	85,743,160	73,690,526
21	2025	1,000,337		5,672,634	1,760,000	4,620,000		12,052,634	90,030,318	77,977,684
22	2026	1,050,354		5,672,634	1,760,000	4,620,000		12,052,634	94,531,834	82,479,200
23	2027	1,102,871		5,672,634	1,760,000	4,620,000		12,052,634	99,258,426	87,205,792
24	2028	1,158,015		5,672,634	1,760,000	4,620,000		12,052,634	104,221,347	92,168,713
25	2029	1,215,916		5,672,634	1,760,000	4,620,000		12,052,634	109,432,415	97,379,781
26	2030	1,276,712		5,672,634	1,760,000	4,620,000		12,052,634	114,904,035	102,851,401
27	2031	1,340,547		5,672,634	1,760,000	4,620,000		12,052,634	120,649,237	108,596,603
28	2032	1,407,574		5,672,634	1,760,000	4,620,000		12,052,634	126,681,699	114,629,065
29	2033	1,477,953	49,720,000	5,672,634	1,760,000	4,620,000		61,772,634	133,015,784	71,243,150
30	2034	1,551,851	99,000,000	5,672,634	1,760,000	4,620,000		111,052,634	139,666,573	28,613,939
31	2035	1,629,443		6,921,530	2,640,000	4,620,000	44,000,000	58,181,530	146,649,902	88,468,372
32	2036	1,710,916		6,921,530	2,640,000	4,620,000		14,181,530	153,982,397	139,800,867
33	2037	1,796,461		6,921,530	2,640,000	4,620,000		14,181,530	161,681,517	147,499,987
34	2038	1,886,284		6,921,530	2,640,000	4,620,000		14,181,530	169,765,592	155,584,062
35	2039	1,980,599		6,921,530	2,640,000	4,620,000		14,181,530	178,253,872	164,072,342
36	2040	2,079,629		6,921,530	2,640,000	4,620,000		14,181,530	187,166,566	172,985,036
37	2041	2,183,610		6,921,530	2,640,000	4,620,000		14,181,530	196,524,894	182,343,364
38	2042	2,292,790		6,921,530	2,640,000	4,620,000		14,181,530	206,351,139	192,169,609
39	2043	2,407,430		6,921,530	2,640,000	4,620,000		14,181,530	216,668,696	202,487,166
40	2044	2,527,801		6,921,530	2,640,000	4,620,000		14,181,530	227,502,130	213,320,600
41	2045	2,654,192		6,921,530	2,640,000	4,620,000		14,181,530	238,877,237	224,695,707
42	2046	2,786,901		6,921,530	2,640,000	4,620,000		14,181,530	250,821,099	236,639,569
43	2047	2,926,246		6,921,530	2,640,000	4,620,000		14,181,530	263,362,154	249,180,624
44	2048	3,072,558		6,921,530	2,640,000	4,620,000		14,181,530	276,530,261	262,348,731
45	2049	3,226,186		6,921,530	2,640,000	4,620,000		14,181,530	290,356,774	276,175,244
46	2050	3,387,496		6,921,530	2,640,000	4,620,000		14,181,530	304,874,613	290,693,083
47	2051	3,556,870		6,921,530	2,640,000	4,620,000		14,181,530	320,118,344	305,936,814
48	2052	3,734,714		6,921,530	2,640,000	4,620,000		14,181,530	336,124,261	321,942,731
49	2053	3,921,450		6,921,530	2,640,000	4,620,000		14,181,530	352,930,474	338,748,944
50	2054	4,117,522		6,921,530	2,640,000	4,620,000		14,181,530	370,576,998	356,395,468
51	2055	4,323,398		6,921,530	2,640,000	4,620,000		14,181,530	389,105,848	374,924,318
52	2056	4,539,568		6,921,530	2,640,000	4,620,000		14,181,530	408,561,140	394,379,610
53	2057	4,766,547		6,921,530	2,640,000	4,620,000		14,181,530	428,989,197	414,807,667
54	2058	5,004,874		6,921,530	2,640,000	4,620,000		14,181,530	450,438,657	436,257,127
55	2059	5,255,118		6,921,530	2,640,000	4,620,000		14,181,530	472,960,590	458,779,060
56	2060	5,517,874		6,921,530	2,640,000	4,620,000		14,181,530	496,608,619	482,427,089
57	2061	5,793,767		6,921,530	2,640,000	4,620,000		14,181,530	521,439,050	507,257,520
Total			986,590,000	317,351,892	111,760,000	231,000,000	44,000,000	1,690,701,892	9,995,320,055	8,304,618,163
									FIRR=	8.33%

Table 12.2-4 Sensitivity Analysis in FIRR Caluculation (10 % Increase in Expenses and 15 % Decrease in Revenues) (Case C)

Unit: US$

No.	Year	Container (TEU)	Initial Investment	Management/Operations and Maintenance Expenses			Renewal Investment	Expense Total (E)	Revenue Total (R)	R-E
				Maintenance for Infrastructure	Maintenance for Equipment	Administrative Expenses				
1	2005		6,930,000					6,930,000		-6,930,000
2	2006		7,150,000					7,150,000		-7,150,000
3	2007		550,000					550,000		-550,000
4	2008		221,100,000					221,100,000		-221,100,000
5	2009		191,290,000					191,290,000		-191,290,000
6	2010		209,440,000					209,440,000		-209,440,000
7	2011		201,410,000					201,410,000		-201,410,000
8	2012	530,500		5,672,634	1,760,000	4,620,000		12,052,634	45,092,500	33,039,866
9	2013	557,025		5,672,634	1,760,000	4,620,000		12,052,634	47,347,125	35,294,491
10	2014	584,876		5,672,634	1,760,000	4,620,000		12,052,634	49,714,481	37,661,847
11	2015	614,120		5,672,634	1,760,000	4,620,000		12,052,634	52,200,205	40,147,571
12	2016	644,826		5,672,634	1,760,000	4,620,000		12,052,634	54,810,216	42,757,582
13	2017	677,067		5,672,634	1,760,000	4,620,000		12,052,634	57,550,726	45,498,092
14	2018	710,921		5,672,634	1,760,000	4,620,000		12,052,634	60,428,263	48,375,629
15	2019	746,467		5,672,634	1,760,000	4,620,000		12,052,634	63,449,676	51,397,042
16	2020	783,790		5,672,634	1,760,000	4,620,000		12,052,634	66,622,160	54,569,526
17	2021	822,980		5,672,634	1,760,000	4,620,000		12,052,634	69,953,268	57,900,634
18	2022	864,129		5,672,634	1,760,000	4,620,000		12,052,634	73,450,931	61,398,297
19	2023	907,335		5,672,634	1,760,000	4,620,000		12,052,634	77,123,478	65,070,844
20	2024	952,702		5,672,634	1,760,000	4,620,000		12,052,634	80,979,651	68,927,017
21	2025	1,000,337		5,672,634	1,760,000	4,620,000		12,052,634	85,028,634	72,976,000
22	2026	1,050,354		5,672,634	1,760,000	4,620,000		12,052,634	89,280,066	77,227,432
23	2027	1,102,871		5,672,634	1,760,000	4,620,000		12,052,634	93,744,069	81,691,435
24	2028	1,158,015		5,672,634	1,760,000	4,620,000		12,052,634	98,431,272	86,378,638
25	2029	1,215,916		5,672,634	1,760,000	4,620,000		12,052,634	103,352,836	91,300,202
26	2030	1,276,712		5,672,634	1,760,000	4,620,000		12,052,634	108,520,478	96,467,844
27	2031	1,340,547		5,672,634	1,760,000	4,620,000		12,052,634	113,946,502	101,893,868
28	2032	1,407,574		5,672,634	1,760,000	4,620,000		12,052,634	119,643,827	107,591,193
29	2033	1,477,953	49,720,000	5,672,634	1,760,000	4,620,000		61,772,634	125,626,018	63,853,384
30	2034	1,551,851	99,000,000	5,672,634	1,760,000	4,620,000		111,052,634	131,907,319	20,854,685
31	2035	1,629,443		6,921,530	2,640,000	4,620,000	44,000,000	58,181,530	138,502,685	80,321,155
32	2036	1,710,916		6,921,530	2,640,000	4,620,000		14,181,530	145,427,819	131,246,289
33	2037	1,796,461		6,921,530	2,640,000	4,620,000		14,181,530	152,699,210	138,517,680
34	2038	1,886,284		6,921,530	2,640,000	4,620,000		14,181,530	160,334,171	146,152,641
35	2039	1,980,599		6,921,530	2,640,000	4,620,000		14,181,530	168,350,879	154,169,349
36	2040	2,079,629		6,921,530	2,640,000	4,620,000		14,181,530	176,768,423	162,586,893
37	2041	2,183,610		6,921,530	2,640,000	4,620,000		14,181,530	185,606,844	171,425,314
38	2042	2,292,790		6,921,530	2,640,000	4,620,000		14,181,530	194,887,187	180,705,657
39	2043	2,407,430		6,921,530	2,640,000	4,620,000		14,181,530	204,631,546	190,450,016
40	2044	2,527,801		6,921,530	2,640,000	4,620,000		14,181,530	214,863,123	200,681,593
41	2045	2,654,192		6,921,530	2,640,000	4,620,000		14,181,530	225,606,279	211,424,749
42	2046	2,786,901		6,921,530	2,640,000	4,620,000		14,181,530	236,886,593	222,705,063
43	2047	2,926,246		6,921,530	2,640,000	4,620,000		14,181,530	248,730,923	234,549,393
44	2048	3,072,558		6,921,530	2,640,000	4,620,000		14,181,530	261,167,469	246,985,939
45	2049	3,226,186		6,921,530	2,640,000	4,620,000		14,181,530	274,225,843	260,044,313
46	2050	3,387,496		6,921,530	2,640,000	4,620,000		14,181,530	287,937,135	273,755,605
47	2051	3,556,870		6,921,530	2,640,000	4,620,000		14,181,530	302,333,991	288,152,461
48	2052	3,734,714		6,921,530	2,640,000	4,620,000		14,181,530	317,450,691	303,269,161
49	2053	3,921,450		6,921,530	2,640,000	4,620,000		14,181,530	333,323,226	319,141,696
50	2054	4,117,522		6,921,530	2,640,000	4,620,000		14,181,530	349,989,387	335,807,857
51	2055	4,323,398		6,921,530	2,640,000	4,620,000		14,181,530	367,488,856	353,307,326
52	2056	4,539,568		6,921,530	2,640,000	4,620,000		14,181,530	385,863,299	371,681,769
53	2057	4,766,547		6,921,530	2,640,000	4,620,000		14,181,530	405,156,464	390,974,934
54	2058	5,004,874		6,921,530	2,640,000	4,620,000		14,181,530	425,414,287	411,232,757
55	2059	5,255,118		6,921,530	2,640,000	4,620,000		14,181,530	446,685,001	432,503,471
56	2060	5,517,874		6,921,530	2,640,000	4,620,000		14,181,530	469,019,252	454,837,722
57	2061	5,793,767		6,921,530	2,640,000	4,620,000		14,181,530	492,470,214	478,288,684
Total			986,590,000	317,351,892	111,760,000	231,000,000	44,000,000	1,690,701,892	9,440,024,497	7,749,322,605
									FIRR=	8.00%

Table 12.2-5(1) Financial Statement

1.2% (Discount Rate for Long Term Loan)
5.0% (Annual Increase in Container Cargo)

Unit : USD 1,000,000

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Container Forecast (1,000TEU)								531	557	585	614	645	677	711	746	784	823	864	907	953	1,000	1,050	1,103	1,158	1,216
Operating Revenue	0	0	0	0	0	0	0	53.1	55.7	58.5	61.4	64.5	67.7	71.1	74.6	78.4	82.3	86.4	90.7	95.3	100.0	105.0	110.3	115.8	121.6
Loan Program																									
Outstanding at beginning of year	0.0	6.3	12.8	13.3	214.3	388.2	578.6	761.7	761.7	761.7	761.7	761.7	761.7	761.7	761.7	761.7	761.7	761.7	731.8	701.9	672.0	642.1	612.2	582.3	552.4
Loan Disbursement (Investment)	6.3	6.5	0.5	201.0	173.9	190.4	183.1																		
Principal Repayment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9
Interest	0.00	0.08	0.15	0.16	2.57	4.66	6.94	9.14	9.14	9.14	9.14	9.14	9.14	9.14	9.14	9.14	9.14	9.14	8.78	8.42	8.06	7.71	7.35	6.99	6.63
Outstanding at year end	6.3	12.8	13.3	214.3	388.2	578.6	761.7	761.7	761.7	761.7	761.7	761.7	761.7	761.7	761.7	761.7	761.7	731.8	701.9	672.0	642.1	612.2	582.3	552.4	522.5
Total Debt Service	0.00	0.08	0.15	0.16	2.57	4.66	6.94	9.14	9.14	9.14	9.14	9.14	9.14	9.14	9.14	9.14	9.14	39.04	38.68	38.32	37.96	37.60	37.24	36.88	36.53
Income Statement																									
Sales Revenue	0	0	0	0	0	0	0	53.1	55.703	58.5	61.4	64.5	67.7	71.1	74.6	78.4	82.3	86.4	90.7	95.3	100.0	105.0	110.3	115.8	121.6
Operation and Maintenance and Administration	0	0	0	0	0.0	0.0	0.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0
Depreciation								11.91	11.91	11.91	11.91	11.91	11.91	11.91	11.91	11.91	11.91	11.91	11.91	11.91	11.91	11.91	11.91	11.91	11.91
Interest	0.00	0.08	0.15	0.16	2.57	4.66	6.94	9.14	9.14	9.14	9.14	9.14	9.14	9.14	9.14	9.14	9.14	9.14	8.78	8.42	8.06	7.71	7.35	6.99	6.63
Net Benefit	0.0	(0.08)	(0.15)	(0.16)	(2.57)	(4.66)	(6.94)	21.0	23.7	26.5	29.4	32.5	35.7	39.1	42.6	46.4	50.3	54.4	59.1	64.0	69.1	74.5	80.1	85.9	92.1
Accumulation of Net Benefit	0.0	(0.08)	(0.23)	(0.39)	(2.96)	(7.62)	(14.56)	6.5	30.2	57	86	119	154	193	236	282	333	387	446	510	579	654	734	820	912
Balance Sheet																									
Asset	6.3	12.7	13.1	213.9	385.2	571	747	768	792	818	848	880	916	955	998	1,044	1,094	1,119	1,148	1,182	1,221	1,266	1,316	1,372	1,434
Current Asset		6.4	6.6	213.4	184.2	179.6	172.6	205.6	241.2	279.6	320.9	365.3	412.9	463.9	518.4	576.7	638.9	675.3	716.4	762.4	813.5	870.0	932.1	1,000.0	1,074.1
Fixed Asset		6.3	6.5	0.5	201	391.4	574.5	562.59	550.68	538.77	526.86	514.95	503.04	491.13	479.22	467.31	455.4	443.49	431.58	419.67	407.76	395.85	383.94	372.03	360.12
Construction in Progress	6.3	6.5	0.5	201.0	173.9	190.4	183.1																		
Liability	6.3	12.724	13.071	213.91	385.24	571	747	768	792	818	848	880	916	955	998	1,044	1,094	1,119	1,148	1,182	1,221	1,266	1,316	1,372	1,434
Bank Loan (JBIC)	6.3	12.8	13.30	214.3	388.2	578.6	761.7	761.7	761.7	761.7	761.7	761.7	761.7	761.7	761.7	761.7	761.7	731.8	701.91	672.01	642.11	612.22	582.32	552.42	522.52
Profit / Loss	0.0	(0.08)	(0.23)	(0.4)	(3)	(8)	(15)	6.5	30	57	86	119	154	193	236	282	333	387	446	510	579	654	734	820	912
Cash Flow																									
In-Flow	6.3	6.6	0.7	201.2	176.5	195.1	190.0	20.1	20.1	20.1	20.1	24.8	20.1	20.1	20.1	20.1	20.1	50.0	49.6	49.3	48.9	48.6	48.2	47.8	47.5
Revenue	0.0	0.0	0.0	0.0	0.0	0.0	0.0	53.1	55.7	58.5	61.4	64.5	67.7	71.1	74.6	78.4	82.3	86.4	90.7	95.3	100.0	105.0	110.3	115.8	121.6
Bank Loan (JBIC)	6.3	6.5	0.5	201	173.9	190.4	183.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Out-Flow	6.3	6.6	0.7	201.2	176.5	195.1	190.0	20.1	20.1	20.1	20.1	24.8	20.1	20.1	20.1	20.1	20.1	50.0	49.6	49.3	48.9	48.6	48.2	47.8	47.5
Investment	6.3	6.5	0.5	201.0	173.9	190.4	183.1	0	0	0	0	4.7	0	0	0	0	0	0	0	0	0	0	0	0	0
Operation and Maintenance Cost	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0	11.0
Debt Services	0.0	0.1	0.2	0.2	2.6	4.7	6.9	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	39.0	38.7	38.3	38.0	37.6	37.2	36.9	36.5
Net Cash Flow																									
Cash Flow (Rev.-Inv.-O&M)	(6.3)	(6.5)	(0.5)	(201.0)	(173.9)	(190.4)	(183.1)	42.1	44.7	47.5	50.5	48.8	56.7	60.1	63.7	67.4	71.3	75.5	79.8	84.3	89.1	94.1	99.3	104.8	110.6

Table 12.2-5(2) Financial Statement

Unit : USD 1,000,000

Year	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051
Container Forecast (1,000TEU)	1,277	1,341	1,408	1,478	1,552	1,629	1,711	1,796	1,886	1,981	2,080	2,184	2,293	2,407	2,528	2,654	2,787	2,926	3,073	3,226	3,387	3,557
Operating Revenue	127.7	134.1	140.8	147.8	155.2	162.9	171.1	179.6	188.6	198.1	208.0	218.4	229.3	240.7	252.8	265.4	278.7	292.6	307.3	322.6	338.7	355.7
Loan Program																						
Outstanding at beginning of year	522.5	492.6	462.7	432.8	448.1	508.2	478.3	448.4	418.5	388.7	358.8	328.9	299.0	269.1	239.2	209.3	179.4	149.5	119.6	89.7	59.8	29.9
Loan Disbursement (Investment)				45.2	90.0																	
Principal Repayment	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9	29.9
Interest	6.27	5.91	5.55	5.19	5.38	6.10	5.74	5.38	5.02	4.66	4.31	3.95	3.59	3.23	2.87	2.51	2.15	1.79	1.43	1.08	0.72	0.36
Outstanding at year end	492.6	462.7	432.8	448.1	508.2	478.3	448.4	418.5	388.7	358.8	328.9	299.0	269.1	239.2	209.3	179.4	149.5	119.6	89.7	59.8	29.9	0.0
Total Debt Service	36.17	35.81	35.45	35.09	35.27	36.00	35.64	35.28	34.92	34.56	34.20	33.84	33.48	33.13	32.77	32.41	32.05	31.69	31.33	30.97	30.61	30.26
Income Statement																						
Sales Revenue	127.7	134.1	140.8	147.8	155.2	162.9	171.1	179.6	188.6	198.1	208.0	218.4	229.3	240.7	252.8	265.4	278.7	292.6	307.3	322.6	338.7	355.7
Operation and Maintenance and Administration	11.0	11.0	11.0	11.0	11.0	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9
Depreciation	11.91	11.91	11.91	11.91	11.91	14.98	14.98	14.98	14.98	14.98	14.98	14.98	14.98	14.98	14.98	14.98	14.98	14.98	14.98	14.98	14.98	14.98
Interest	6.27	5.91	5.55	5.19	5.38	6.10	5.74	5.38	5.02	4.66	4.31	3.95	3.59	3.23	2.87	2.51	2.15	1.79	1.43	1.08	0.72	0.36
Net Benefit	98.5	105.3	112.3	119.7	126.9	129.0	137.5	146.4	155.7	165.5	175.8	186.5	197.8	209.6	222.0	235.0	248.7	263.0	278.0	293.7	310.2	327.5
Accumulation of Net Benefit	1,010	1,116	1,228	1,348	1,475	1,604	1,741	1,887	2,043	2,209	2,384	2,571	2,769	2,978	3,200	3,436	3,684	3,947	4,225	4,519	4,829	5,156
Balance Sheet																						
Asset	1,503	1,578	1,661	1,796	1,983	2,082	2,189	2,306	2,432	2,567	2,713	2,870	3,038	3,218	3,410	3,615	3,834	4,067	4,315	4,579	4,859	5,156
Current Asset	1,154.7	1,242.0	1,336.3	1,438.0	1,547.0	1,661.1	1,783.6	1,915.1	2,055.9	2,206.5	2,367.4	2,539.0	2,721.9	2,916.7	3,123.8	3,343.9	3,577.6	3,825.7	4,088.7	4,367.5	4,662.7	4,975.3
Fixed Asset	348.21	336.3	324.39	357.68	435.77	420.79	405.81	390.83	375.85	360.87	345.89	330.91	315.93	300.95	285.97	270.99	256.01	241.03	226.05	211.07	196.09	181.11
Construction in Progress																						
Liability	1,503	1,578	1,661	1,796	1,983	2,082	2,189	2,306	2,432	2,567	2,713	2,870	3,038	3,218	3,410	3,615	3,834	4,067	4,315	4,579	4,859	5,156
Bank Loan (JBIC)	492.63	462.73	432.83	448.14	508.24	478.34	448.45	418.55	388.65	358.75	328.86	298.96	269.06	239.17	209.27	179.37	149.48	119.58	89.681	59.784	29.887	-0.01
Profit / Loss	1,010	1,116	1,228	1,348	1,475	1,604	1,741	1,887	2,043	2,209	2,384	2,571	2,769	2,978	3,200	3,436	3,684	3,947	4,225	4,519	4,829	5,156
Cash Flow																						
In-Flow	47.1	46.8	46.4	46.1	46.2	48.9	48.5	48.2	47.8	47.5	47.1	46.7	46.4	46.0	45.7	45.3	44.9	44.6	44.2	43.9	43.5	43.1
Revenue	127.7	134.1	140.8	147.8	155.2	162.9	171.1	179.6	188.6	198.1	208.0	218.4	229.3	240.7	252.8	265.4	278.7	292.6	307.3	322.6	338.7	355.7
Bank Loan (JBIC)	0	0	0	45.2	90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Out-Flow	47.1	46.8	46.4	46.1	46.2	48.9	48.5	48.2	47.8	47.5	47.1	46.7	46.4	46.0	45.7	45.3	44.9	44.6	44.2	43.9	43.5	43.1
Investment	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Operation and Maintenance Cost	11.0	11.0	11.0	11.0	11.0	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9
Debt Services	36.2	35.8	35.4	35.1	35.3	36.0	35.6	35.3	34.9	34.6	34.2	33.8	33.5	33.1	32.8	32.4	32.0	31.7	31.3	31.0	30.6	30.3
Net Cash Flow																						
Cash Flow (Rev.-Inv.-O&M)	116.7	123.1	129.8	136.8	144.2	150.1	158.2	166.8	175.7	185.2	195.1	205.5	216.4	227.9	239.9	252.5	265.8	279.7	294.4	309.7	325.9	342.8

CHAPTER 13 CONCLUSIONS AND RECOMMENDATIONS

JETRO Feasibility Study for the Construction of an Artificial Island at the Pacific Entrance to the Panama Canal was carried out in cooperation with Autoridad del Canal de Panama (ACP) from August 2003 to January 2004. In this feasibility study, an artificial island construction plan was proposed with a view to the beneficial usage of excavated materials coming from Panama Canal Expansion Plan activities, and this proposed artificial island construction project was ascertained to be feasible from technical, economic, financial and environmental point of views.

Proposed Artificial Island Construction Plan:

Category	Item	Particular
Artificial Island	Location of Artificial Island [Location I]	North End: N978 000 East End: E656 700
	Size of Artificial Island [Plan B]	1,100m*1,800m = 198 ha
	Ground Level	M.L.W.S. + 7.00 m
	Volume of Reclamation Soil	39 million m3
Quaywall/Revetment	Water Depth: Quaywall side Revetment side	M.L.W.S. - 16.75 m M.L.W.S. - 11.50 m
	Type of Structure	Prefabricated steel sheet pile cellular-bulkhead quaywall
	Construction Period	18 months
Land Reclamation	Material Transportation Method	By Barge
	Land Reclamation Method	By Reclaimer
Accessway	Length of Accessway	5,525m
Construction Cost	Quaywall Construction	$ 269 M.
	Land Reclamation	$ 96 M.
	Total of Island Construction	$ 365 M.
	Accessway	$ 99 M.

[Remarks]

Advantages of adopting prefabricated steel sheet pile cellular-bulkhead quaywall:

(1) Seawater pollution is minimized during land reclamation because the reclamation area is isolated from external seawater by cellular-bulkhead quaywall.

(2) Construction period is short.

(3) Quaywall can be used for container berth.

CONCLUSIONS AND RECOMMENDATIONS

1. The proposed structure of revetment with pre-fabricated steel sheet pile cellular bulk-head has merits in view of environment, construction workability and construction period. Also, its structure can be utilized for quaywalls of post Panamax container terminal supplementing the berth equipment and accessories such as fenders, apron concrete, bollards and bitts.

2. Container terminal planning for an artificial island size was examined considering the "Target Vessel" and based on "Container Demand Forecast." And, it is still in conceptual basis. The requirements of the container terminal have to be verified in detailed considering the container transshipment hub and connection of the feeder lines to the Pacific coast of America, Central America and South America. The berth requirement has been given based on the post Panamax type vessels. The requirement might be revised taking into account the characteristics of the vessel calling at the Artificial Island

3. Artificial Island Location was selected based on environmental study and construction cost survey. In estimating the construction cost, dredging volume of soil and/or rock, water depth at construction site, reclamation volume and length of accessway were taken into account.

4. The proposed island location will not interfere the operation at former Howard Air Force Base.

5. The proposed access channel and island location were configured based on the available sea charts and the seismic survey data executed by ACP. As shown in Section 3.3, the depth of seabed and the elevation of top of bedrock have much impact on the dredging cost. For further detailed study, it is recommended to carry out more precise surveys of the depth of seabed and the elevation of top of bedrock at the construction site.

6. The access channel width is proposed at 280 meters based on the PIANC Guideline. It has also impact on the dredging cost. In the further detailed study, it is recommended to conduct "Ship Maneuvering Simulation" incorporating the marine conditions.

7. The navigation of convey barges may have a little impact to the existing maritime traffic. However, a traffic study is necessary based on the actual data in order to clarify this matter.

APPENDICES

CONTENTS OF APPENDICES

A.1.1 Minutes of Meeting

MINUTE OF MEETING

This MINUTE OF MEETING (hereinafter called the "MOM") was prepared on this 19th day of August, 2003, to document the results of the meeting held on that same day between the Autoridad del Canal de Panama (ACP) and the JETRO Study Team (JST) to define the Scope of Work for the "Feasibility Study for the Construction of an Artificial Island at the Pacific Entrance to the Panama Canal"(hereinafter called the "Study") sponsored by the Japan External Trade Organization (JETRO).

1. **Objectives of the Study**
   a. Both parties agreed that the purpose of this Study is to analyze the feasibility of constructing an artificial island using the excavated materials resulting from the proposed construction of new Pacific locks.
   b. Both parties agreed that the full scope of this Study on land reclamation alternatives at the Pacific Entrance to the Panama Canal must be directed toward evaluating the construction of an artificial island.

2. **Scope of the Study**
   The ACP and the JST discussed and agreed upon the Terms of Reference as attached hereto.

3. **ACP preparation of the Technical and Engineering Data Requested by the JST**
   The ACP provided technical data related to the Study, except for the following information that could be available at a later date:
   a. Transshipment forecast data will be provided by the end of September 2003

4. **Intellectual Property and Confidentiality**
   All data and information provided by the ACP used for this Study are the property of the ACP and shall not be used, released to the public or issued by the JST to other sources without written authorization by the ACP. However, due to the fact that JETRO is a government organization, JETRO shall have the right to disclose to the public only the report of the Study, providing it is so required by Japanese laws.

IN WITNESS WHEREOF, the Parties have prepared this MOM to be signed by their duly-authorized representatives on the preceding date.

JETRO Study Team	Panama Canal Authority
T. Kokado	
Dr. Takeshi Kokado	Mr. Agustín Arias, Director
Team Leader	Engineering and Projects Department

A.1.2 Terms of Reference

TERMS OF REFERENCE

FOR THE FEASIBILITY STUDY

ON THE CONSTRUCTION OF AN ARTIFICIAL ISLAND

AT THE PACIFIC ENTRANCE TO THE PANAMA CANAL

AUTORIDAD DEL CANAL DE PANAMA (ACP)

JAPAN EXTERNAL TRADE ORGANIZATION (JETRO)

1. OBJECTIVES OF THE FEASIBILITY STUDY

The Autoridad del Canal de Panama (ACP) is evaluating the possibility to expand the Canal to accommodate ships larger than Panamax vessels. The proposed construction of new locks and the related work for the expansion of the Panama Canal are expected to generate significant quantities of excavated materials, amounting to some 50-70 million m^3. As part of its activities, the Panama Canal Master Plan for the expansion of the waterway is considering land reclamation at the Pacific entrance to the Panama Canal, as an alternative to give excavated material a beneficial use.
In order to assess the technical and environmental aspects of the land reclamation alternatives, JETRO's Preliminary Study on "Land Reclamation Alternatives for the Pacific Entrance to the Panama Canal" was carried out in cooperation with the Panama Canal Authority (ACP) from December 2002 to March 2003. In this preliminary study, due to time constraints and lack of data, some bold assumptions were adopted in evaluating land reclamation alternatives.

The full scope of this feasibility study on land reclamation alternatives at the Pacific entrance to the Panama Canal is directed toward the evaluation of constructing an artificial island.

2. SCOPE OF STUDY

To achieve the above-mentioned objectives, the Feasibility Study shall include the following study items:

A. Data Collection:

a. Collection and review of data on traffic demand, including transshipment, to plan for the use of the artificial island as a container terminal

b. Collection and review of the available data and information related to the operations of the existing container port(s) in Panama.

c. Collection of data on the natural condition of the Pacific Ocean-side of the Canal :
   c-1. Observed data and/or hindcast data (direction, period and height) on waves and swells, including wave spectrum.
   c-2. Typical weather maps describing high waves and seasonal pressure pattern.
   c-3. Wind data at some spots.

d. Collection of data on the cost of labor, material and the equipment necessary for the cost estimation.

* Regarding data collection for this feasibility study, the ACP shall, whenever possible, provide JETRO Study Team engineers with any available data and information requested by them.

B. Assessment for the Construction of an Artificial Island:

a. Selection of artificial island location, from the viewpoint of wave and current conditions, bathymetric and seismological information, and environmental aspects including tidal current analysis.
   This includes the study of the necessity of the breakwater, and its proposal of the specification (length, height, etc.).
   This study also includes the proposal of the structural type of the access road.

b. Boring exploration at the sites. (See the "Technical Specification for Offshore Geotechnical Investigation for Artificial Island Construction at the Pacific Entrance to the Panama Canal.")

c. Structural design of quaywall, revetment, foundation of gantry crane, and breakwater.
   Conceptual design of access road (alternative to the Causeway).

d. Analysis of transportation and handling of excavated materials.

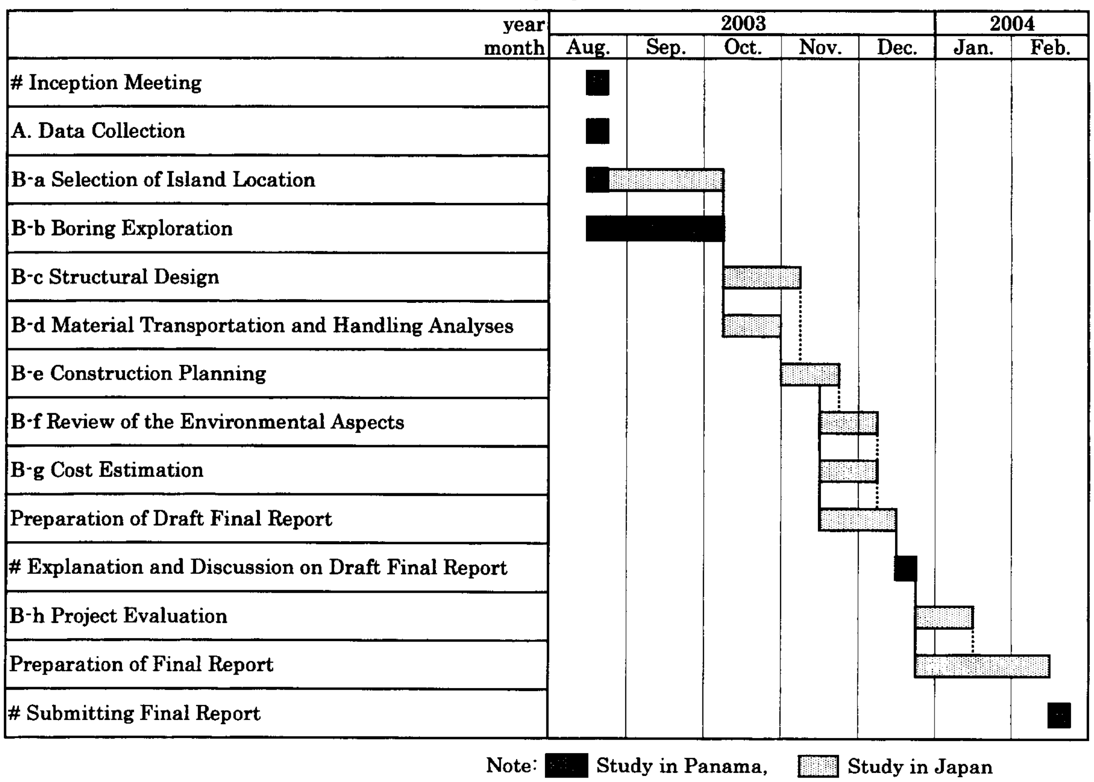
e. Construction method and program.

f. Review and update of the environmental aspects, Chapter 4 in the report of the preliminary study by JETRO Study Team, March 2003: 4.1 Present situation of the artificial island project, 4.2 Legal framework, 4.3 JBIC's Environmental guidelines, and 4.4 Review of existing environmental conditions.
Proposal for environment management and monitoring plan for the artificial island.

g. Cost estimation for the construction of the artificial island.

h. Project evaluation.

3. SCHEDULE OF THE FEASIBILITY STUDY



4. EXPERTS REQUIRED

Experts required for the implementation of the feasibility study shall include at least, but may not be limited to, the following:

1) Team Leader (Dr. Takeshi KOKADO)
2) Port Planner (Mr. Teruo ONUKI)
3) Marine Engineer (Mr. Hiroyuki TAKAKAZE)
4) Geo-Technical Engineer (Mr. Yuzoh AKASHI)
5) Structural Engineer (Dr. Masato TSUJII)
6) Construction and Cost Surveyor (Mr. Hideo KIMURA)
7) Financial Expert (Mr. Isao FURUTA)
8) Environmental Expert (Mr. Juan Antonio UMANA)

Results of Analysis of Wharf Operation Efficiency (Figures and Tables)

March 2004

JETRO STUDY TEAM

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A.2.1 Percent Occurrence – Offshore Waves

Table A.2.1.1 Percent Occurrence – Significant Wave Height by Peak Wave Period (1970-2000)

	Peak Wave Period, Tp(sec)								
Significant Wave Height, Hs(m)	6	8	10	12	14	16	18	20	Total Percent Occurrence
0	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
0.25	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
0.5	0.00%	0.00%	0.00%	0.01%	0.01%	0.00%	0.00%	0.00%	0.02%
0.75	0.01%	0.06%	0.36%	1.21%	2.51%	1.75%	0.85%	0.27%	7.02%
1	0.03%	0.10%	0.87%	3.29%	6.65%	5.47%	2.70%	0.83%	19.94%
1.25	0.19%	0.30%	1.16%	3.68%	7.80%	7.21%	3.62%	1.12%	25.08%
1.5	0.84%	0.29%	1.26%	2.94%	6.36%	6.12%	3.82%	1.23%	22.86%
1.75	1.44%	0.09%	0.83%	1.87%	3.39%	4.04%	2.59%	0.91%	15.17%
2	0.94%	0.01%	0.18%	0.78%	1.49%	1.72%	1.28%	0.41%	6.80%
2.25	0.37%	0.01%	0.05%	0.13%	0.46%	0.63%	0.48%	0.15%	2.27%
2.5	0.12%	0.06%	0.00%	0.03%	0.08%	0.17%	0.14%	0.04%	0.64%
2.75	0.00%	0.05%	0.00%	0.00%	0.02%	0.03%	0.03%	0.01%	0.15%
3	0.00%	0.02%	0.00%	0.00%	0.00%	0.01%	0.01%	0.00%	0.04%
Total Percent Occurrence	3.93%	1.01%	4.70%	13.95%	28.77%	27.14%	15.52%	4.97%	100.00%

Table A.2.1.2 Percent Occurrence – Peak Wave Period by Wave Direction (1970-2000)

	Wave Direction(degrees)							
Peak Wave Period, Tp (sec)	205	210	215	220	225	230	235	Total Percent Occurrence
6	0.0%	0.1%	0.4%	0.8%	0.9%	0.8%	0.6%	3.7%
8	0.0%	0.1%	0.2%	0.2%	0.2%	0.1%	0.0%	0.9%
10	0.5%	1.1%	1.3%	1.1%	0.6%	0.2%	0.1%	4.8%
12	1.2%	2.7%	3.1%	3.1%	2.0%	1.3%	0.8%	14.2%
14	1.3%	3.8%	6.3%	6.9%	5.3%	3.4%	1.9%	28.8%
16	0.8%	3.0%	6.3%	7.6%	5.2%	2.8%	1.7%	27.3%
18	0.5%	1.5%	3.8%	4.3%	3.0%	1.5%	0.8%	15.4%
20	0.1%	0.5%	1.2%	1.5%	0.9%	0.5%	0.1%	4.8%
Total Percent Occurrence	4.4%	12.8%	22.5%	25.4%	18.2%	10.8%	6.0%	100.0%

Table A.2.1.3 Percent Occurrence – Significant Wave Height by Wave Direction (for Peak Wave Period : 6sec)

	Wave Direction(degrees)							
Significant Wave Height, Hs(m)	205	210	215	220	225	230	235	Total Percent Occurrence
0	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%
0.25	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%
0.5	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%
0.75	0.000%	0.000%	0.001%	0.002%	0.003%	0.002%	0.002%	0.01%
1	0.000%	0.001%	0.003%	0.007%	0.008%	0.007%	0.005%	0.03%
1.25	0.000%	0.006%	0.017%	0.040%	0.045%	0.040%	0.028%	0.18%
1.5	0.000%	0.025%	0.075%	0.176%	0.201%	0.176%	0.126%	0.78%
1.75	0.000%	0.043%	0.130%	0.304%	0.347%	0.304%	0.217%	1.34%
2	0.000%	0.028%	0.085%	0.198%	0.226%	0.198%	0.141%	0.88%
2.25	0.000%	0.011%	0.033%	0.077%	0.088%	0.077%	0.055%	0.34%
2.5	0.000%	0.003%	0.010%	0.024%	0.028%	0.024%	0.017%	0.11%
2.75	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%
3	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%
Total Percent Occurrence	0.00%	0.12%	0.35%	0.83%	0.95%	0.83%	0.59%	3.7%

Table A.2.1.4 Percent Occurrence – Significant Wave Height by Wave Direction (for Peak Wave Period : 8sec)

	Wave Direction(degrees)							
Significant Wave Height, Hs(m)	205	210	215	220	225	230	235	Total Percent Occurrence
0	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%
0.25	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%
0.5	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%
0.75	0.000%	0.007%	0.015%	0.015%	0.015%	0.007%	0.000%	0.06%
1	0.000%	0.012%	0.024%	0.024%	0.024%	0.012%	0.000%	0.10%
1.25	0.000%	0.035%	0.071%	0.071%	0.071%	0.035%	0.000%	0.28%
1.5	0.000%	0.034%	0.068%	0.068%	0.068%	0.034%	0.000%	0.27%
1.75	0.000%	0.011%	0.022%	0.022%	0.022%	0.011%	0.000%	0.09%
2	0.000%	0.001%	0.002%	0.002%	0.002%	0.001%	0.000%	0.01%
2.25	0.000%	0.001%	0.002%	0.002%	0.002%	0.001%	0.000%	0.01%
2.5	0.000%	0.007%	0.015%	0.015%	0.015%	0.007%	0.000%	0.06%
2.75	0.000%	0.006%	0.012%	0.012%	0.012%	0.006%	0.000%	0.05%
3	0.000%	0.002%	0.005%	0.005%	0.005%	0.002%	0.000%	0.02%
Total Percent Occurrence	0.00%	0.12%	0.24%	0.24%	0.24%	0.12%	0.00%	0.9%

Table A.2.1.5 Percent Occurrence – Significant Wave Height by Wave Direction (for Peak Wave Period : 10sec)

	Wave Direction(degrees)							
Significant Wave Height, Hs(m)	205	210	215	220	225	230	235	Total Percent Occurrence
0	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%
0.25	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%
0.5	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%
0.75	0.036%	0.081%	0.098%	0.081%	0.045%	0.018%	0.009%	0.37%
1	0.087%	0.197%	0.240%	0.197%	0.109%	0.044%	0.022%	0.90%
1.25	0.117%	0.263%	0.321%	0.263%	0.146%	0.058%	0.029%	1.20%
1.5	0.126%	0.284%	0.348%	0.284%	0.158%	0.063%	0.032%	1.30%
1.75	0.083%	0.187%	0.229%	0.187%	0.104%	0.042%	0.021%	0.85%
2	0.018%	0.040%	0.049%	0.040%	0.022%	0.009%	0.004%	0.18%
2.25	0.005%	0.012%	0.014%	0.012%	0.007%	0.003%	0.001%	0.05%
2.5	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%
2.75	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%
3	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%
Total Percent Occurrence	0.47%	1.06%	1.30%	1.06%	0.59%	0.24%	0.12%	4.8%

Table A.2.1.6 Percent Occurrence – Significant Wave Height by Wave Direction (for Peak Wave Period : 12sec)

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%
0.25	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%
0.5	0.001%	0.002%	0.002%	0.002%	0.002%	0.001%	0.001%	0.01%
0.75	0.103%	0.237%	0.267%	0.267%	0.175%	0.113%	0.072%	1.23%
1	0.278%	0.640%	0.724%	0.724%	0.473%	0.306%	0.195%	3.34%
1.25	0.312%	0.718%	0.812%	0.812%	0.531%	0.343%	0.218%	3.75%
1.5	0.249%	0.573%	0.648%	0.648%	0.424%	0.274%	0.174%	2.99%
1.75	0.159%	0.365%	0.413%	0.413%	0.270%	0.175%	0.111%	1.90%
2	0.067%	0.153%	0.173%	0.173%	0.113%	0.073%	0.047%	0.80%
2.25	0.011%	0.024%	0.028%	0.028%	0.018%	0.012%	0.007%	0.13%
2.5	0.003%	0.006%	0.007%	0.007%	0.005%	0.003%	0.002%	0.03%
2.75	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%
3	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%
Total Percent Occurrence	1.18%	2.72%	3.07%	3.07%	2.01%	1.30%	0.83%	14.2%

Table A.2.1.7 Percent Occurrence – Significant Wave Height by Wave Direction (for Peak Wave Period : 14sec)

	Wave Direction(degrees)							
Significant Wave Height, Hs(m)	205	210	215	220	225	230	235	Total Percent Occurrence
0	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%
0.25	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%
0.5	0.000%	0.001%	0.002%	0.002%	0.002%	0.001%	0.001%	0.01%
0.75	0.113%	0.330%	0.547%	0.598%	0.464%	0.299%	0.165%	2.52%
1	0.301%	0.875%	1.449%	1.586%	1.230%	0.793%	0.437%	6.67%
1.25	0.352%	1.025%	1.697%	1.857%	1.441%	0.929%	0.512%	7.81%
1.5	0.287%	0.836%	1.385%	1.516%	1.176%	0.758%	0.418%	6.38%
1.75	0.153%	0.446%	0.738%	0.808%	0.627%	0.404%	0.223%	3.40%
2	0.067%	0.195%	0.323%	0.354%	0.275%	0.177%	0.098%	1.49%
2.25	0.021%	0.061%	0.100%	0.110%	0.085%	0.055%	0.030%	0.46%
2.5	0.004%	0.011%	0.018%	0.020%	0.015%	0.010%	0.006%	0.08%
2.75	0.001%	0.003%	0.005%	0.005%	0.004%	0.002%	0.001%	0.02%
3	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%
Total Percent Occurrence	1.30%	3.78%	6.26%	6.86%	5.32%	3.43%	1.89%	28.8%

Table A.2.1.8 Percent Occurrence – Significant Wave Height by Wave Direction (for Peak Wave Period : 16sec)

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%
0.25	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%
0.5	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%
0.75	0.053%	0.190%	0.403%	0.487%	0.335%	0.183%	0.107%	1.76%
1	0.167%	0.596%	1.263%	1.525%	1.049%	0.572%	0.334%	5.51%
1.25	0.220%	0.785%	1.664%	2.009%	1.381%	0.754%	0.440%	7.25%
1.5	0.187%	0.666%	1.413%	1.706%	1.173%	0.640%	0.373%	6.16%
1.75	0.123%	0.440%	0.932%	1.126%	0.774%	0.422%	0.246%	4.06%
2	0.052%	0.187%	0.396%	0.478%	0.329%	0.179%	0.105%	1.73%
2.25	0.019%	0.068%	0.145%	0.175%	0.120%	0.066%	0.038%	0.63%
2.5	0.005%	0.018%	0.039%	0.047%	0.032%	0.017%	0.010%	0.17%
2.75	0.001%	0.003%	0.007%	0.009%	0.006%	0.003%	0.002%	0.03%
3	0.000%	0.001%	0.002%	0.003%	0.002%	0.001%	0.001%	0.01%
Total Percent Occurrence	0.83%	2.96%	6.26%	7.57%	5.20%	2.84%	1.65%	27.3%

Table A.2.1.9 Percent Occurrence – Significant Wave Height by Wave Direction (for Peak Wave Period : 18sec)

	Wave Direction(degrees)							
Significant Wave Height, Hs(m)	205	210	215	220	225	230	235	Total Percent Occurrence
0	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%
0.25	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%
0.5	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%
0.75	0.026%	0.084%	0.207%	0.232%	0.161%	0.084%	0.045%	0.84%
1	0.082%	0.267%	0.658%	0.740%	0.514%	0.267%	0.144%	2.67%
1.25	0.110%	0.359%	0.882%	0.993%	0.689%	0.359%	0.193%	3.59%
1.5	0.116%	0.378%	0.931%	1.047%	0.727%	0.378%	0.204%	3.78%
1.75	0.079%	0.257%	0.633%	0.712%	0.494%	0.257%	0.138%	2.57%
2	0.039%	0.126%	0.311%	0.350%	0.243%	0.126%	0.068%	1.26%
2.25	0.015%	0.048%	0.117%	0.132%	0.092%	0.048%	0.026%	0.48%
2.5	0.004%	0.013%	0.033%	0.037%	0.026%	0.013%	0.007%	0.13%
2.75	0.001%	0.003%	0.008%	0.009%	0.006%	0.003%	0.002%	0.03%
3	0.000%	0.001%	0.003%	0.003%	0.002%	0.001%	0.001%	0.01%
Total Percent Occurrence	0.47%	1.54%	3.78%	4.26%	2.96%	1.54%	0.83%	15.4%

Table A.2.1.10 Percent Occurrence – Significant Wave Height by Wave Direction (for Peak Wave Period : 20sec)

	Wave Direction(degrees)							
Significant Wave Height, Hs(m)	205	210	215	220	225	230	235	Total Percent Occurrence
0	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%
0.25	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%
0.5	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%
0.75	0.006%	0.026%	0.065%	0.084%	0.052%	0.026%	0.006%	0.27%
1	0.020%	0.079%	0.197%	0.256%	0.157%	0.079%	0.020%	0.81%
1.25	0.027%	0.107%	0.266%	0.346%	0.213%	0.107%	0.027%	1.09%
1.5	0.029%	0.117%	0.294%	0.382%	0.235%	0.117%	0.029%	1.20%
1.75	0.022%	0.087%	0.216%	0.281%	0.173%	0.087%	0.022%	0.89%
2	0.010%	0.039%	0.097%	0.126%	0.078%	0.039%	0.010%	0.40%
2.25	0.003%	0.014%	0.035%	0.045%	0.028%	0.014%	0.003%	0.14%
2.5	0.001%	0.004%	0.010%	0.013%	0.008%	0.004%	0.001%	0.04%
2.75	0.000%	0.001%	0.002%	0.003%	0.002%	0.001%	0.000%	0.01%
3	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%
Total Percent Occurrence	0.12%	0.47%	1.18%	1.54%	0.95%	0.47%	0.12%	4.8%

A.2.2 Results of Analysis of Wave Transformation

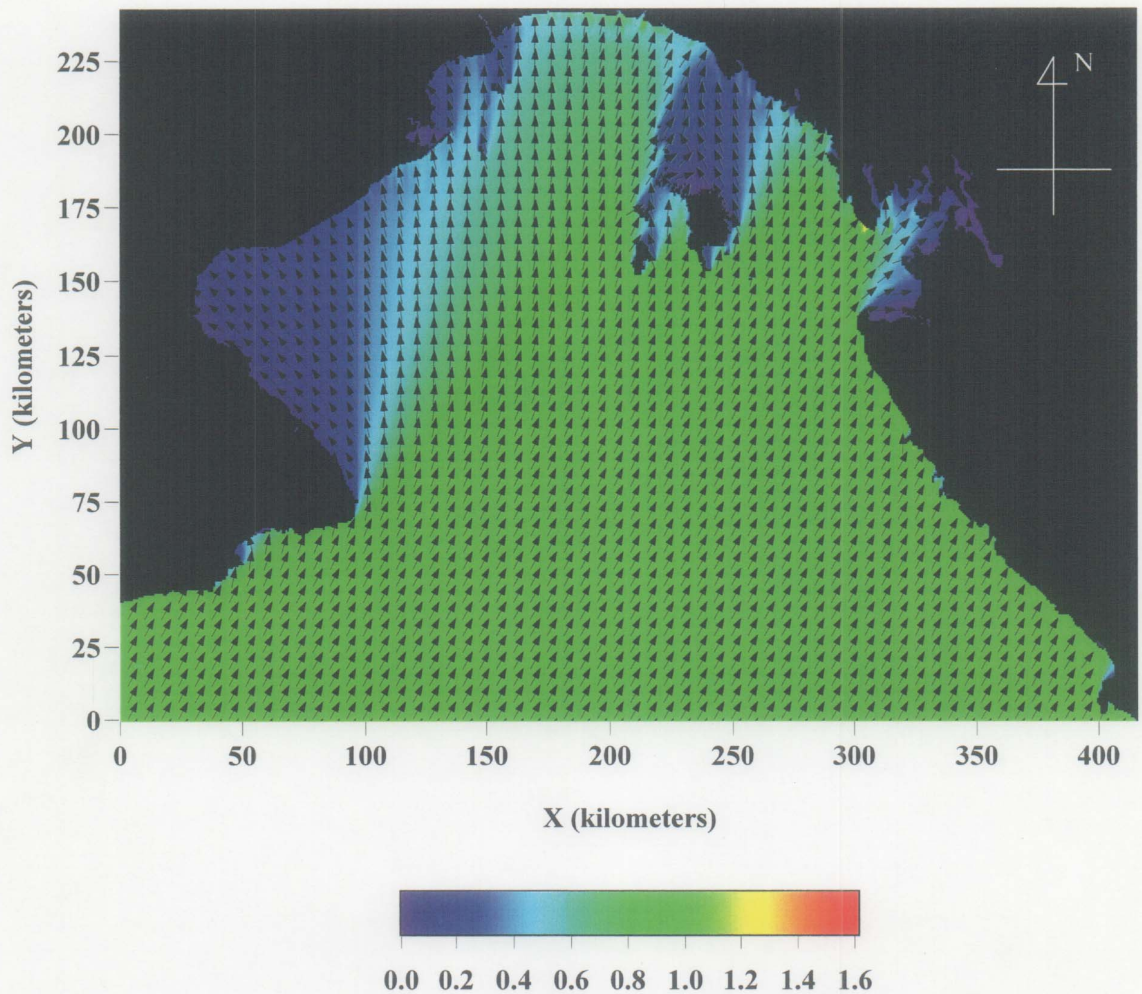


Figure A.2.2.1 Ratio of Wave Height and Mean Wave Directions（Regional Model）

（In the case.01_2 ; 6-second-period-waves from 210 degrees）

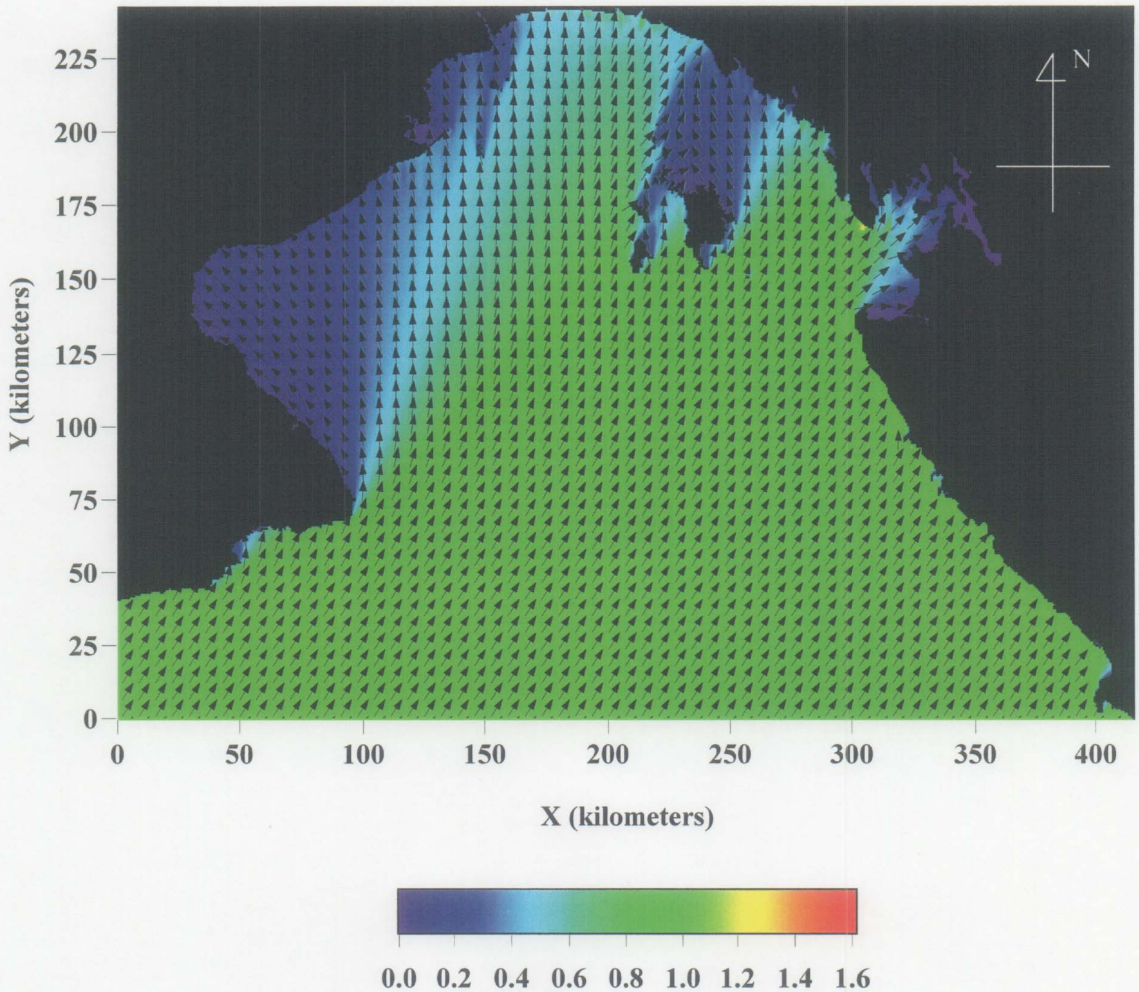


Figure A.2.2.2 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.01_3 ; 6-second-period-waves from 215 degrees)

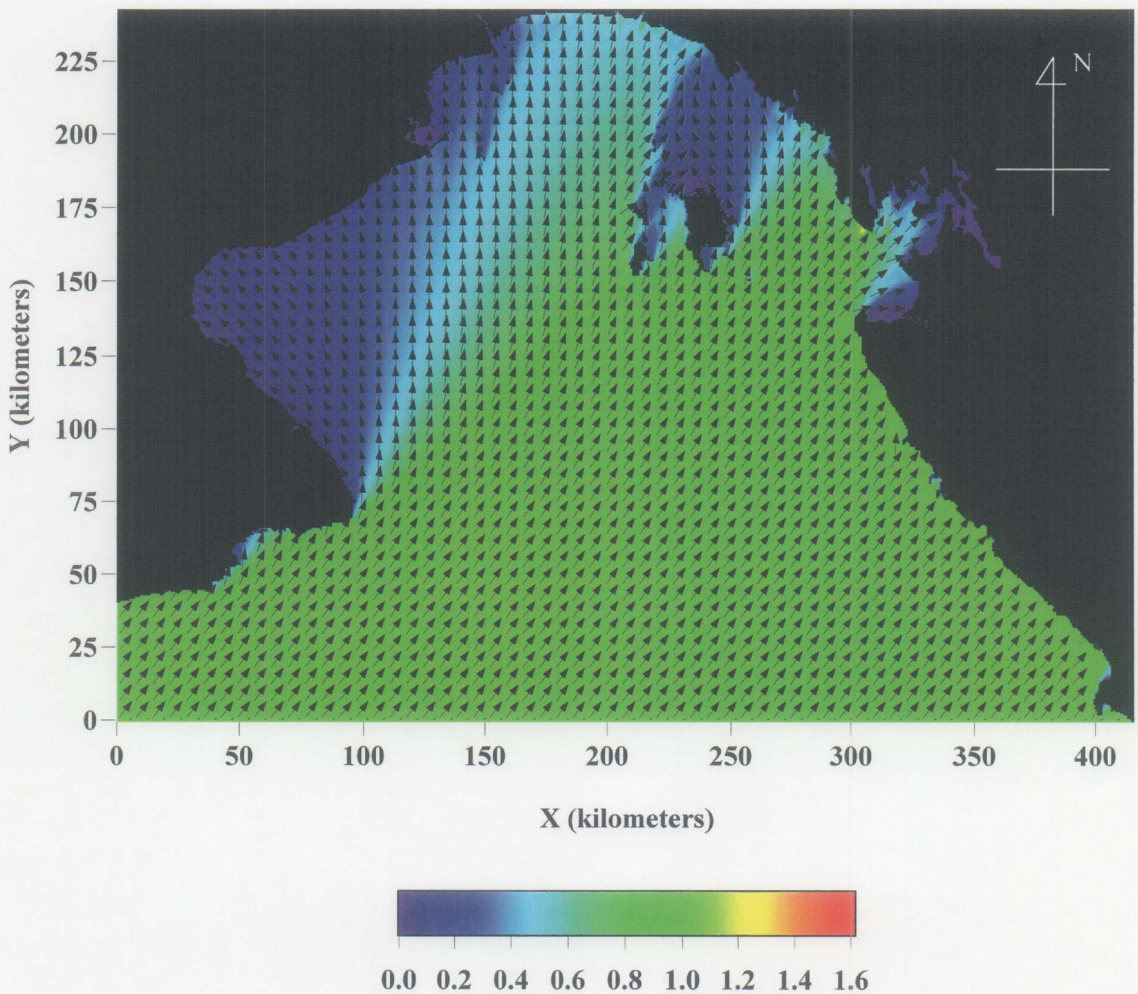


Figure A.2.2.3 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.01_4 ; 6-second-period-waves from 220 degrees)

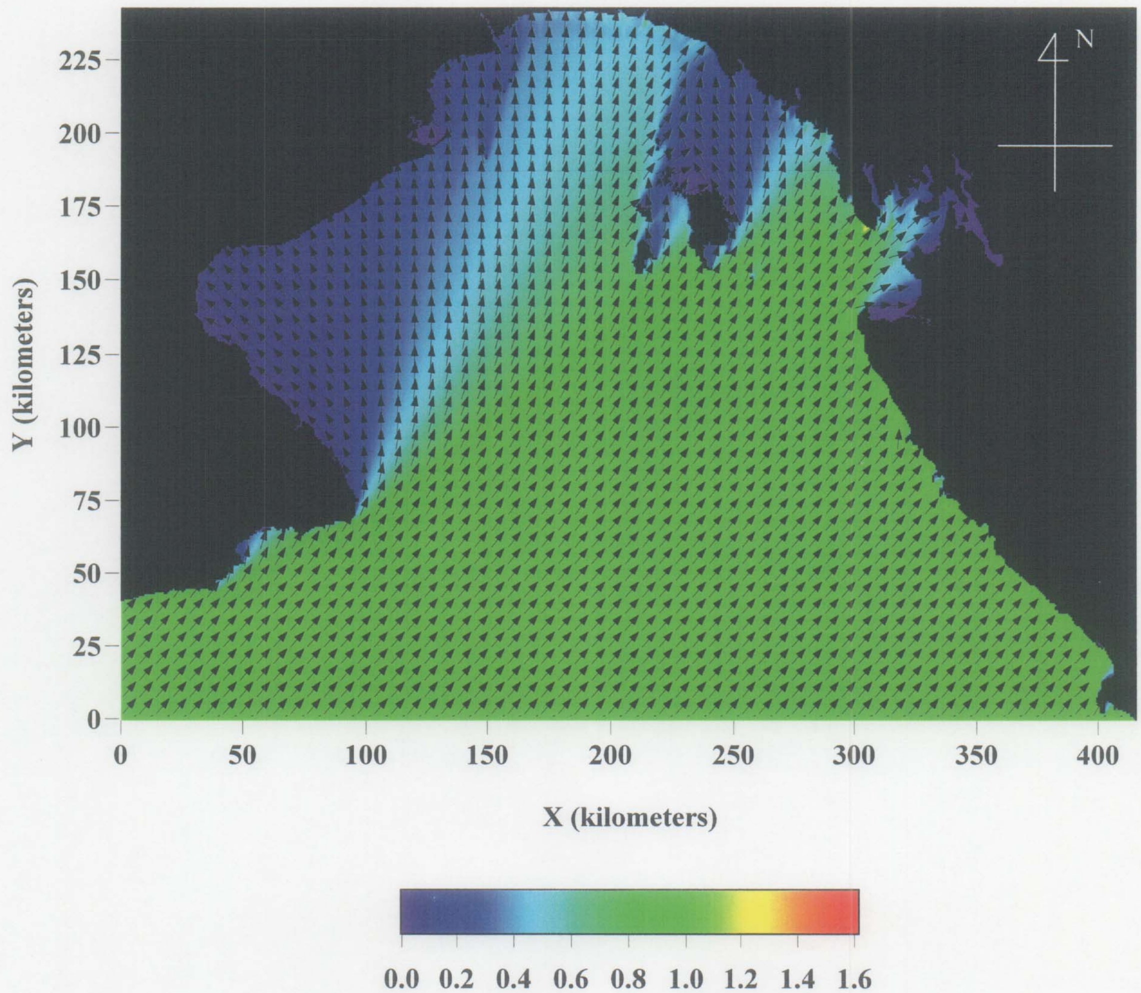


Figure A.2.2.4 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.01_5 ; 6-second-period-waves from 225 degrees)

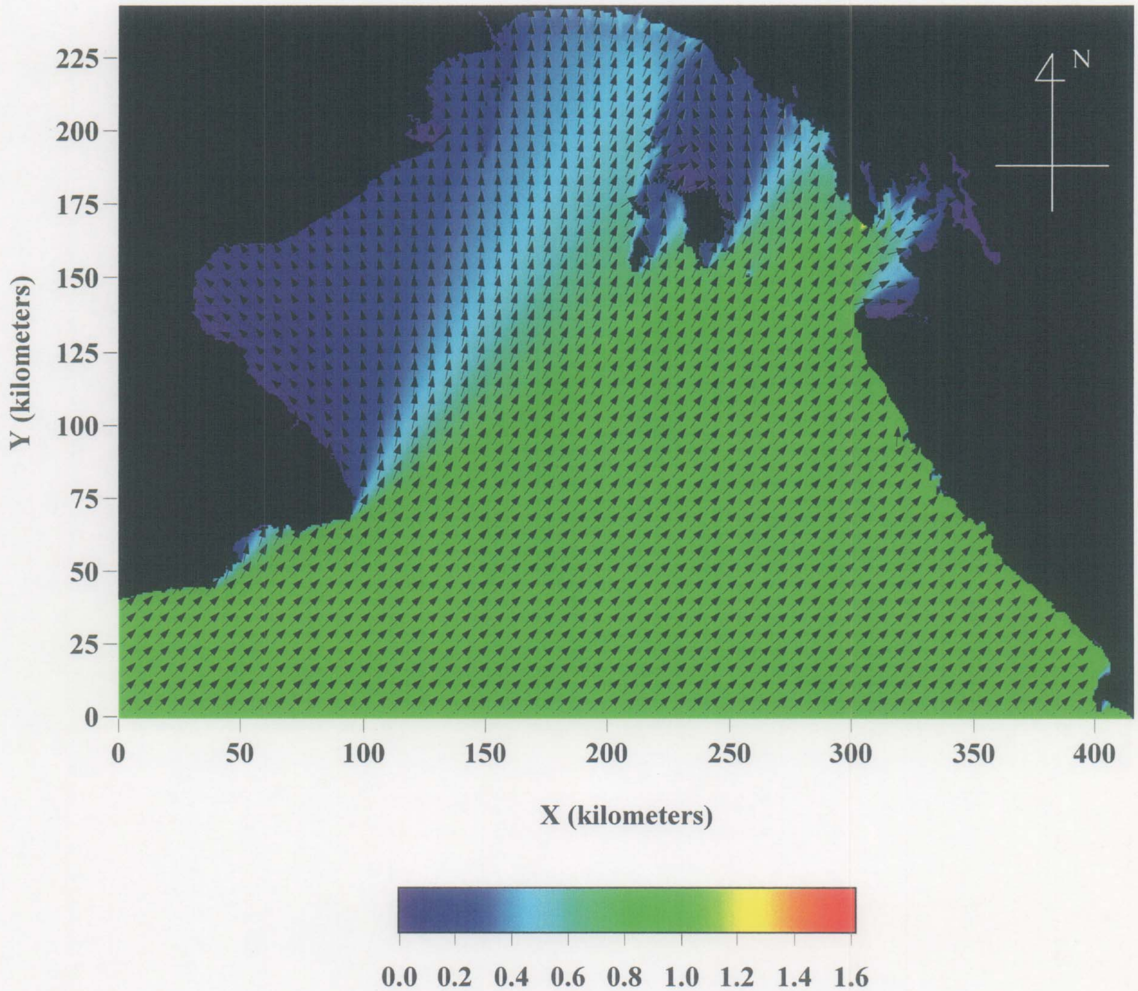


Figure A.2.2.5 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.01_6 ; 6-second-period-waves from 230 degrees)

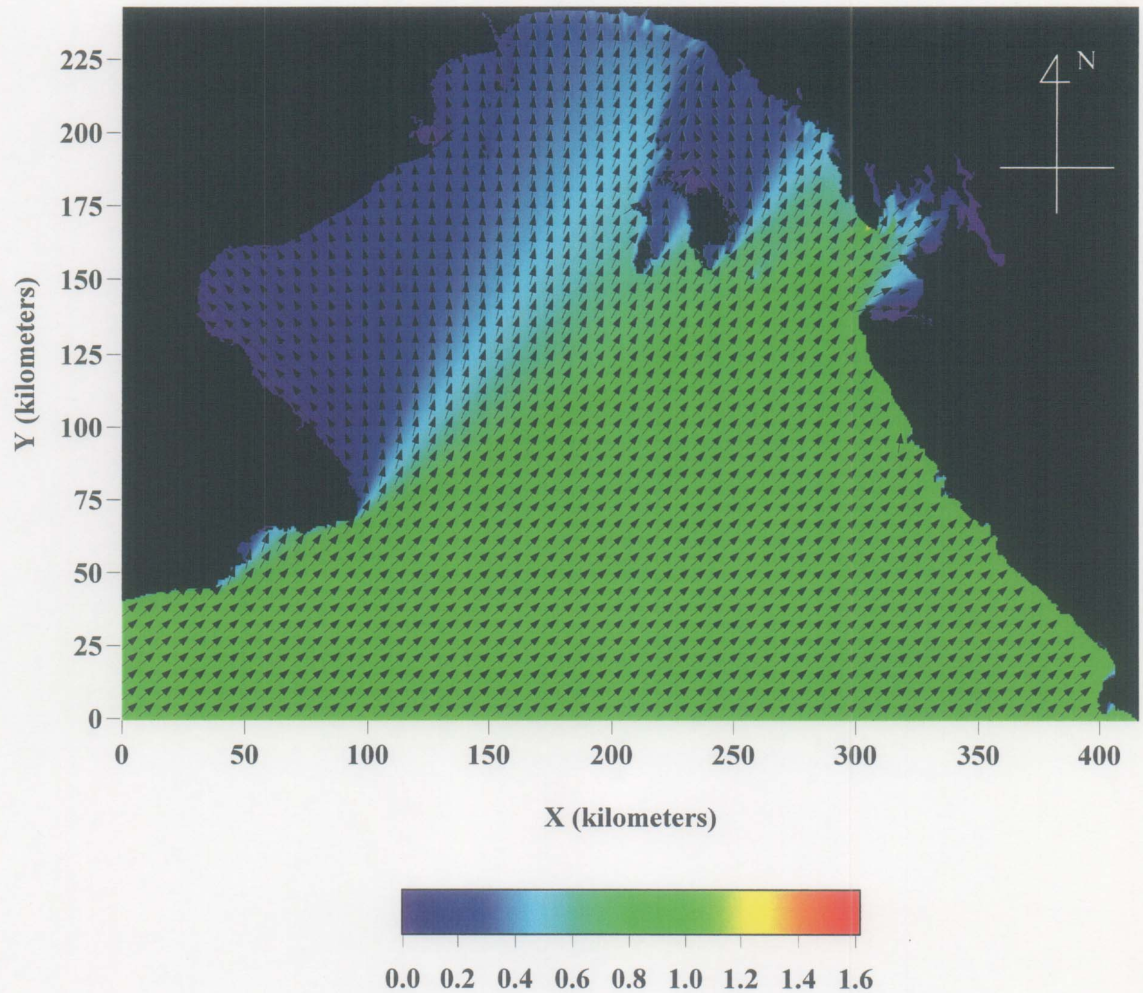


Figure A.2.2.6 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.01_7 ; 6-second-period-waves from 235 degrees)

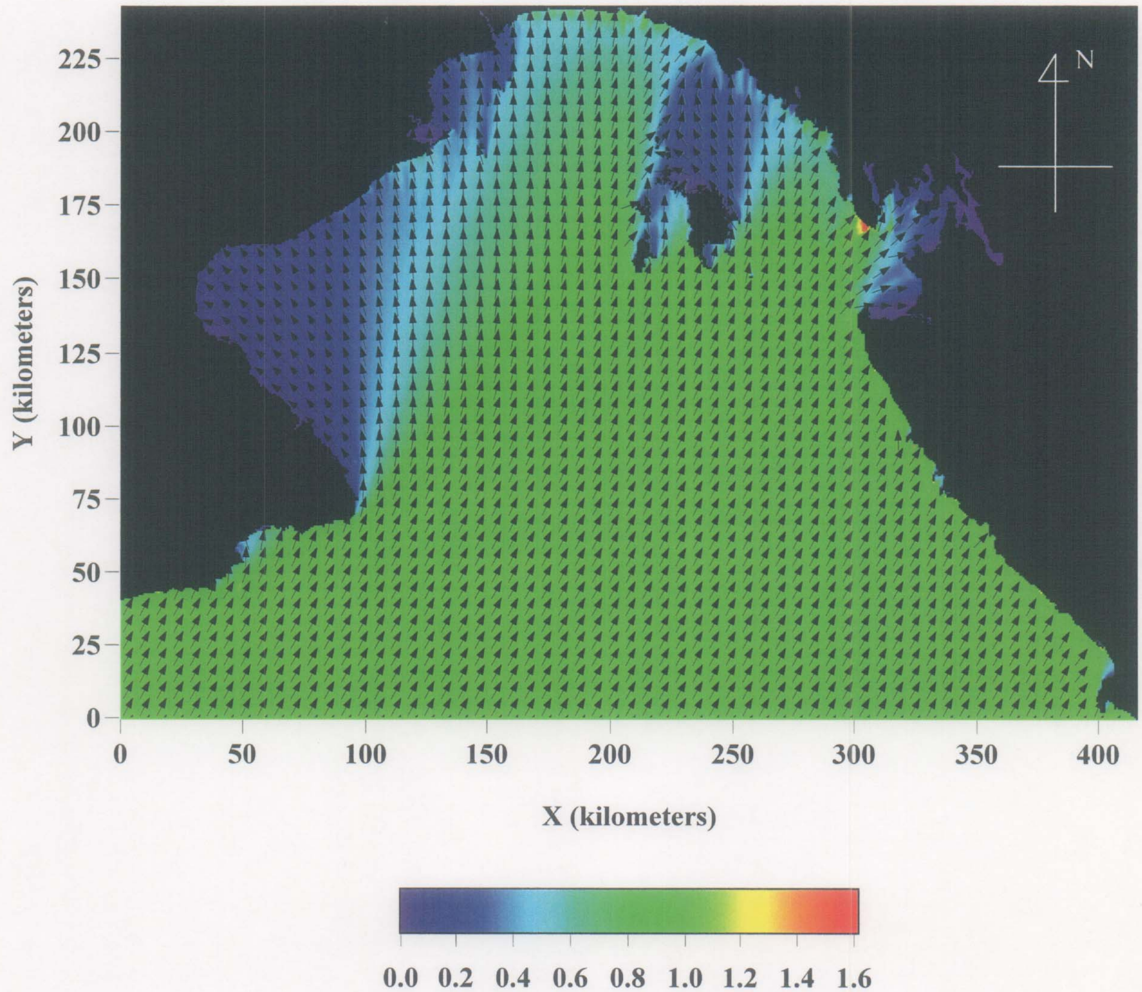


Figure A.2.2.7 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.02_2 ; 8-second-period-waves from 210 degrees)

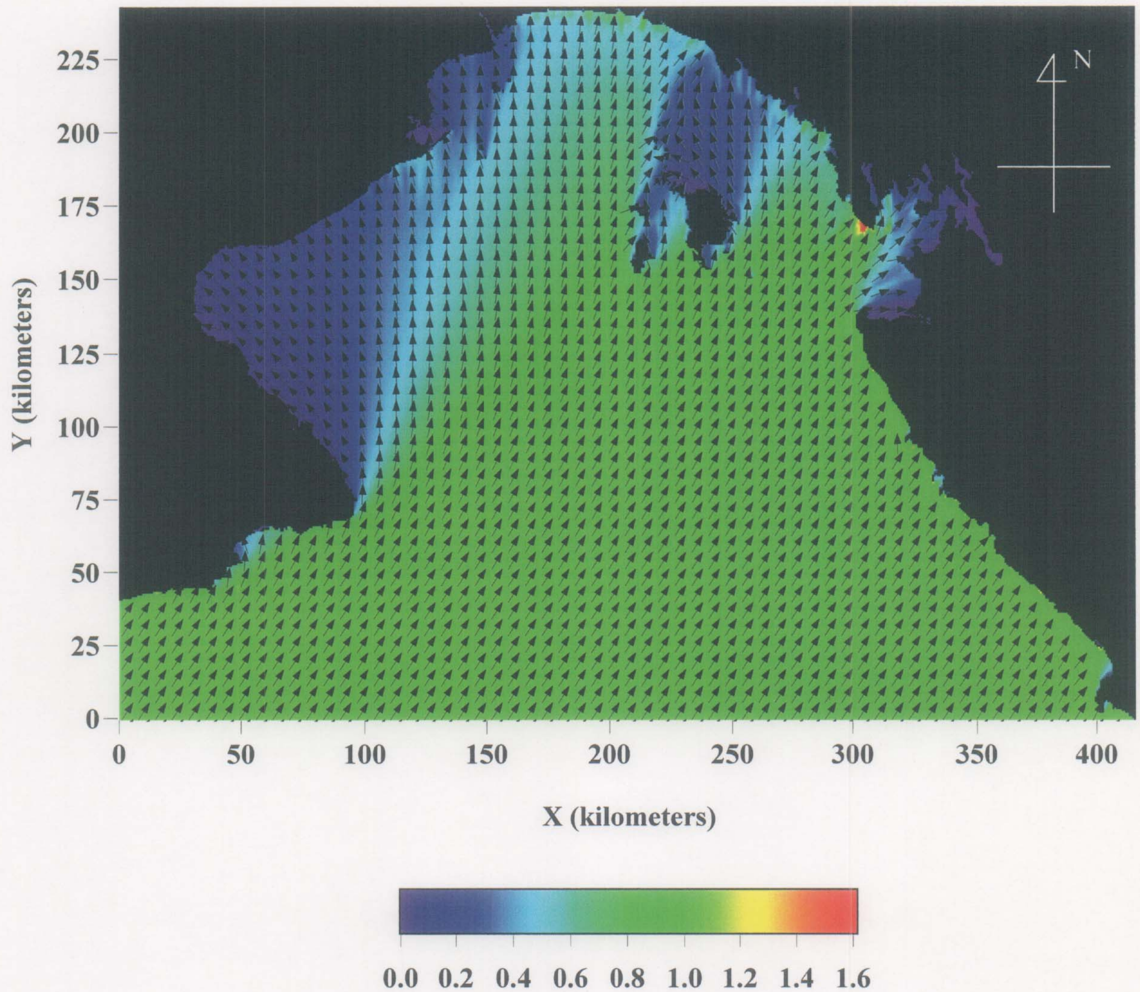


Figure A.2.2.8 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.02_3 ; 8-second-period-waves from 215 degrees)

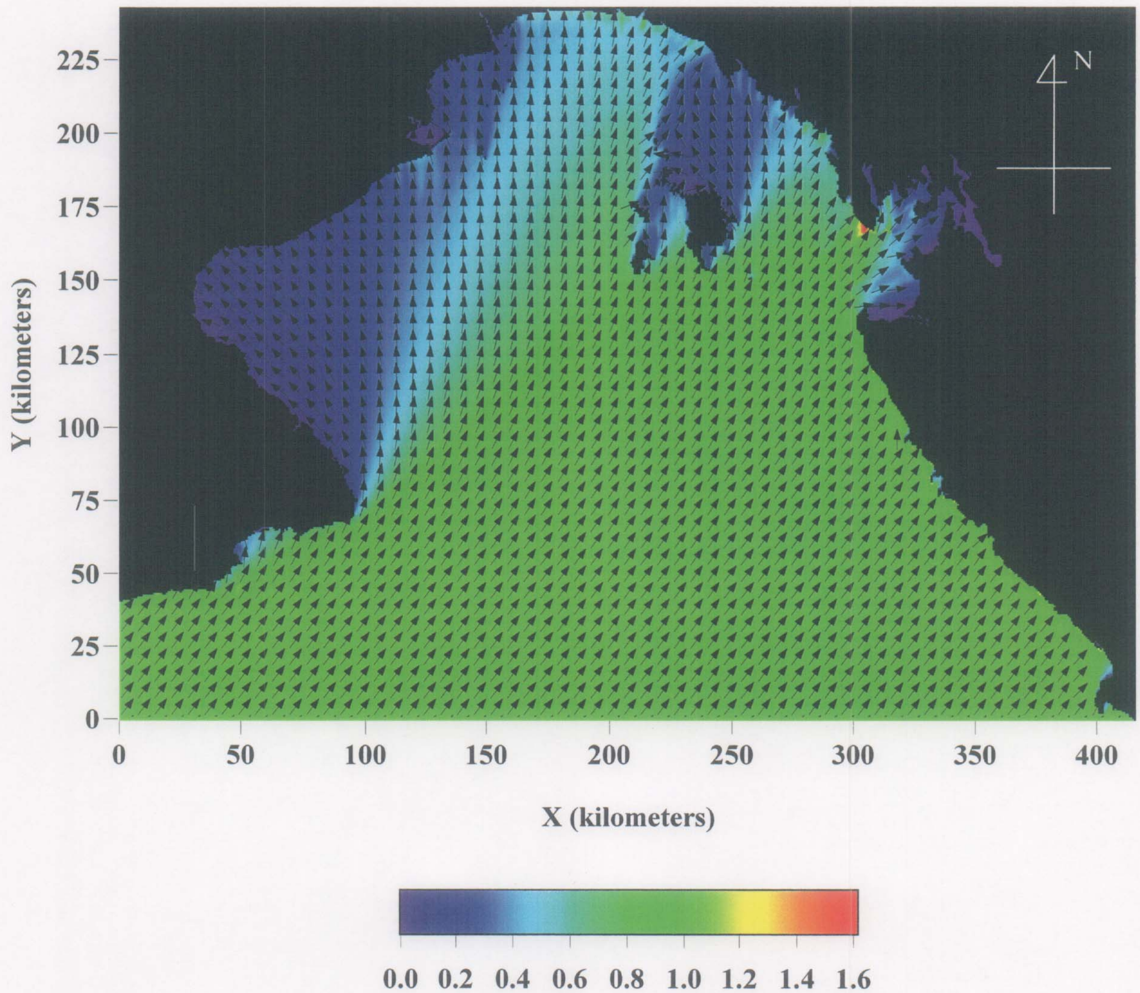


Figure A.2.2.9 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.02_4 ; 8-second-period-waves from 220 degrees)

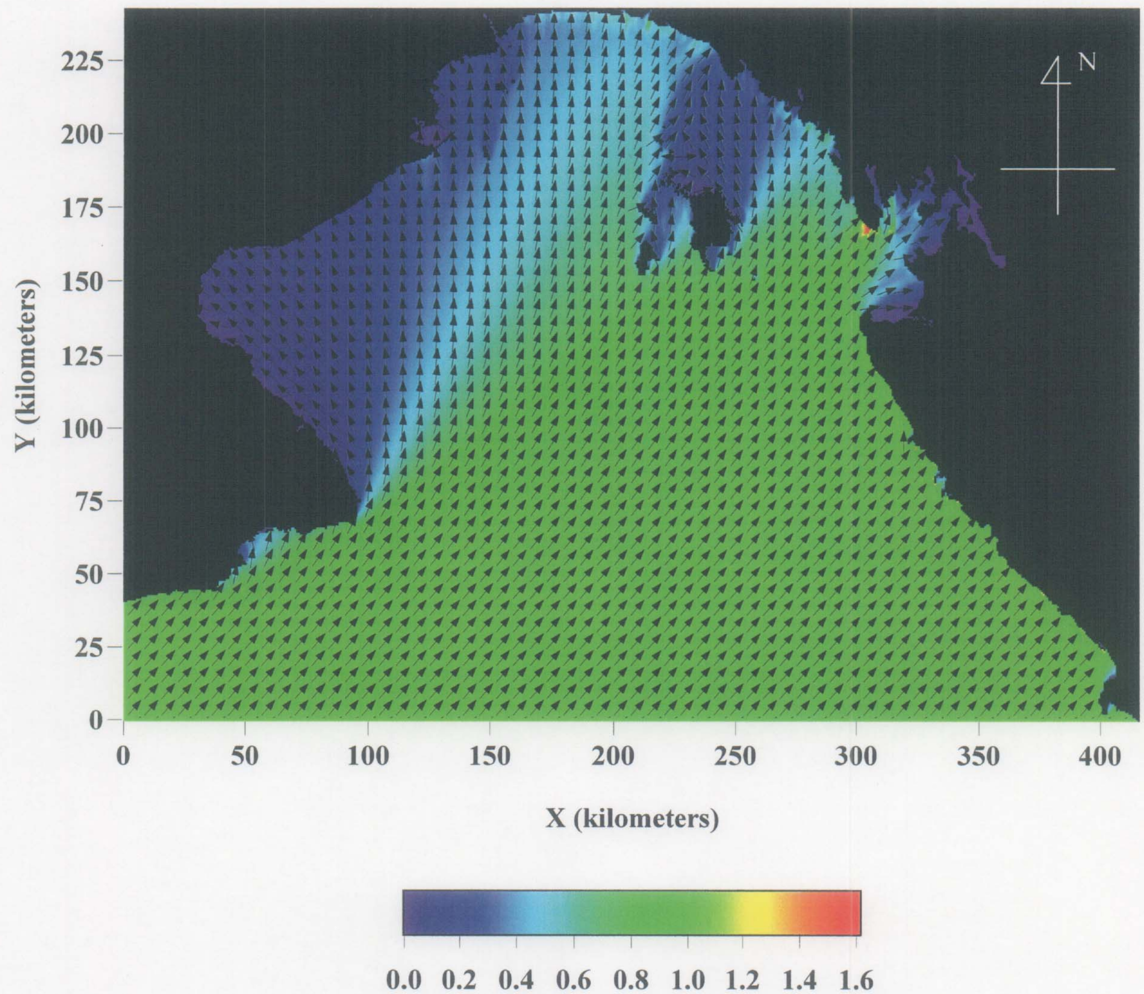


Figure A.2.2.10 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.02_5 ; 8-second-period-waves from 225 degrees)

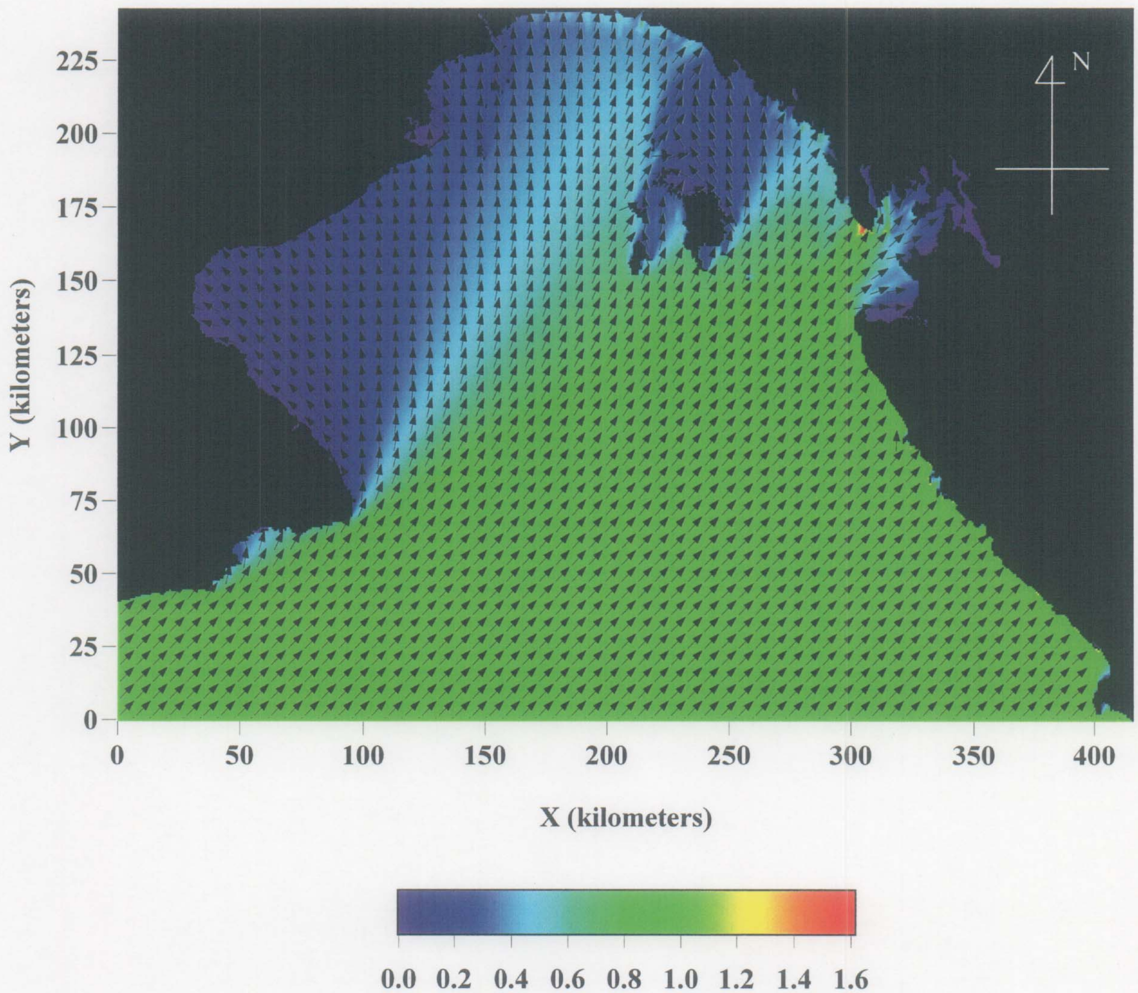


Figure A.2.2.11 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.02_6 ; 8-second-period-waves from 230 degrees)

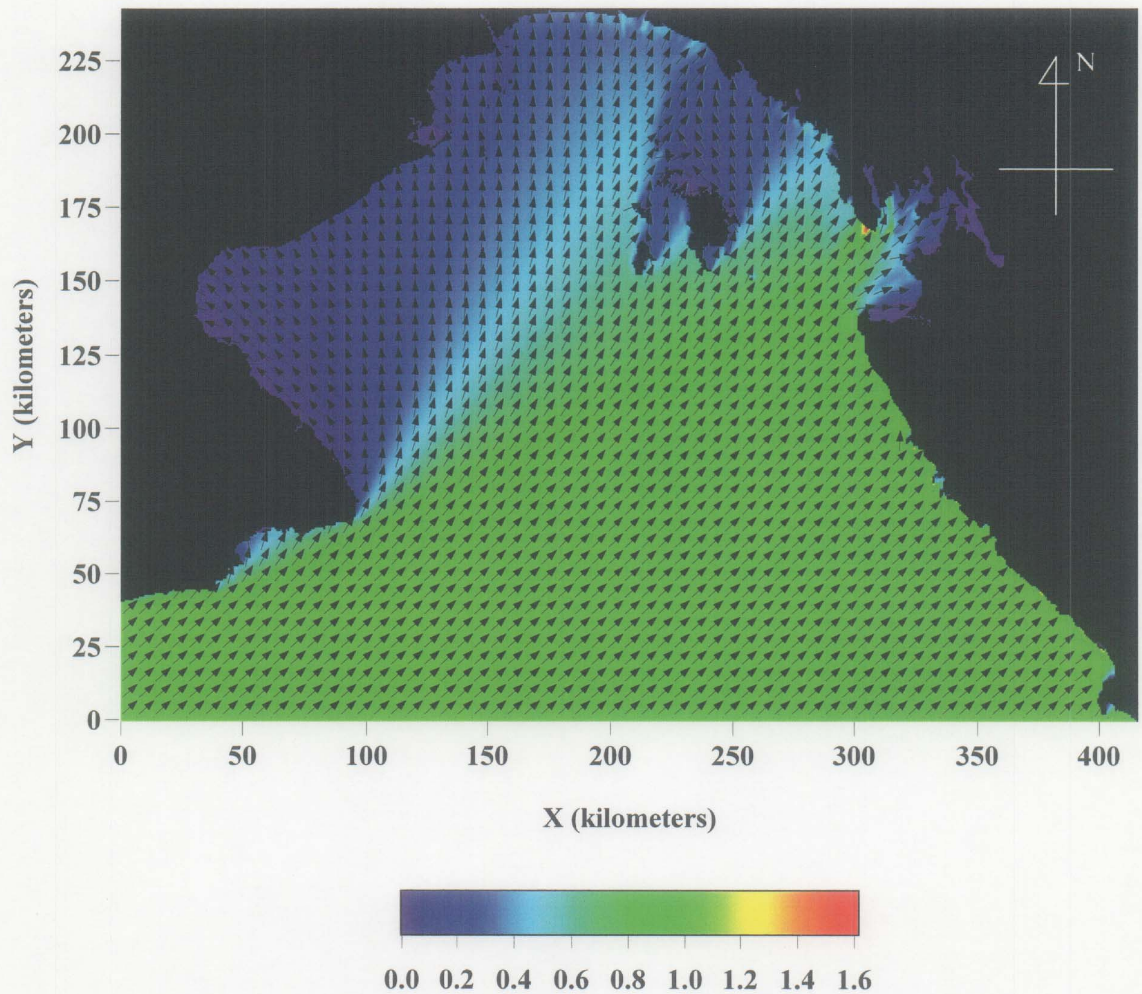


Figure A.2.2.12 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.02_7 ; 8-second-period-waves from 235 degrees)

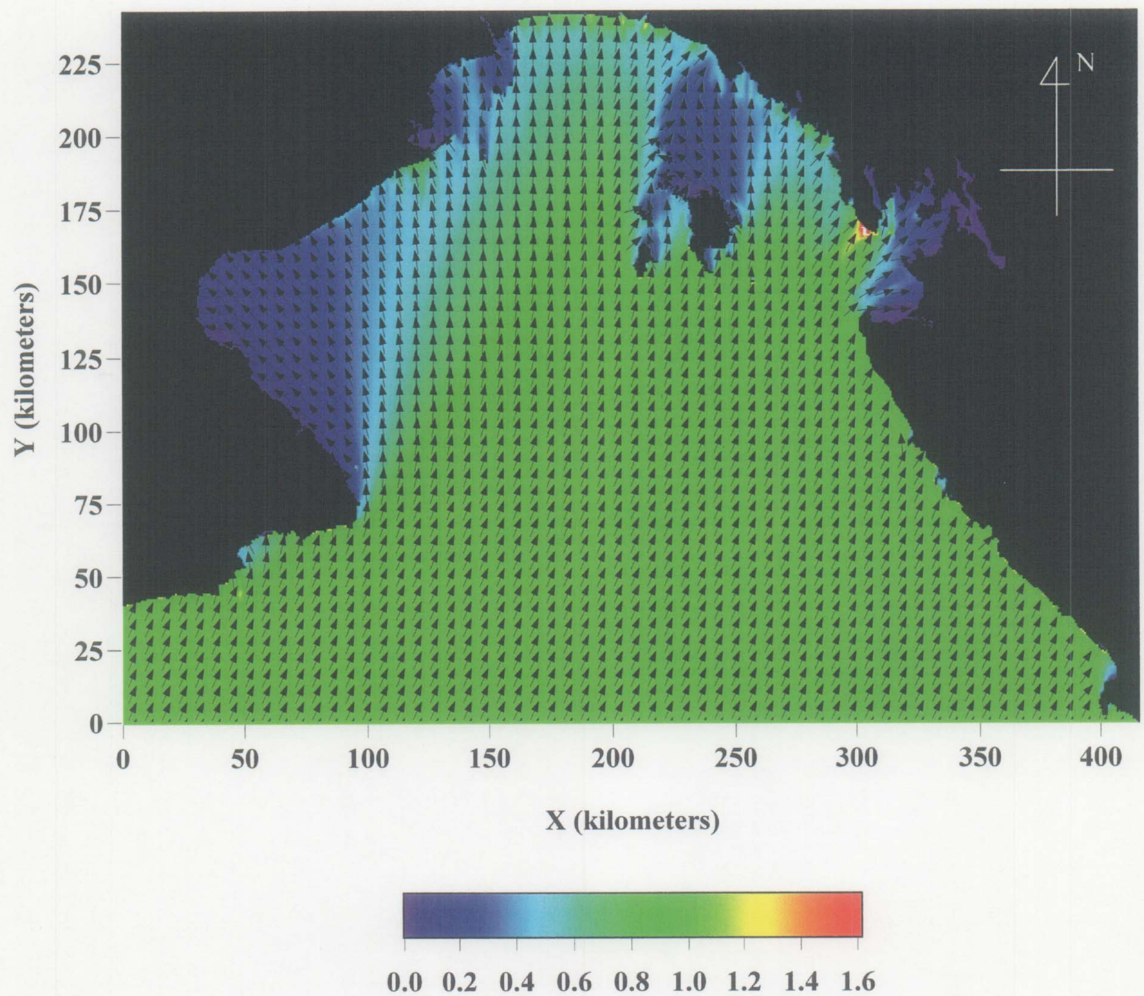


Figure A.2.2.13 Ratio of Wave Height and Mean Wave Directions（Regional Model）

（In the case.03_1 ; 10-second-period-waves from 205 degrees）

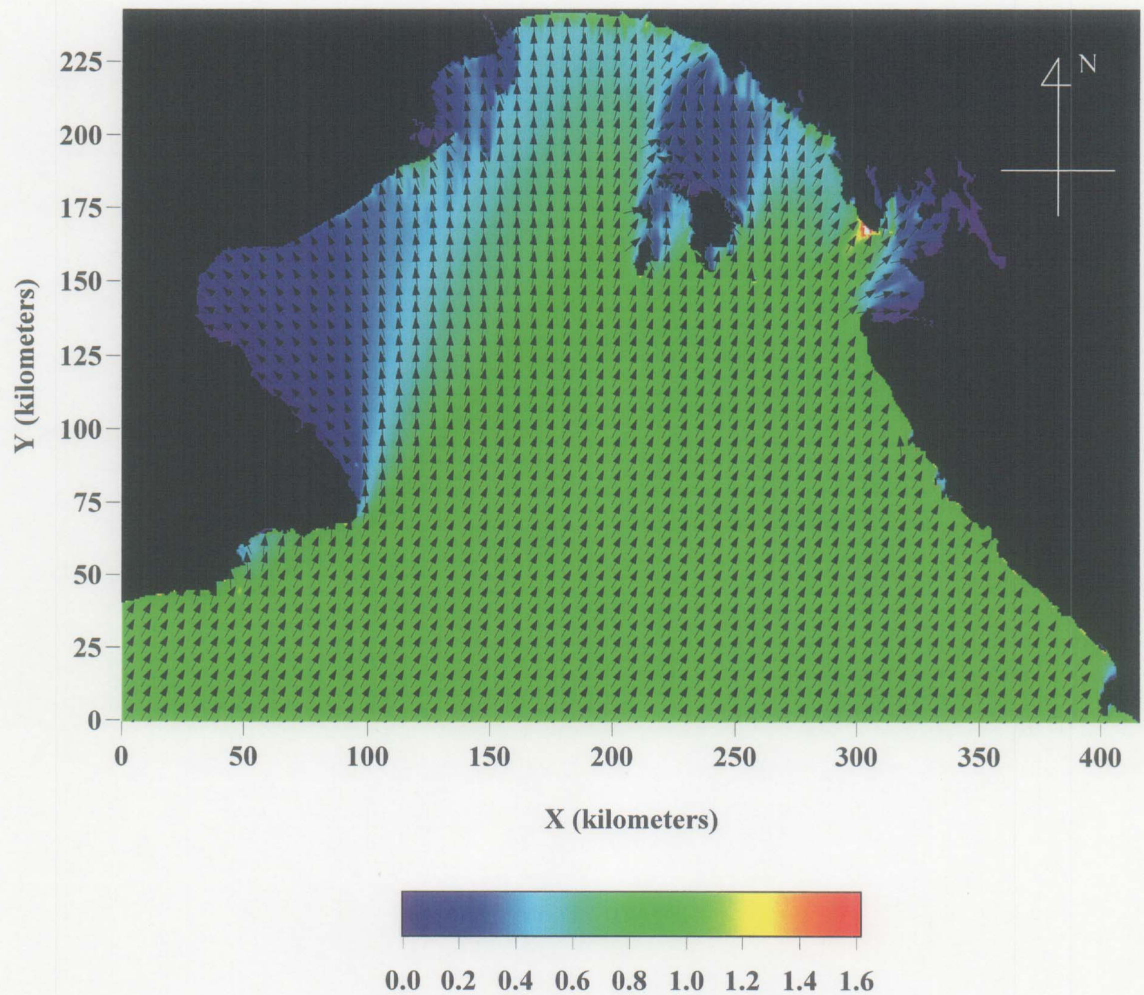


Figure A.2.2.14 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.03_2 ; 10-second-period-waves from 210 degrees)

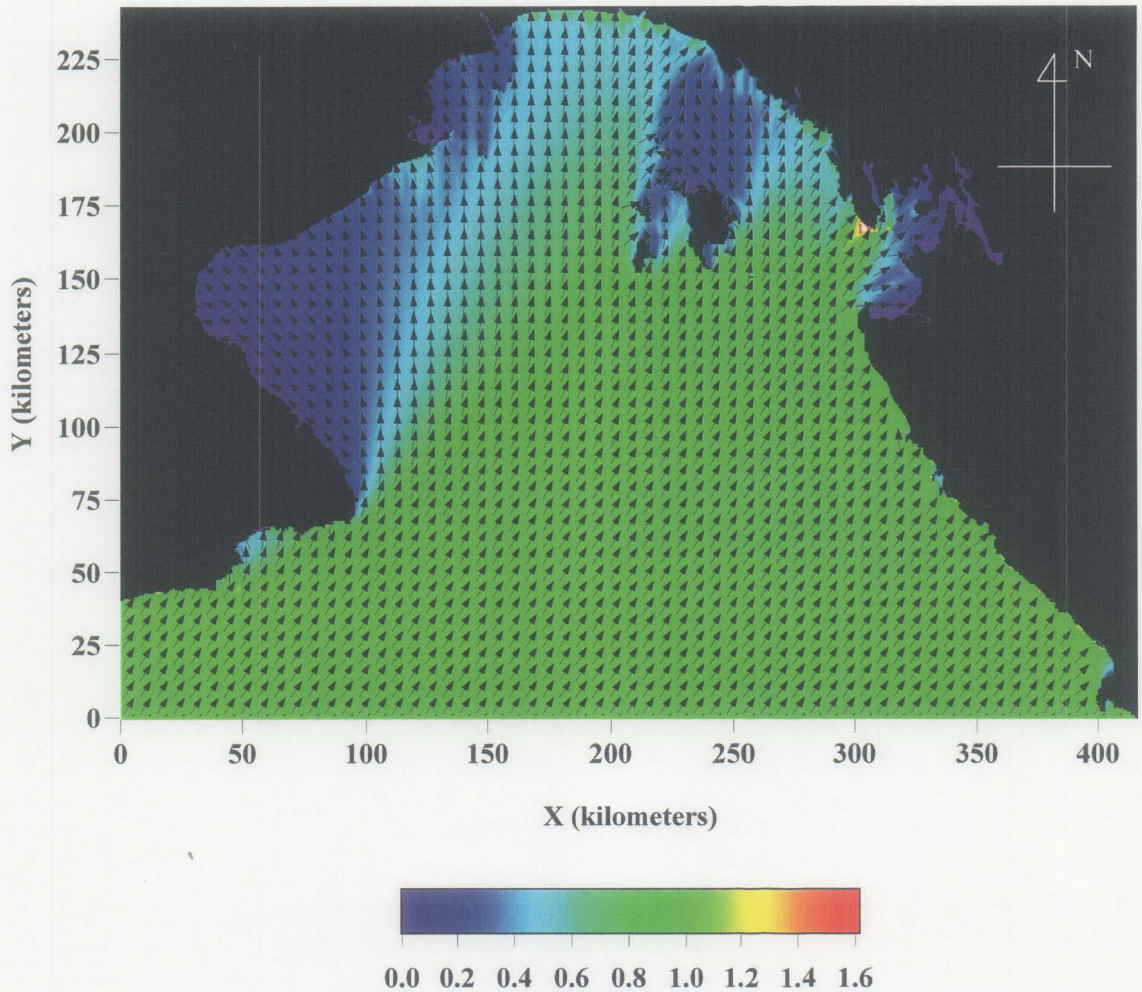


Figure A.2.2.15 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.03_3 ; 10-second-period-waves from 215 degrees)

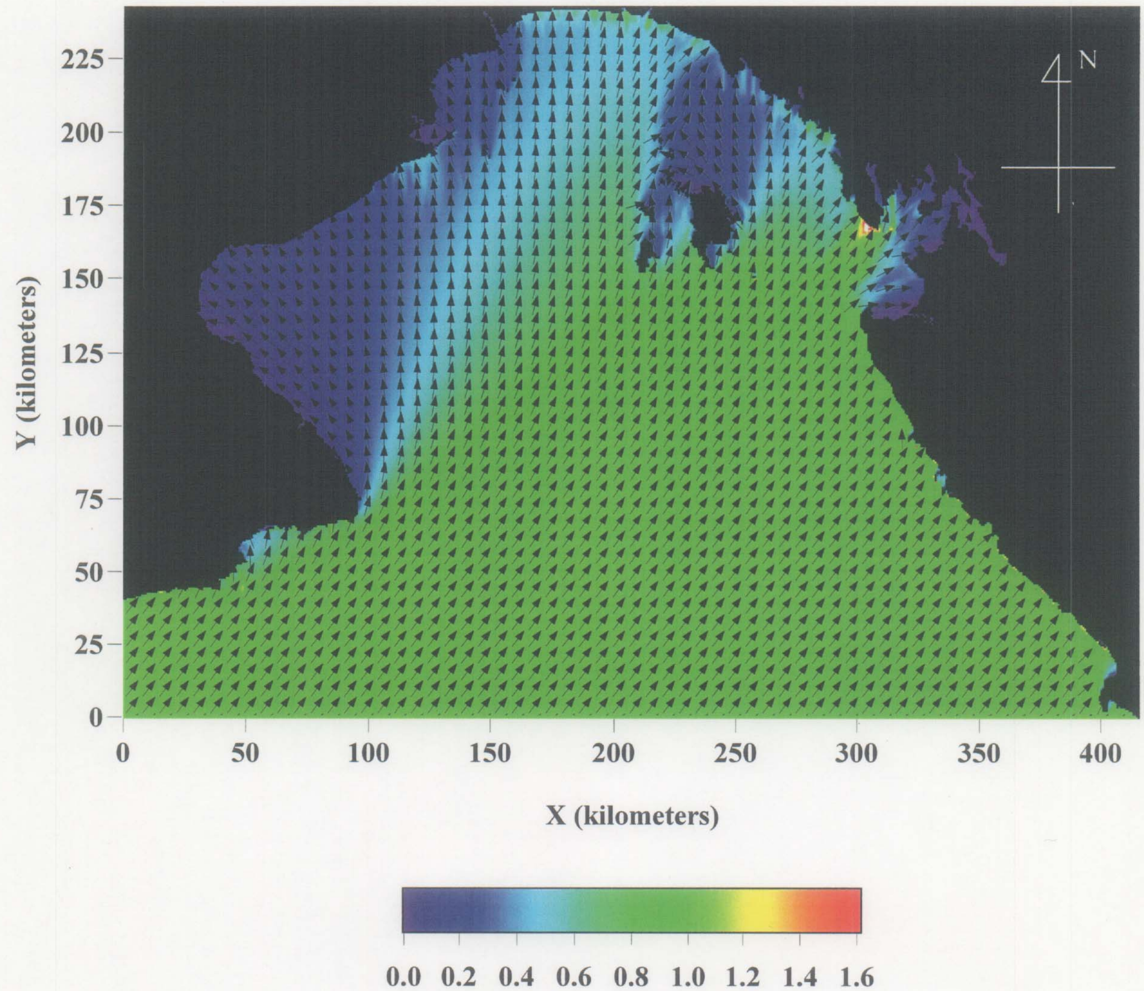


Figure A.2.2.16 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.03_4 ; 10-second-period-waves from 220 degrees)

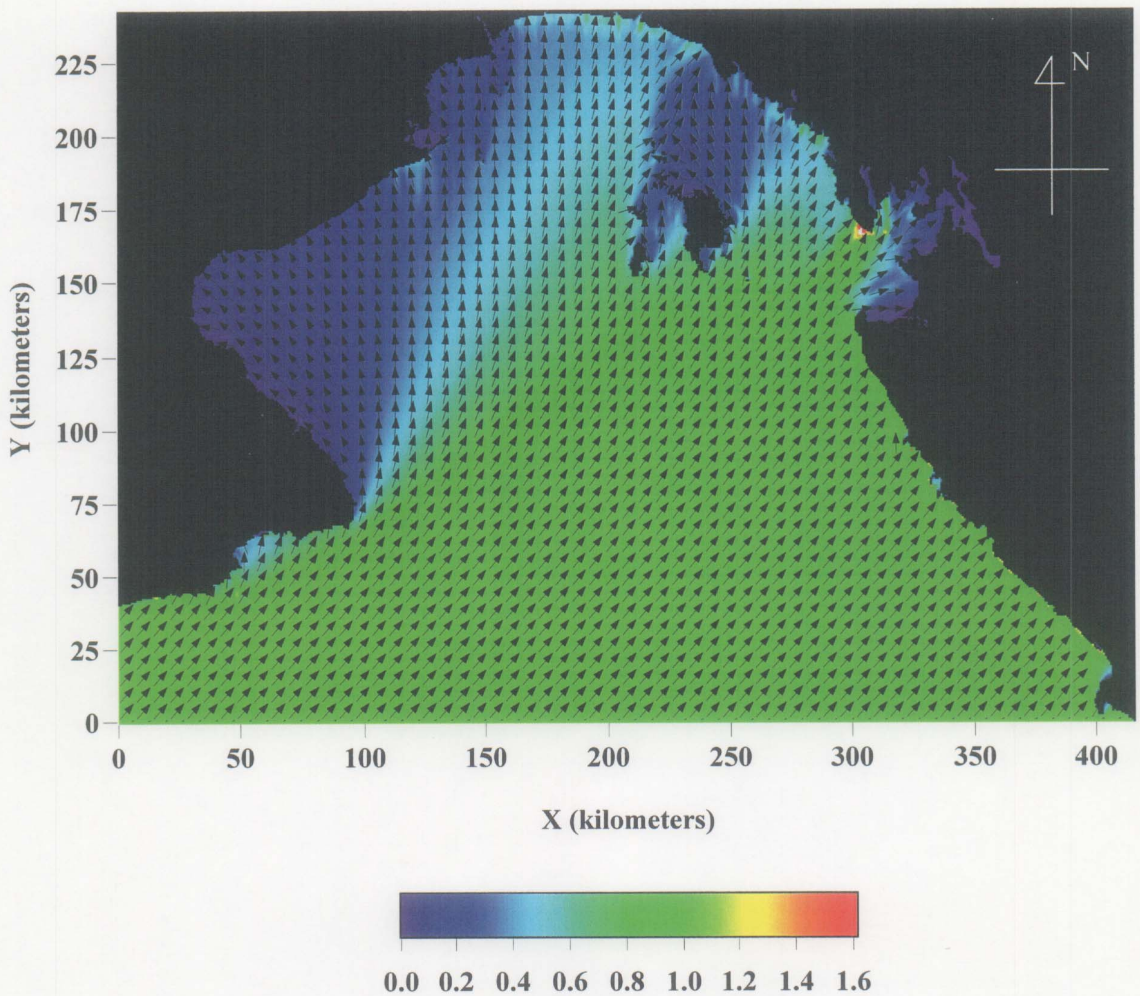


Figure A.2.2.17 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.03_5 ; 10-second-period-waves from 225 degrees)

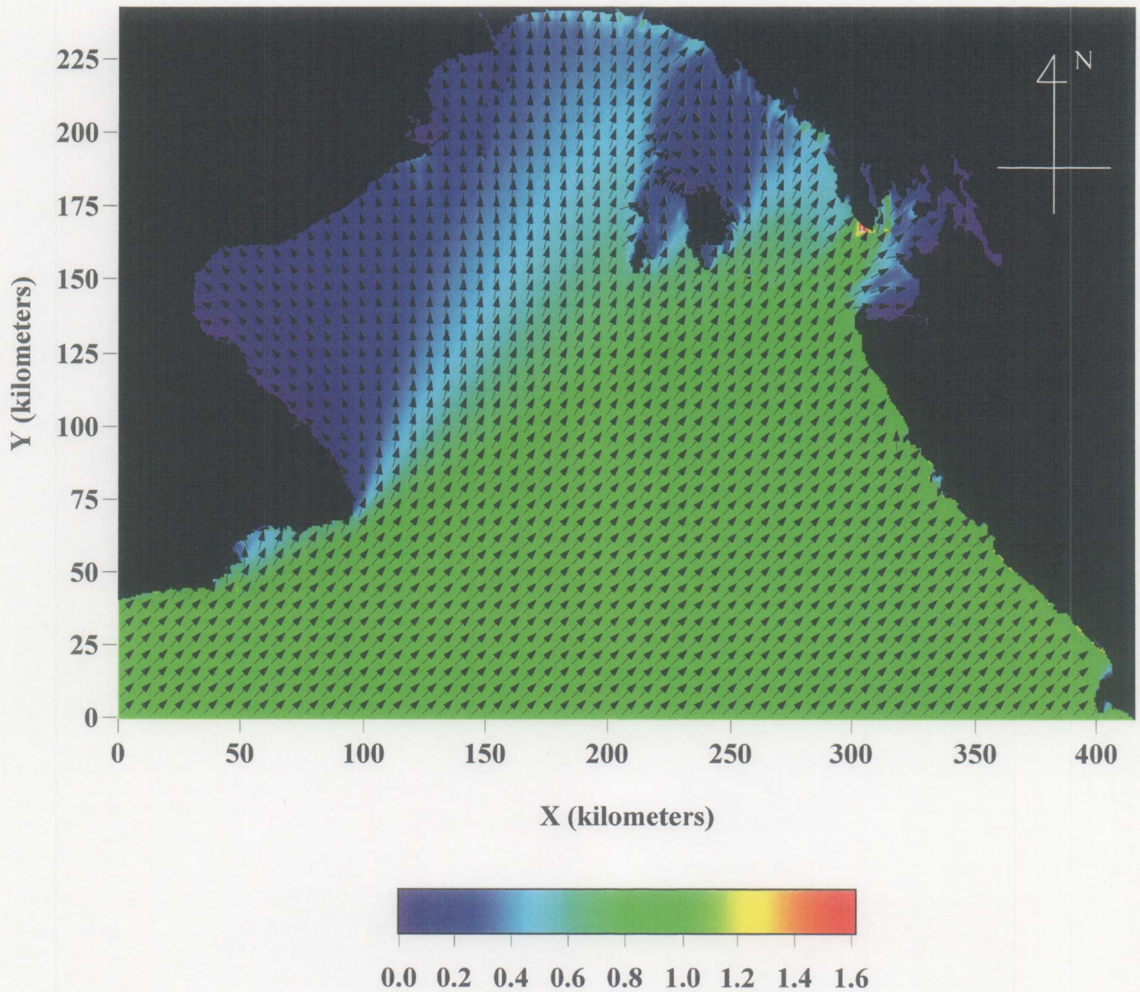


Figure A.2.2.18 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.03_6 ; 10-second-period-waves from 230 degrees)

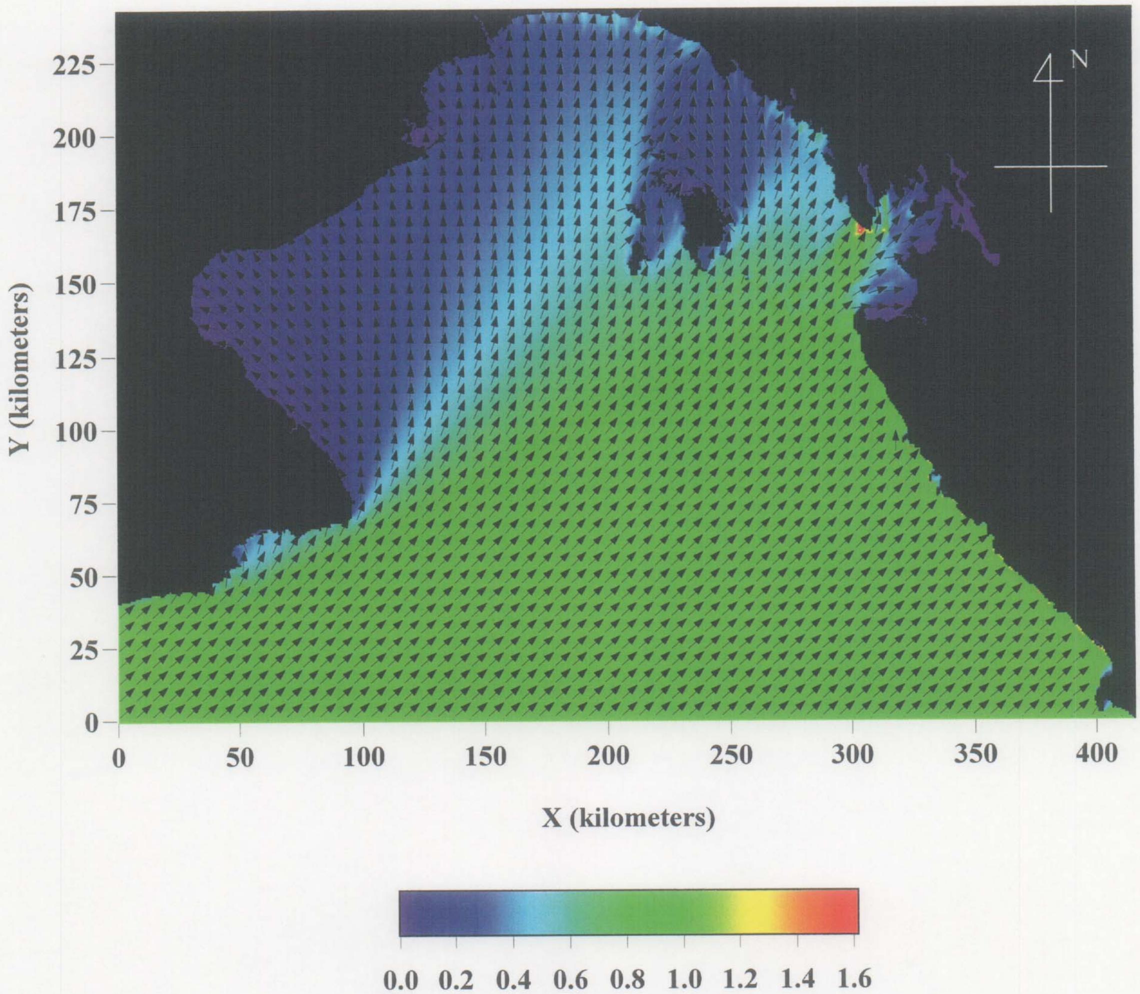


Figure A.2.2.19 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.03_7 ; 10-second-period-waves from 235 degrees)

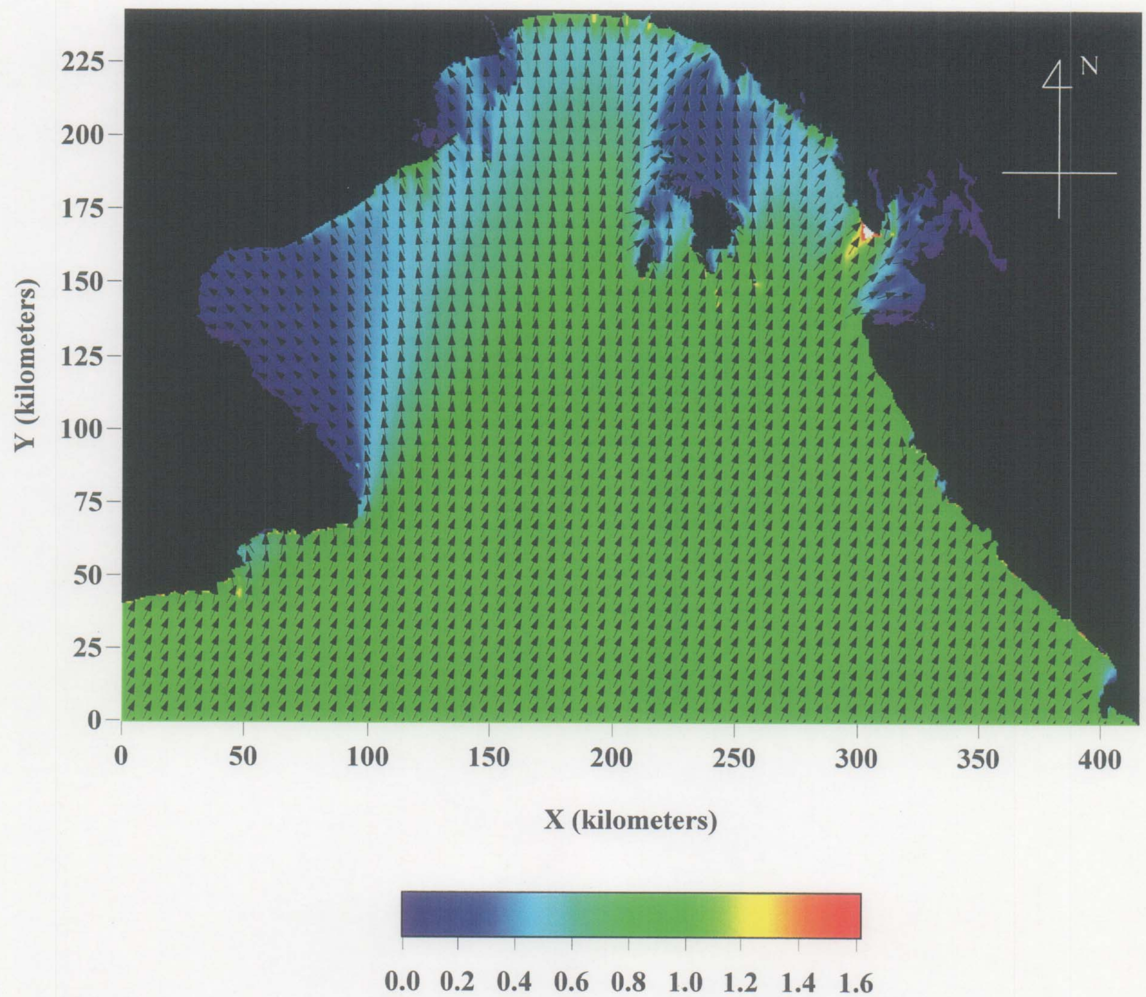


Figure A.2.2.20 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.04_1 ; 12-second-period-waves from 205 degrees)

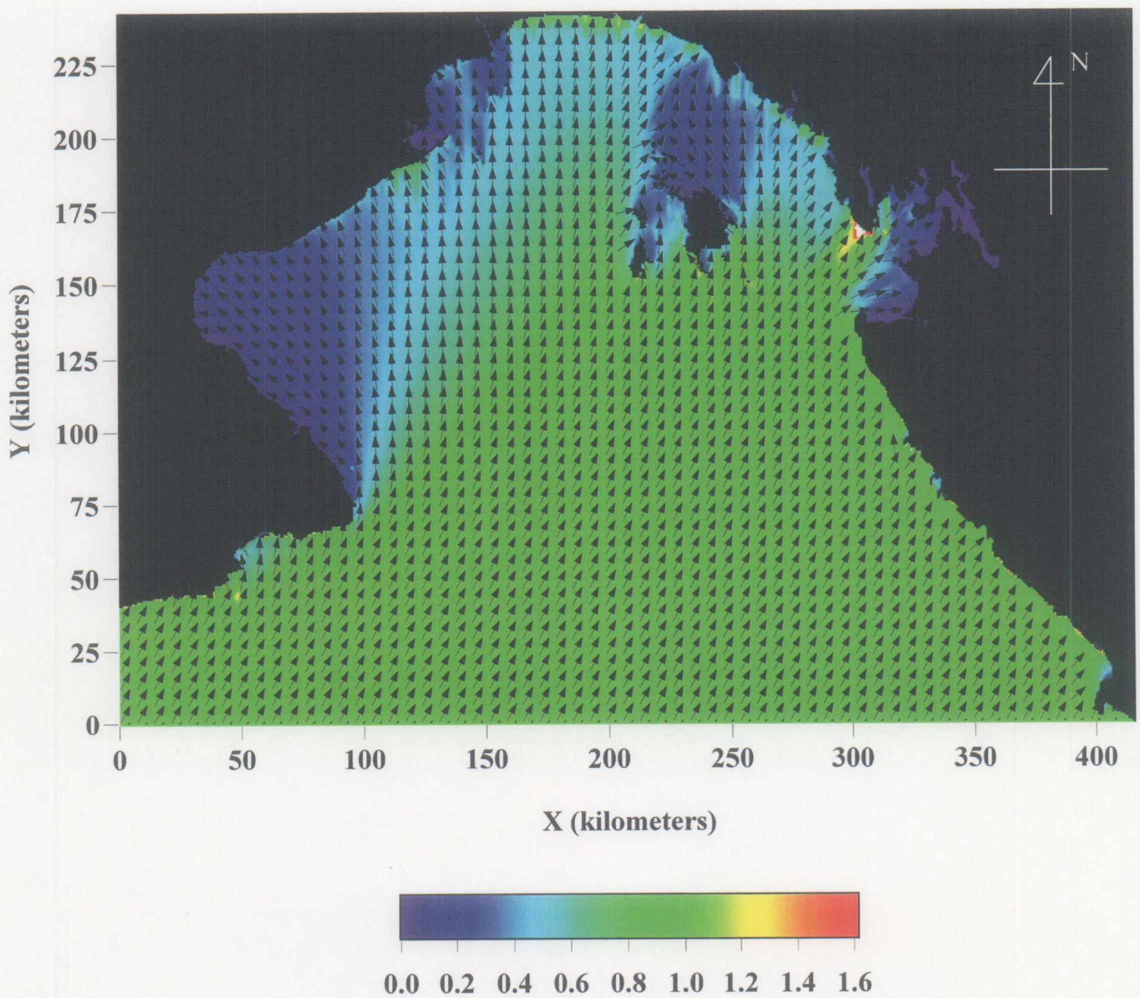


Figure A.2.2.21 Ratio of Wave Height and Mean Wave Directions（Regional Model）

（In the case.04_2 ; 12-second-period-waves from 210 degrees）

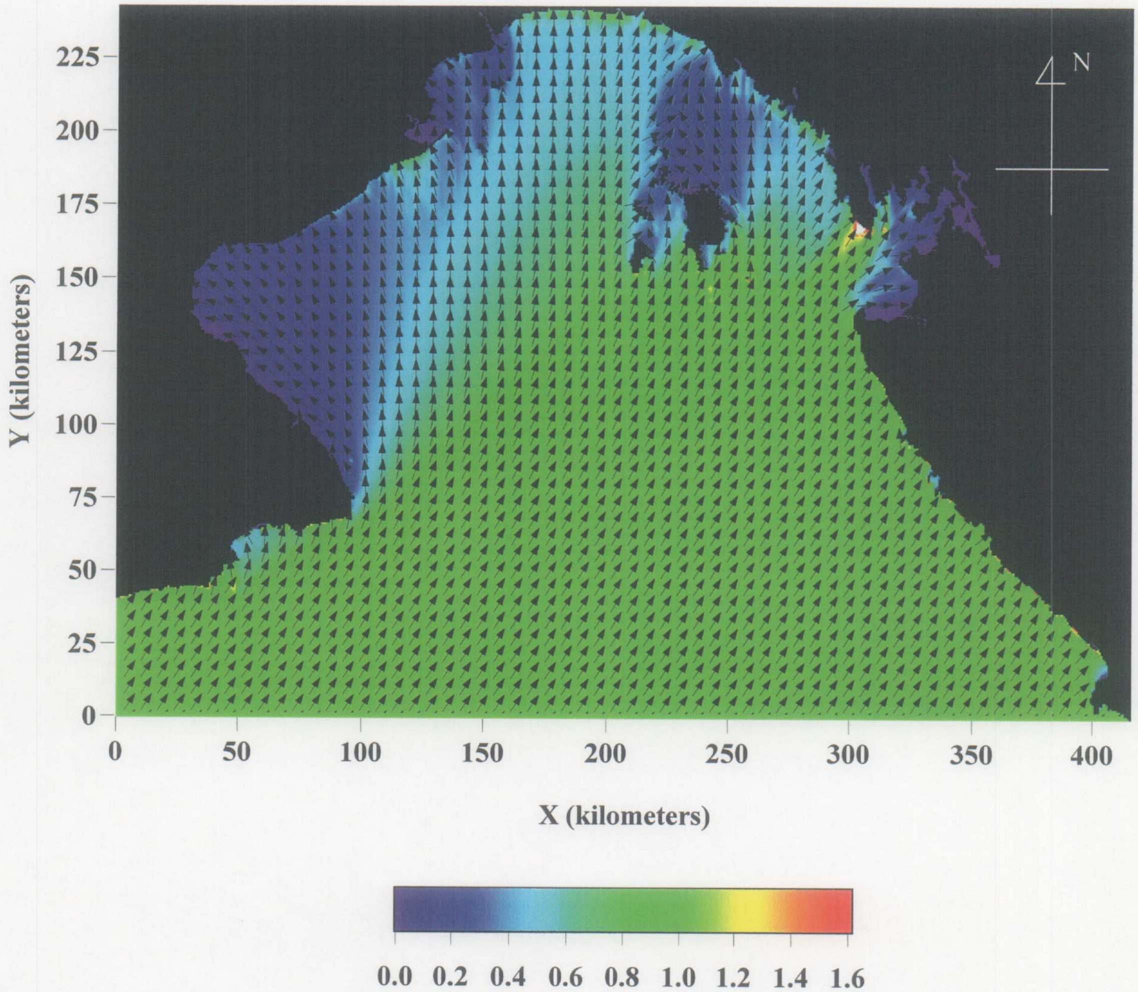


Figure A.2.2.22 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.04_3 ; 12-second-period-waves from 215 degrees)

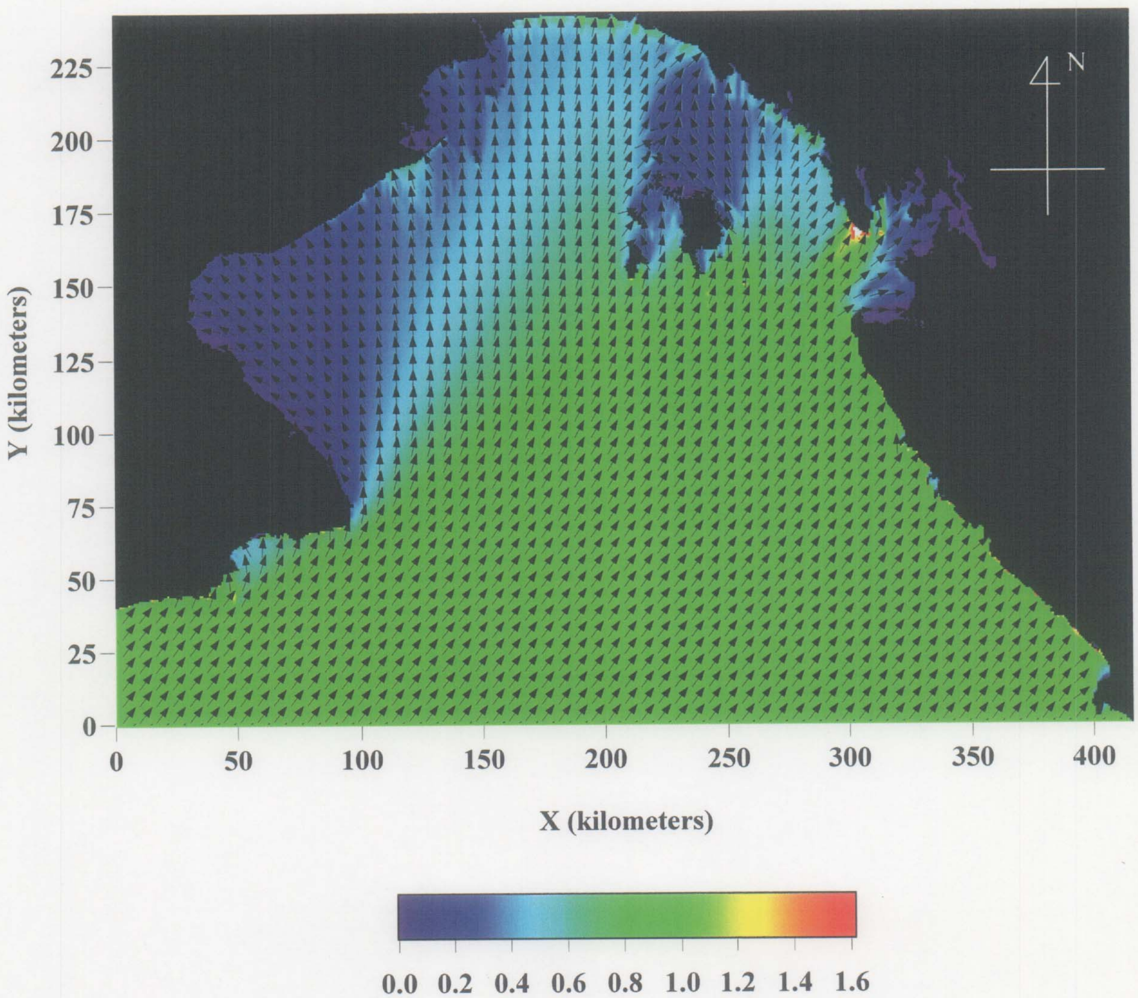


Figure A.2.2.23 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.04_4 ; 12-second-period-waves from 220 degrees)

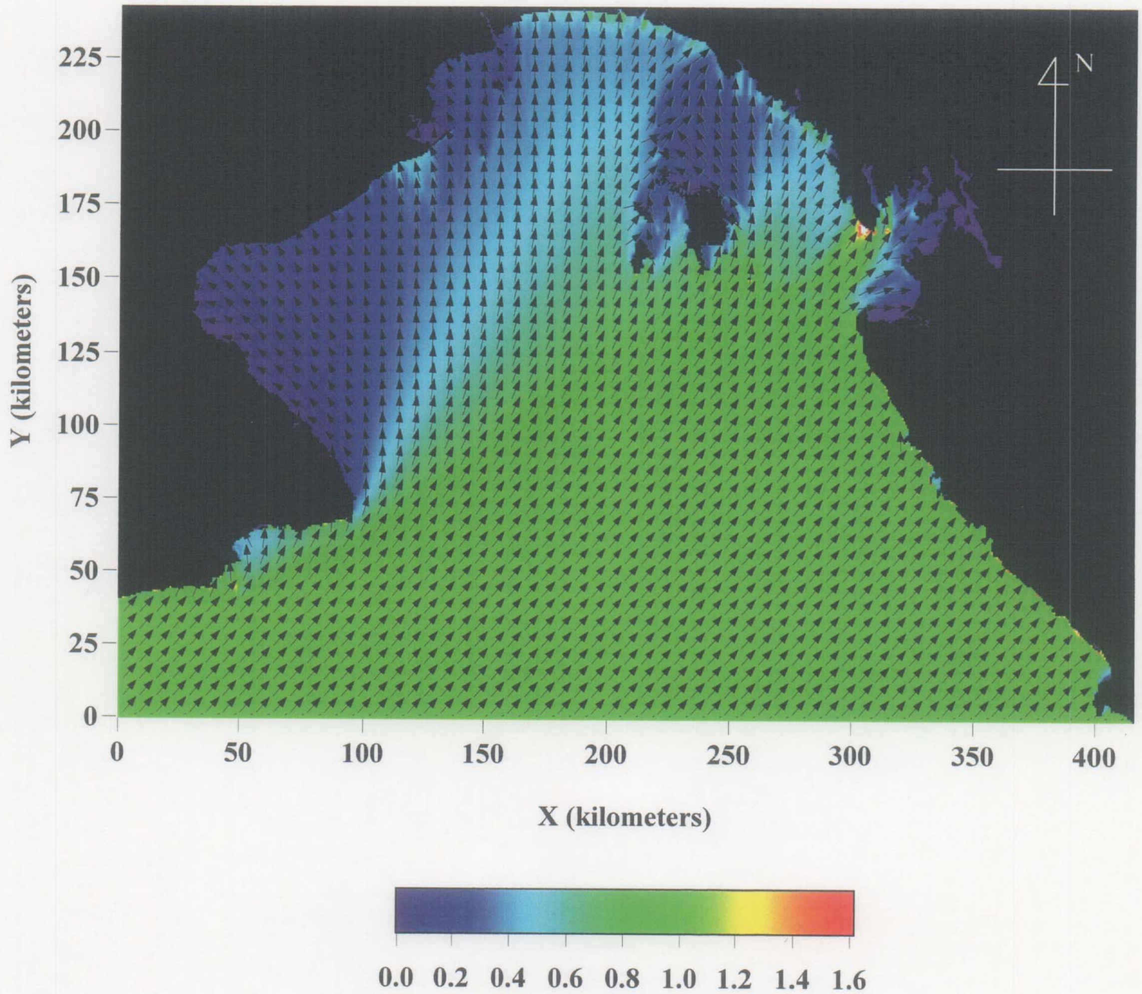


Figure A.2.2.24 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.04_5 ; 12-second-period-waves from 225 degrees)

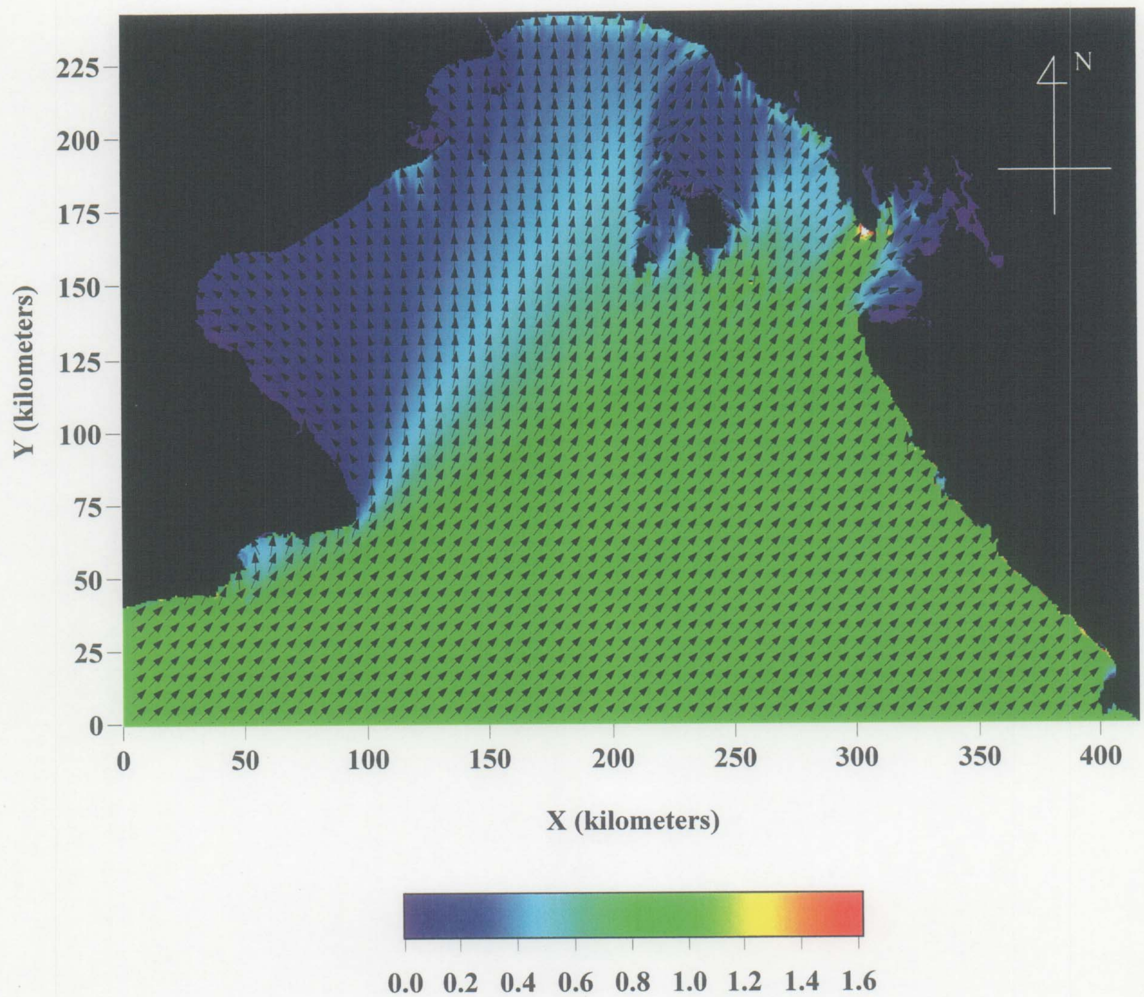


Figure A.2.2.25 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.04_6 ; 12-second-period-waves from 230 degrees)

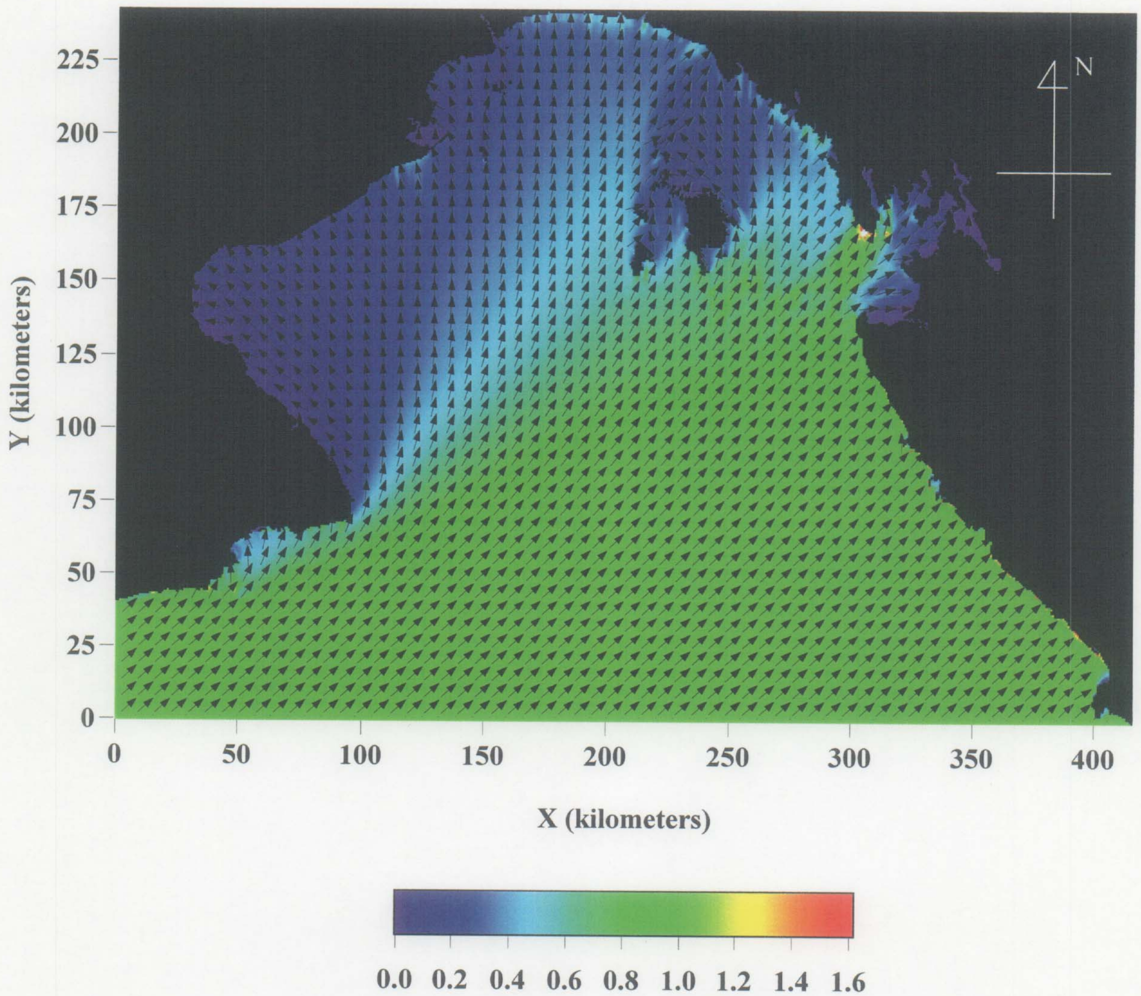


Figure A.2.2.26 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.04_7 ; 12-second-period-waves from 235 degrees)

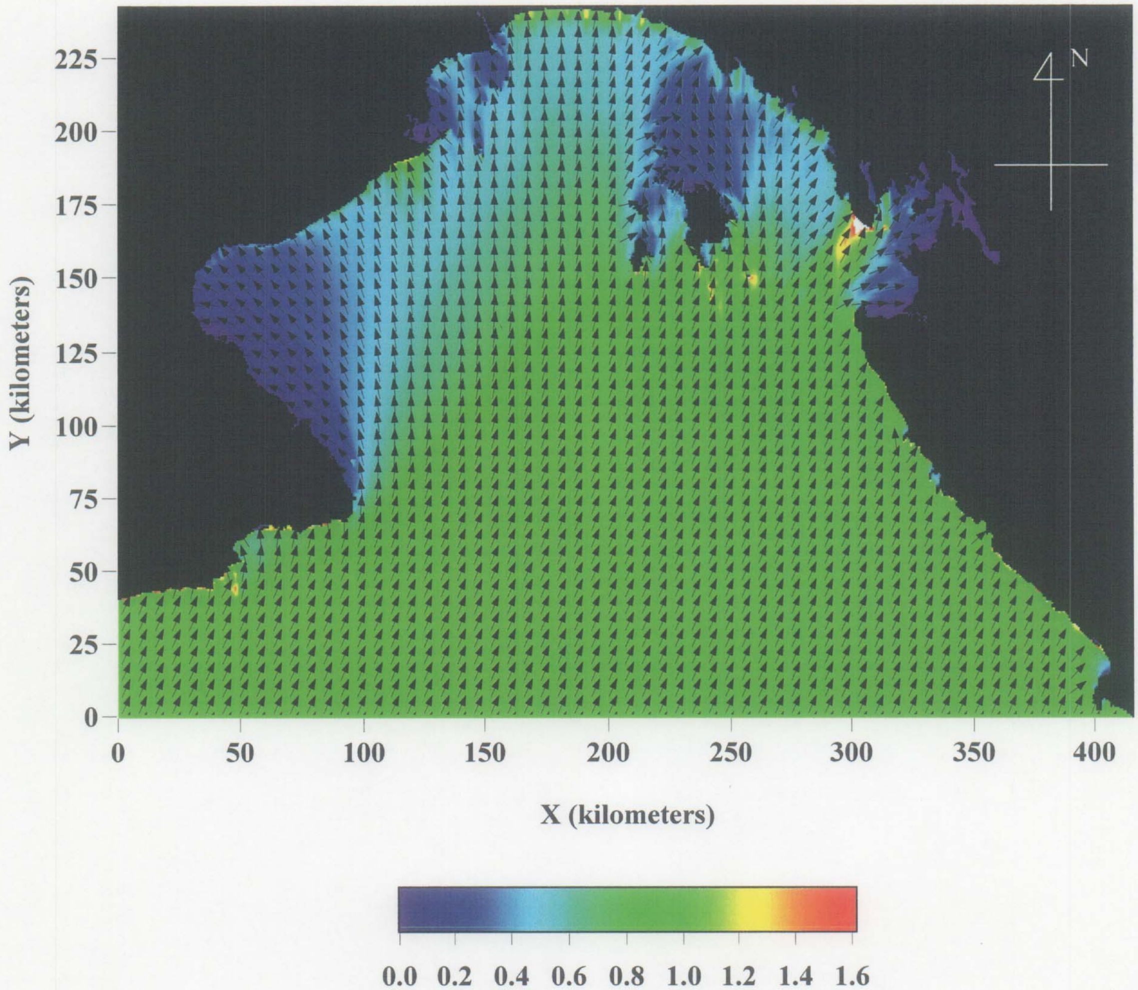


Figure A.2.2.27 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.05_1 ; 14-second-period-waves from 205 degrees)

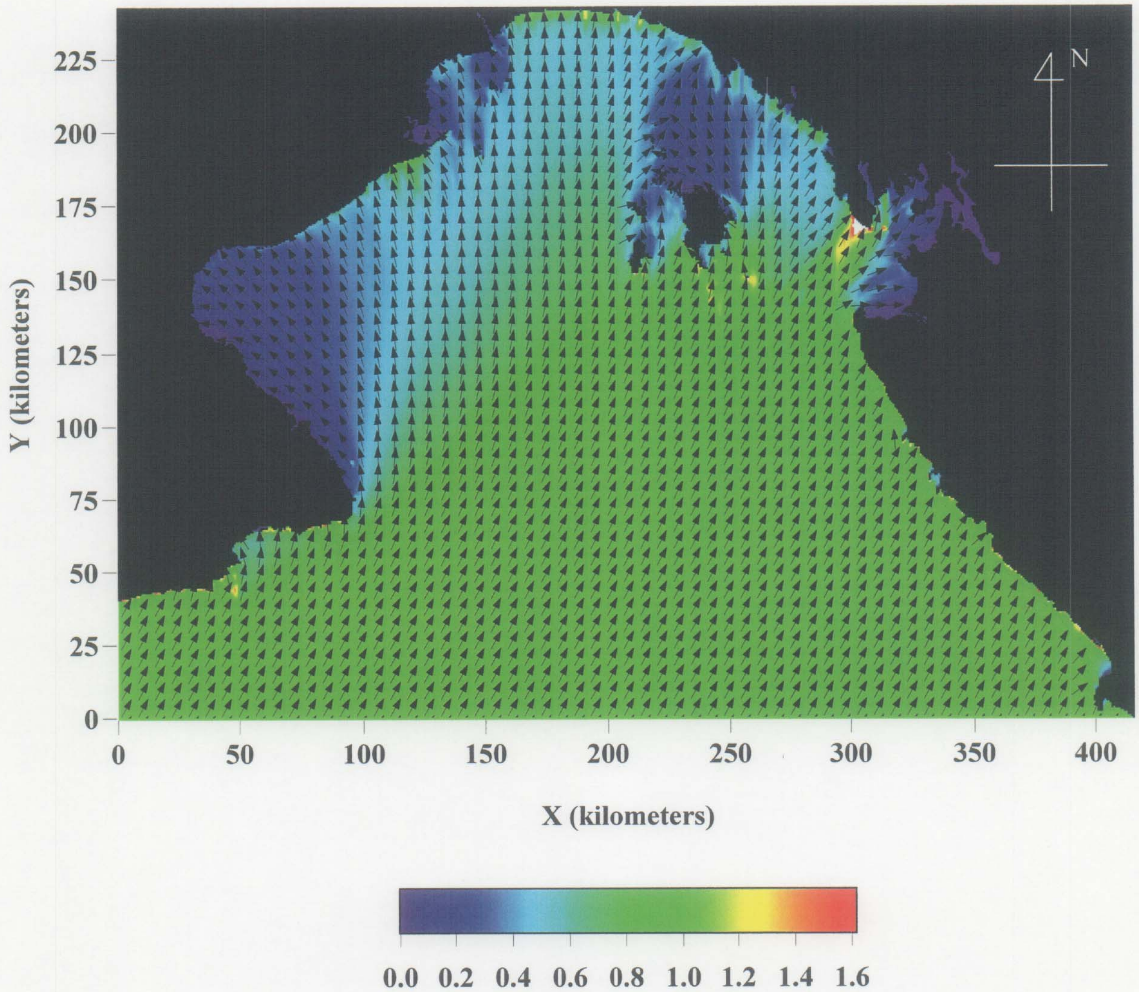


Figure A.2.2.28 Ratio of Wave Height and Mean Wave Directions（Regional Model）

（In the case.05_2 ; 14-second-period-waves from 210 degrees）

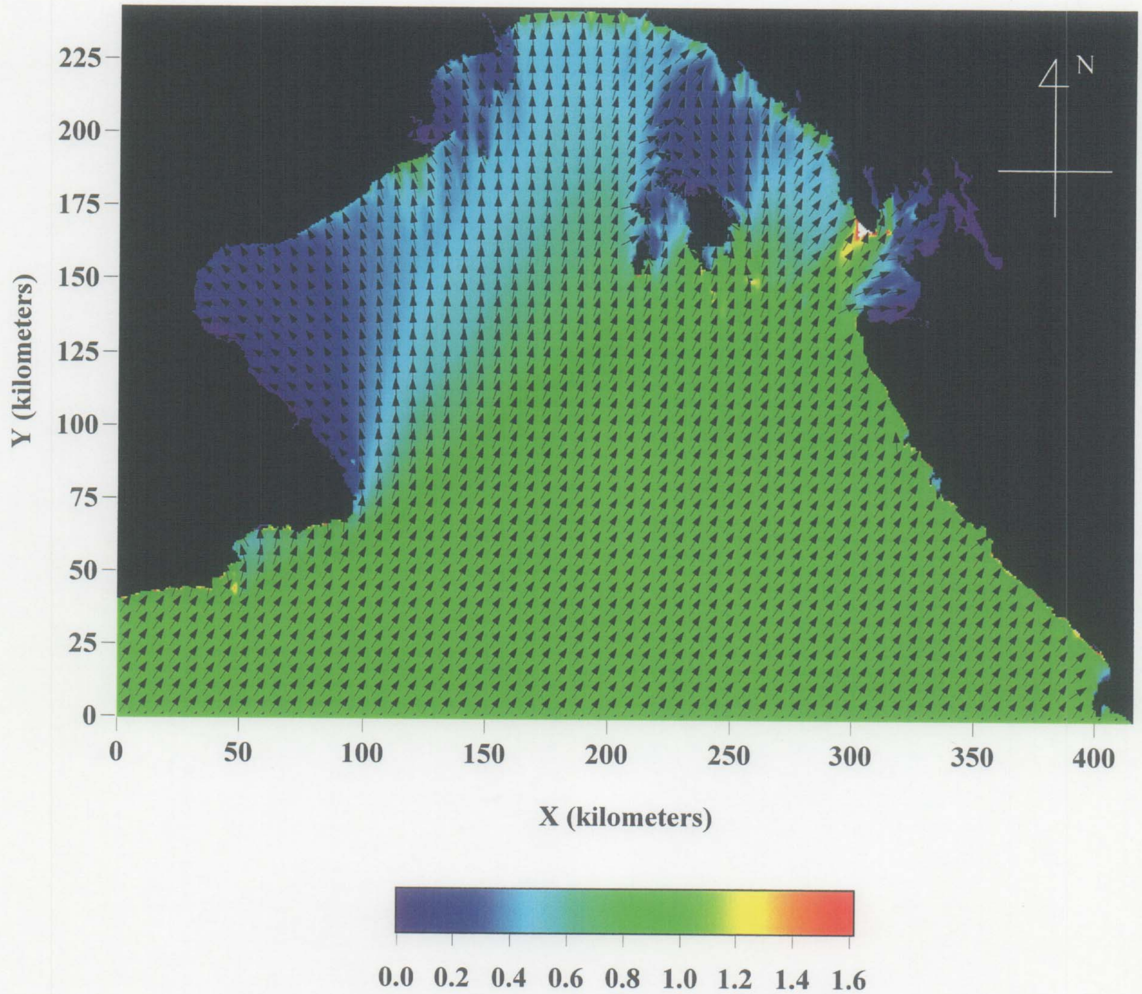


Figure A.2.2.29 Ratio of Wave Height and Mean Wave Directions (Regional Model)
(In the case.05_3 ; 14-second-period-waves from 215 degrees)

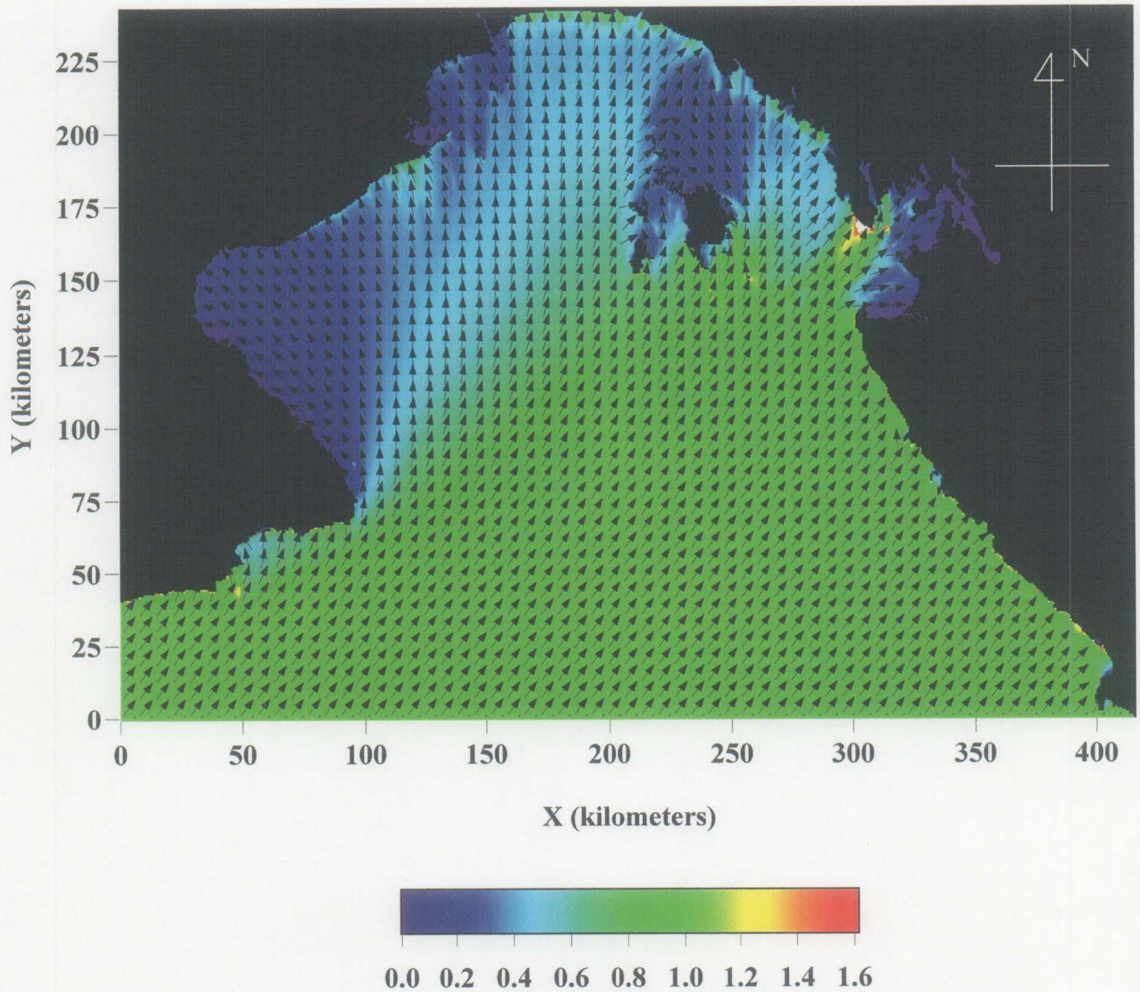


Figure A.2.2.30 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.05_4 ; 14-second-period-waves from 220 degrees)

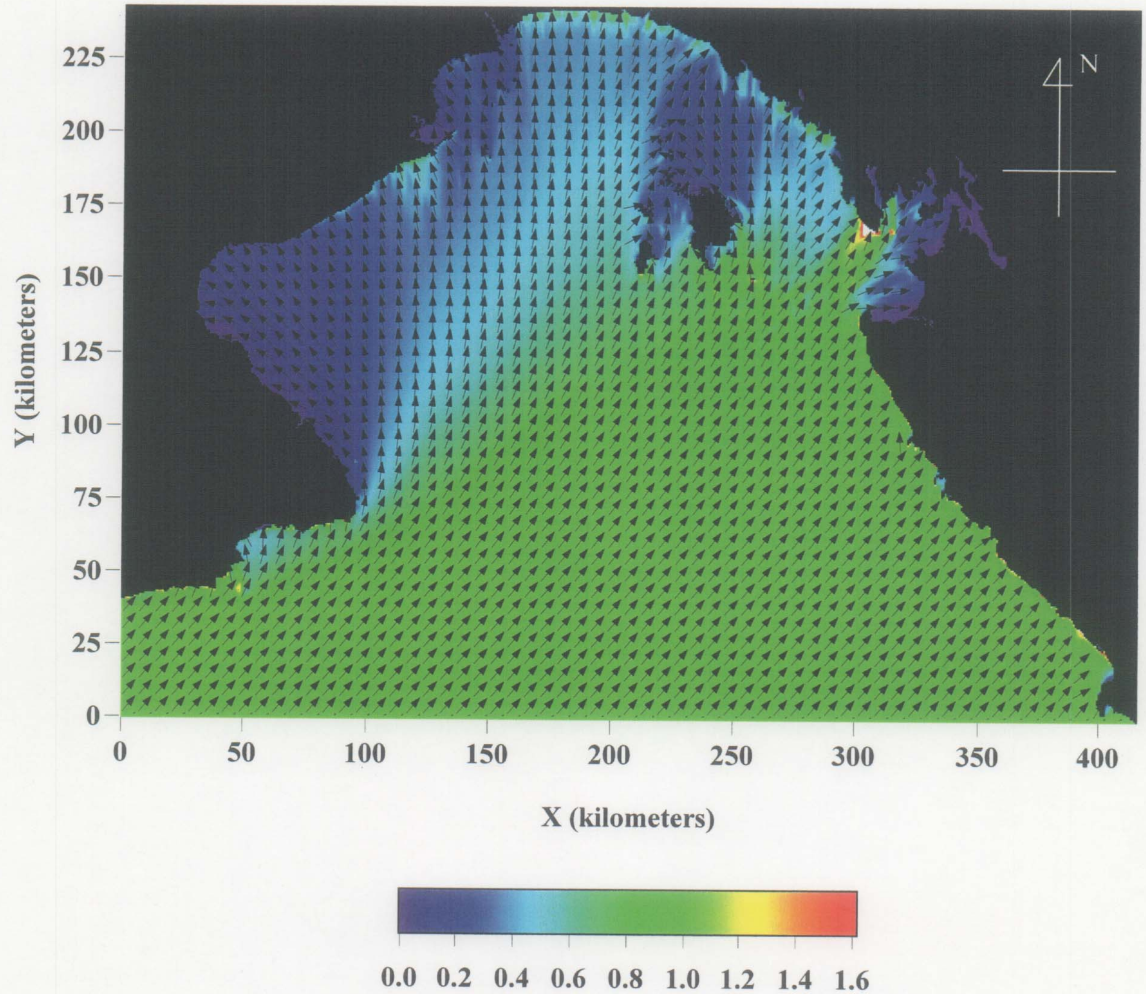


Figure A.2.2.31 Ratio of Wave Height and Mean Wave Directions（Regional Model）

（In the case.05_5 ; 14-second-period-waves from 225 degrees）

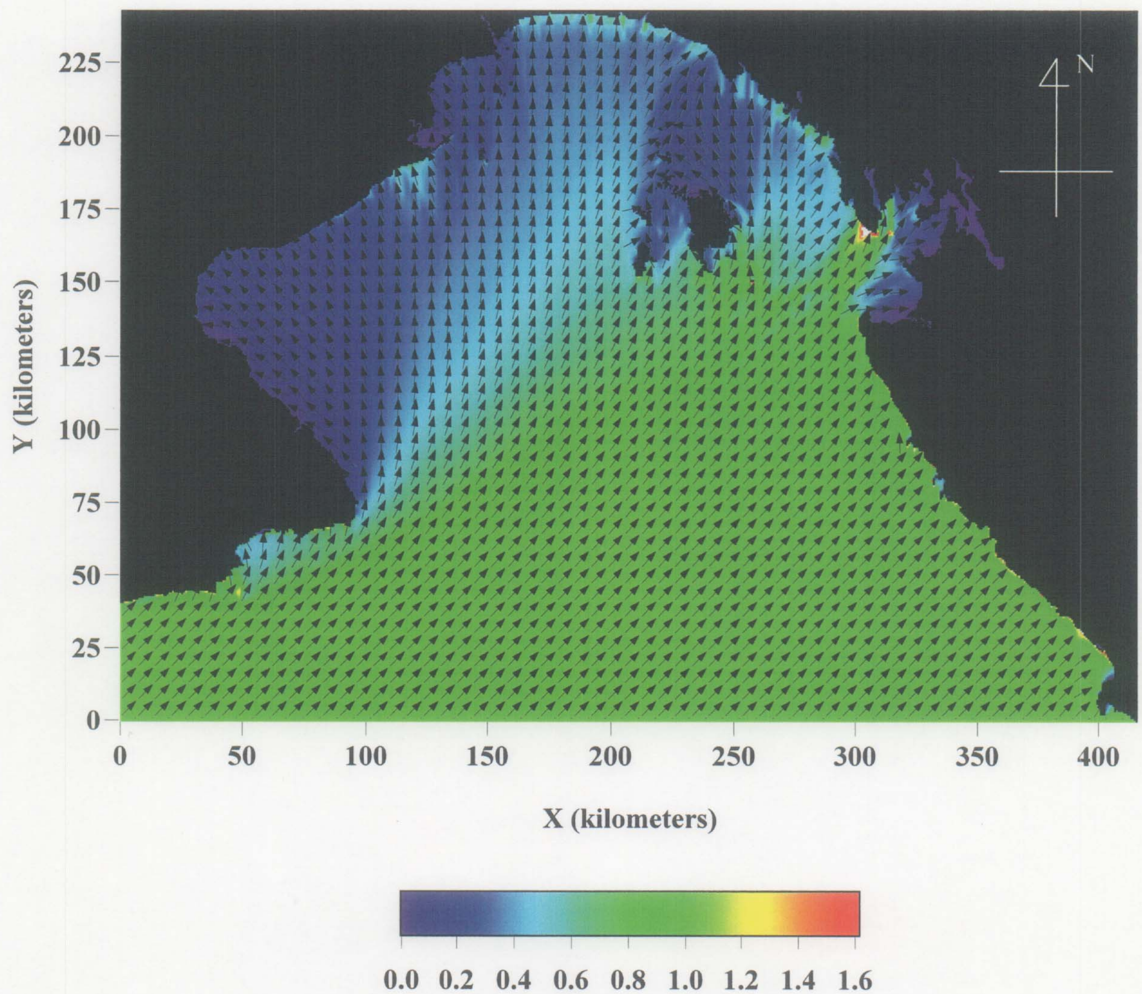


Figure A.2.2.32 Ratio of Wave Height and Mean Wave Directions（Regional Model）

（In the case.05_6 ; 14-second-period-waves from 230 degrees）

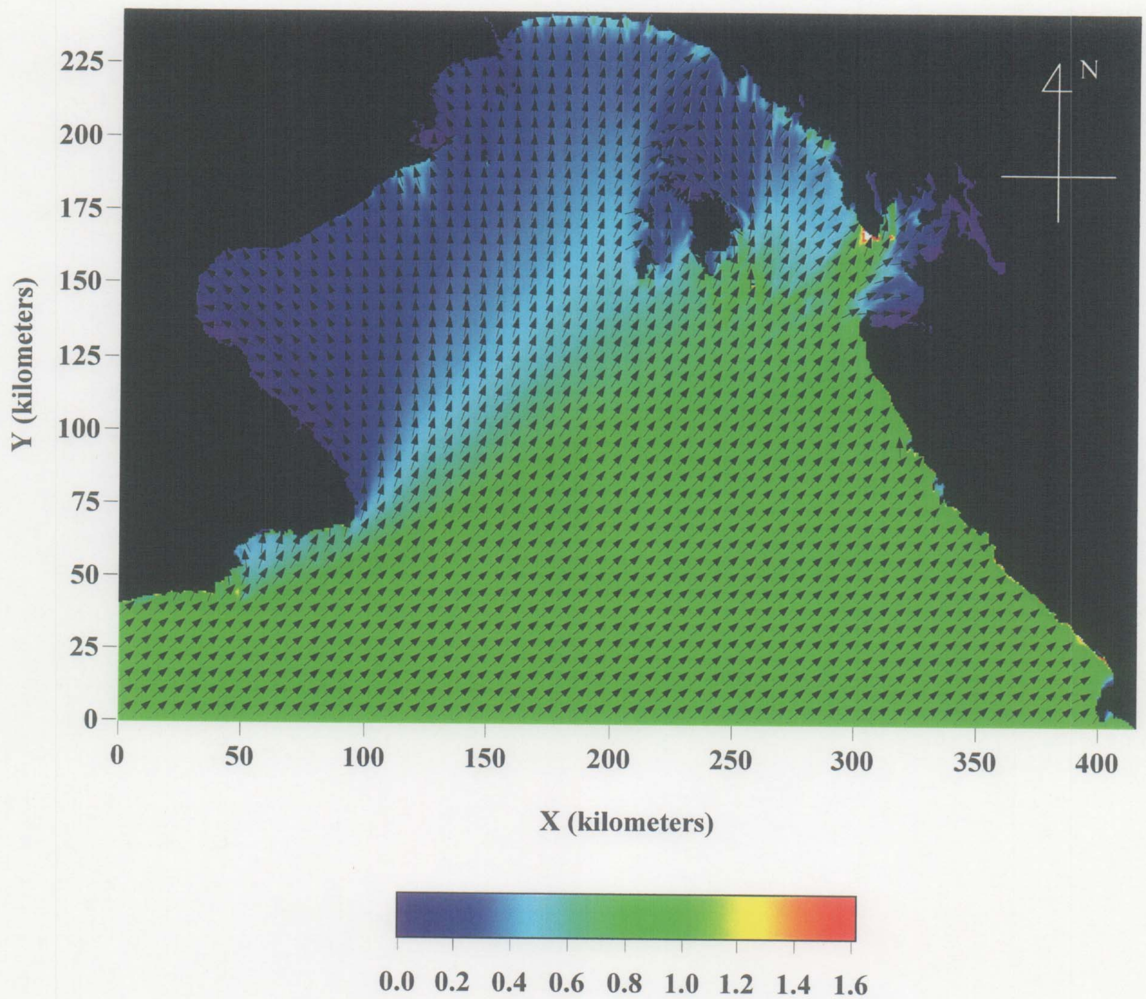


Figure A.2.2.33 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.05_7 ; 14-second-period-waves from 235 degrees)

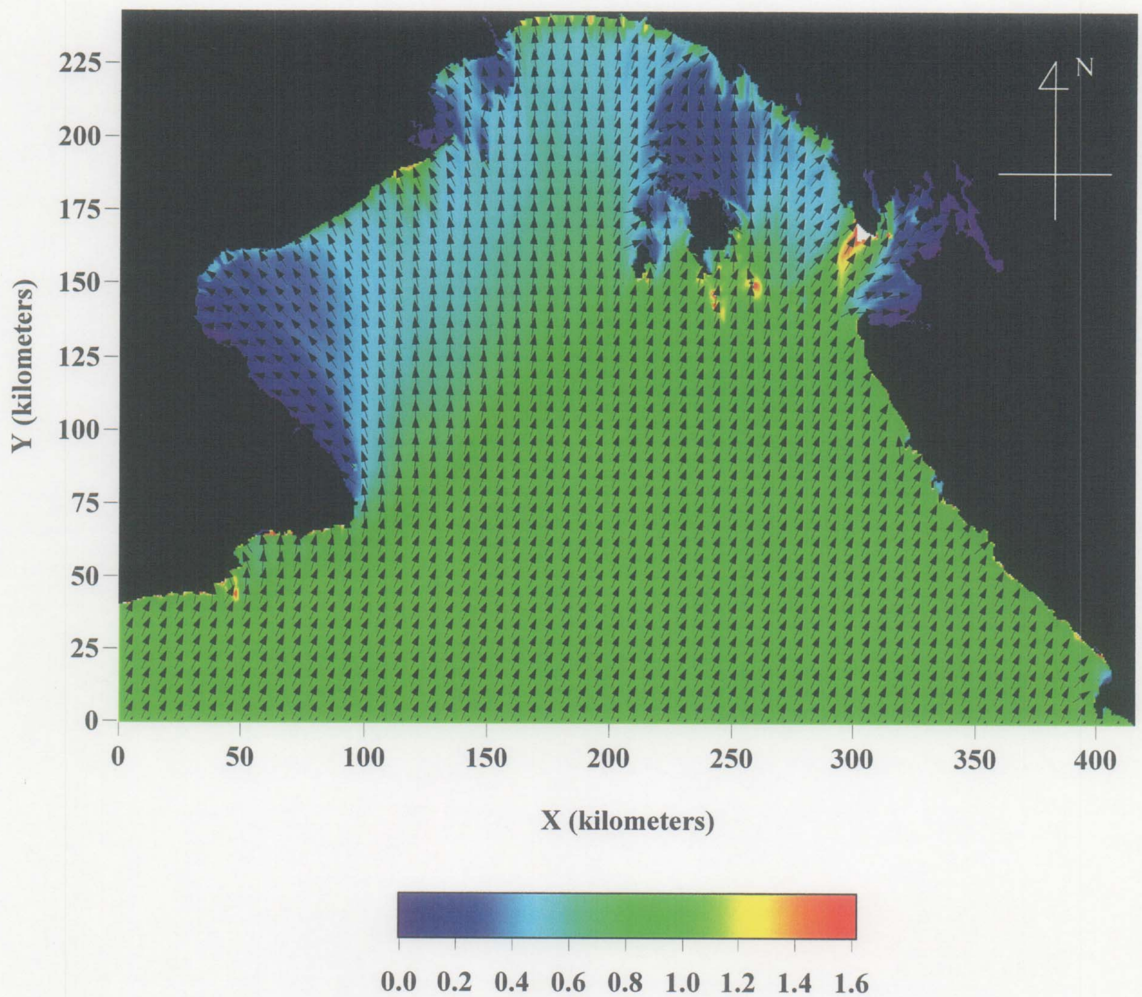


Figure A.2.2.34 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.06_1 ; 16-second-period-waves from 205 degrees)

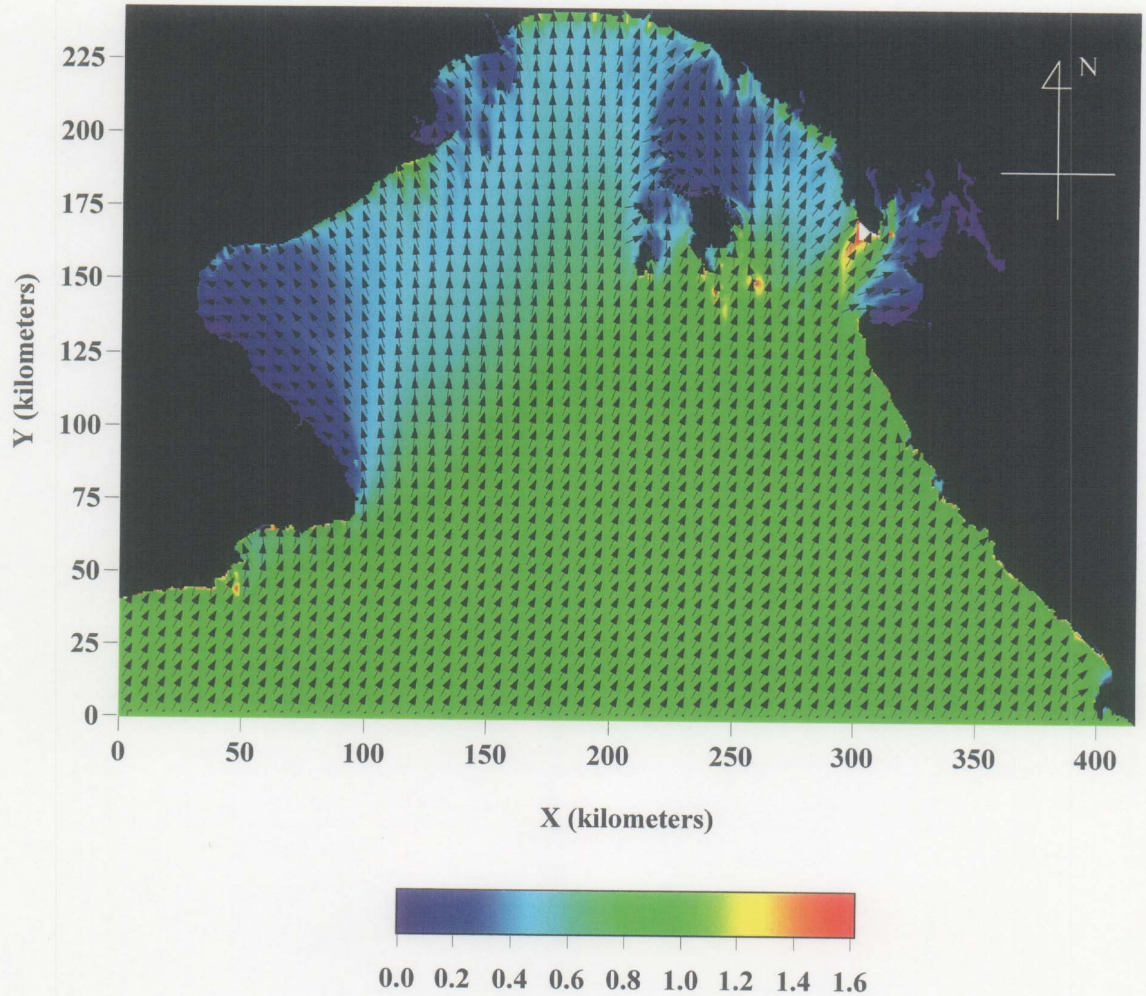


Figure A.2.2.35 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.06_2 ; 16-second-period-waves from 210 degrees)

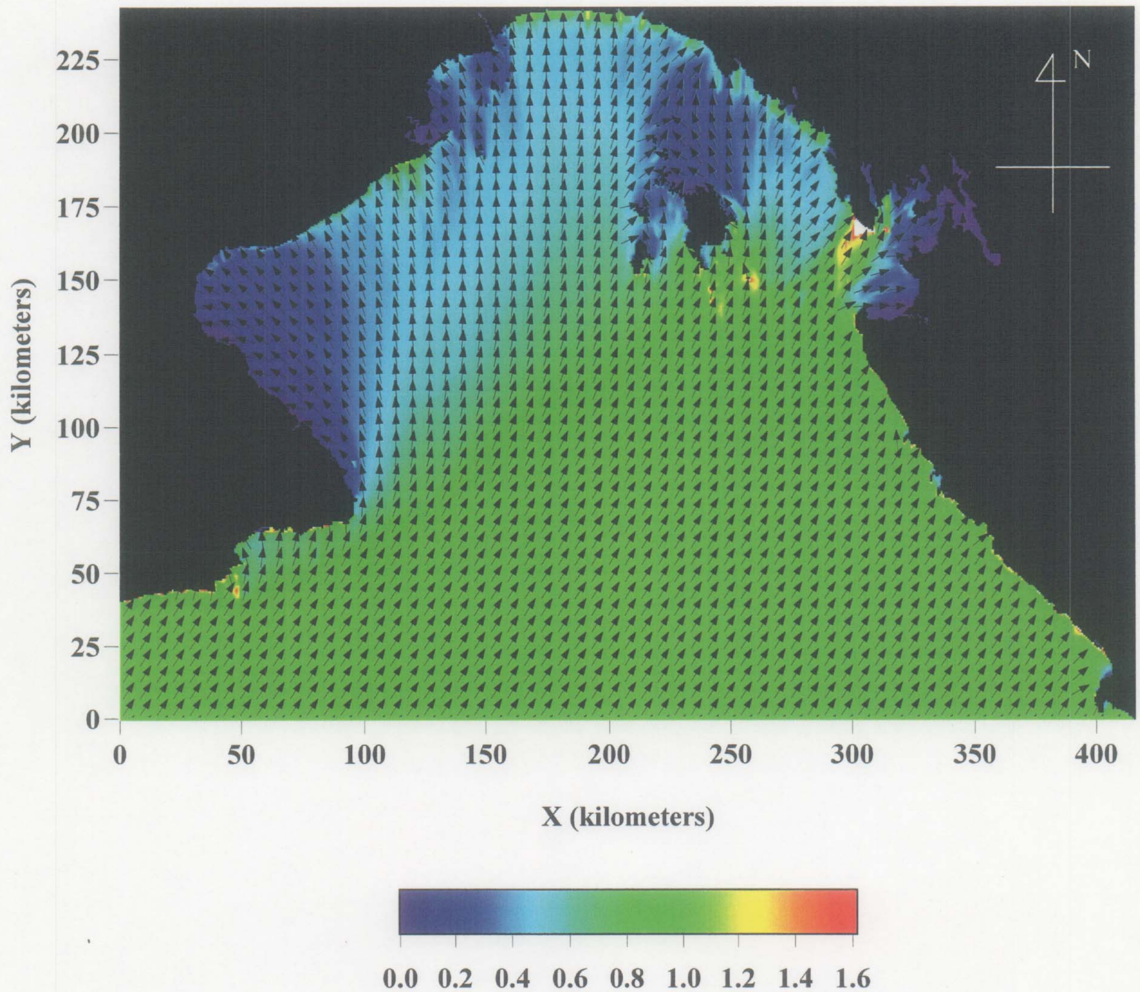


Figure A.2.2.36 Ratio of Wave Height and Mean Wave Directions（Regional Model）

（In the case.06_3 ; 16-second-period-waves from 215 degrees）

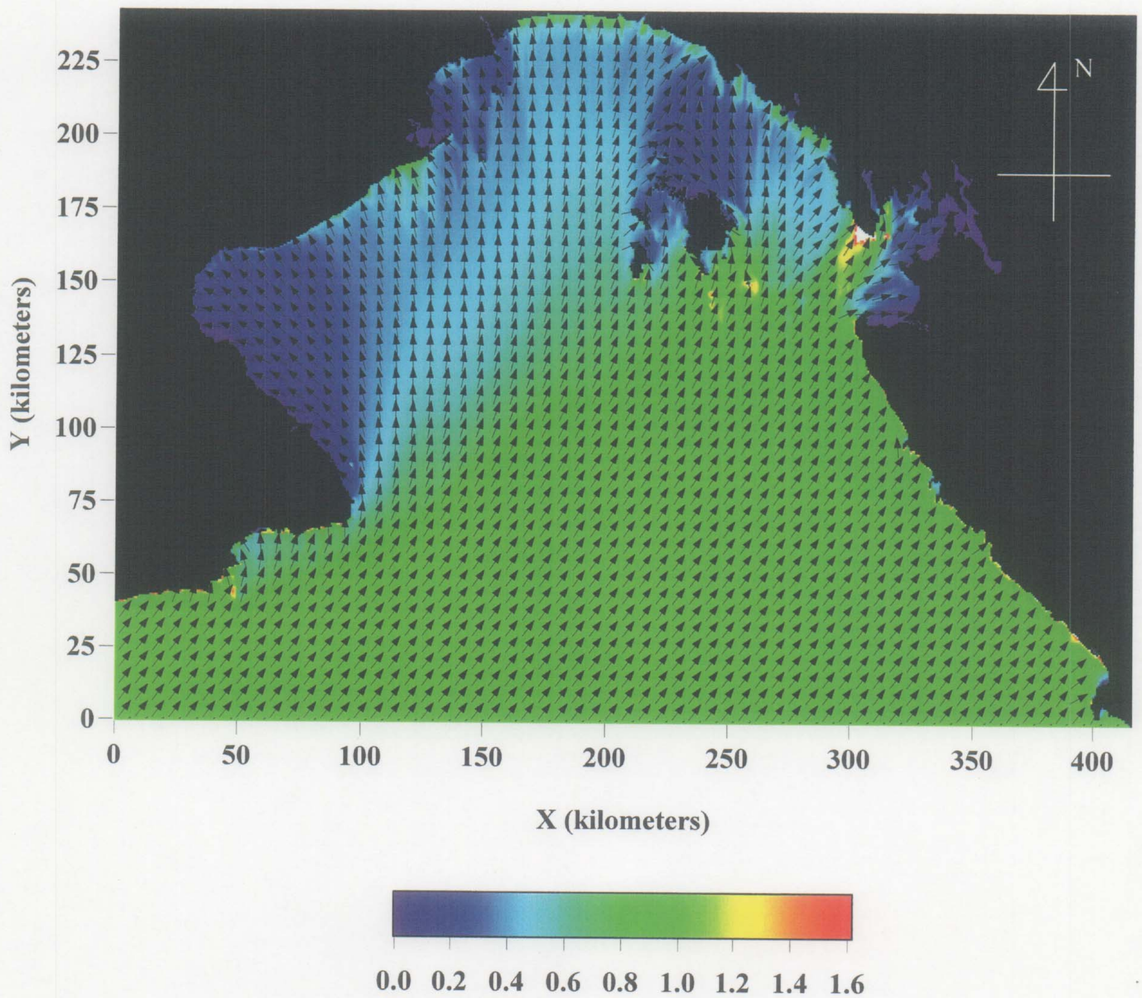


Figure A.2.2.37 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.06_4 ; 16-second-period-waves from 220 degrees)

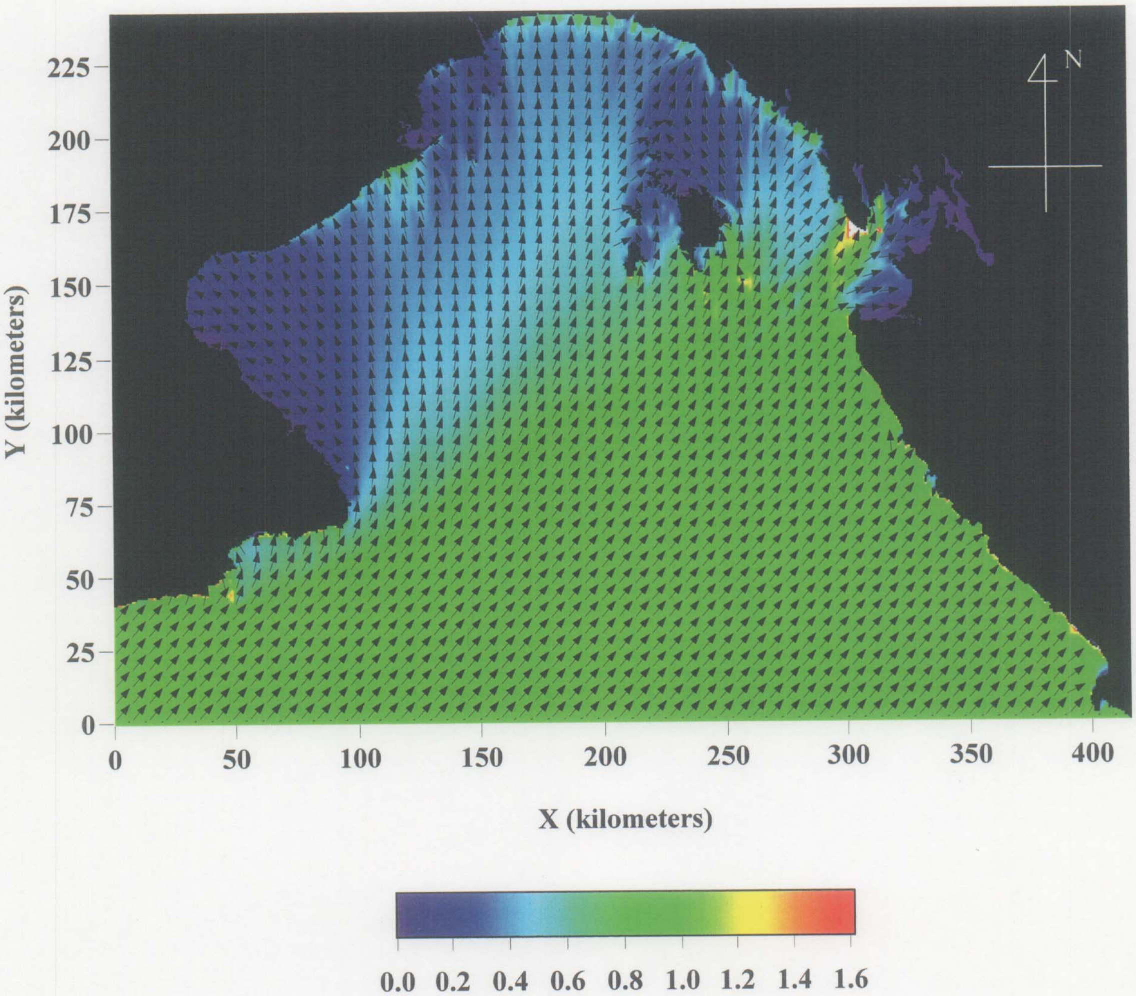


Figure A.2.2.38 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.06_5 ; 16-second-period-waves from 225 degrees)

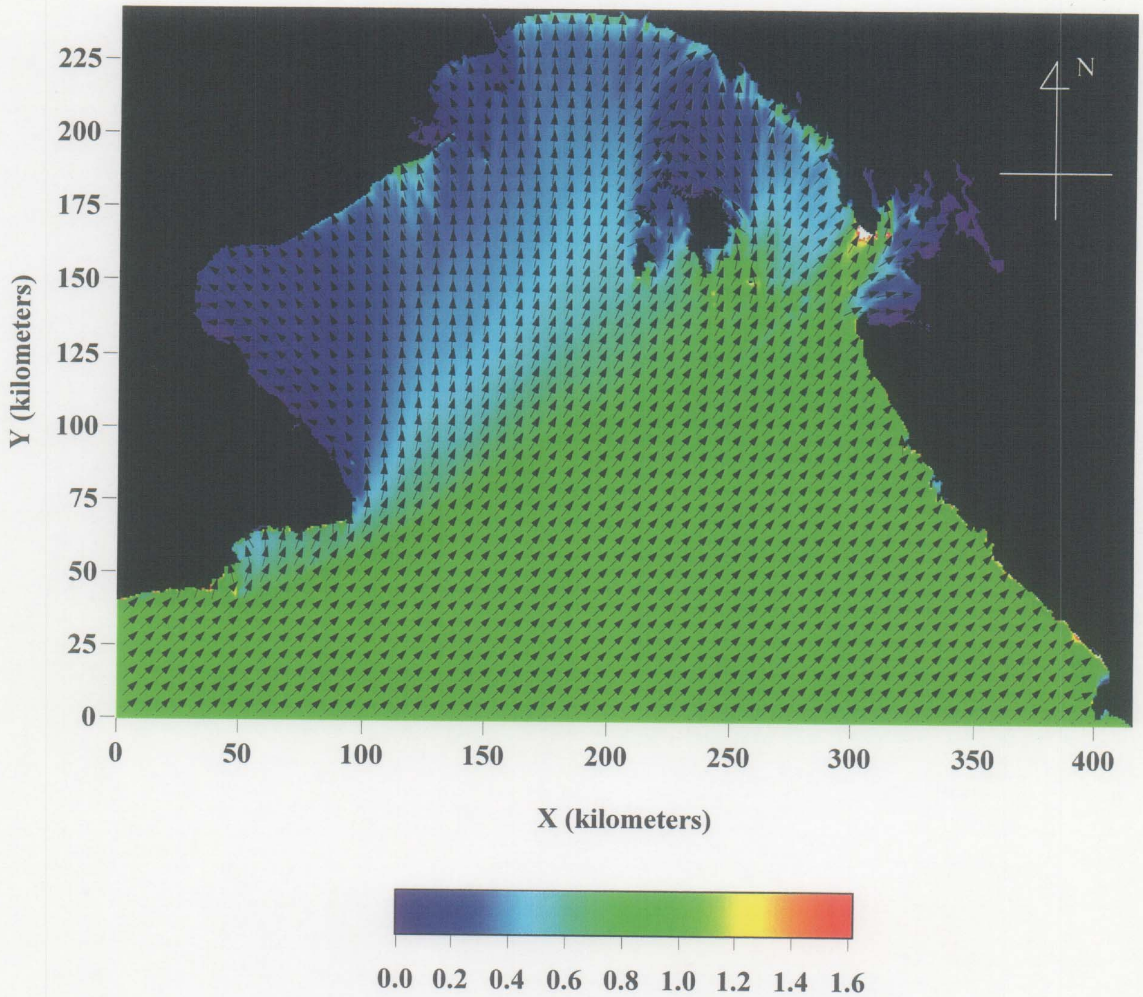


Figure A.2.2.39 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.06_6 ; 16-second-period-waves from 230 degrees)

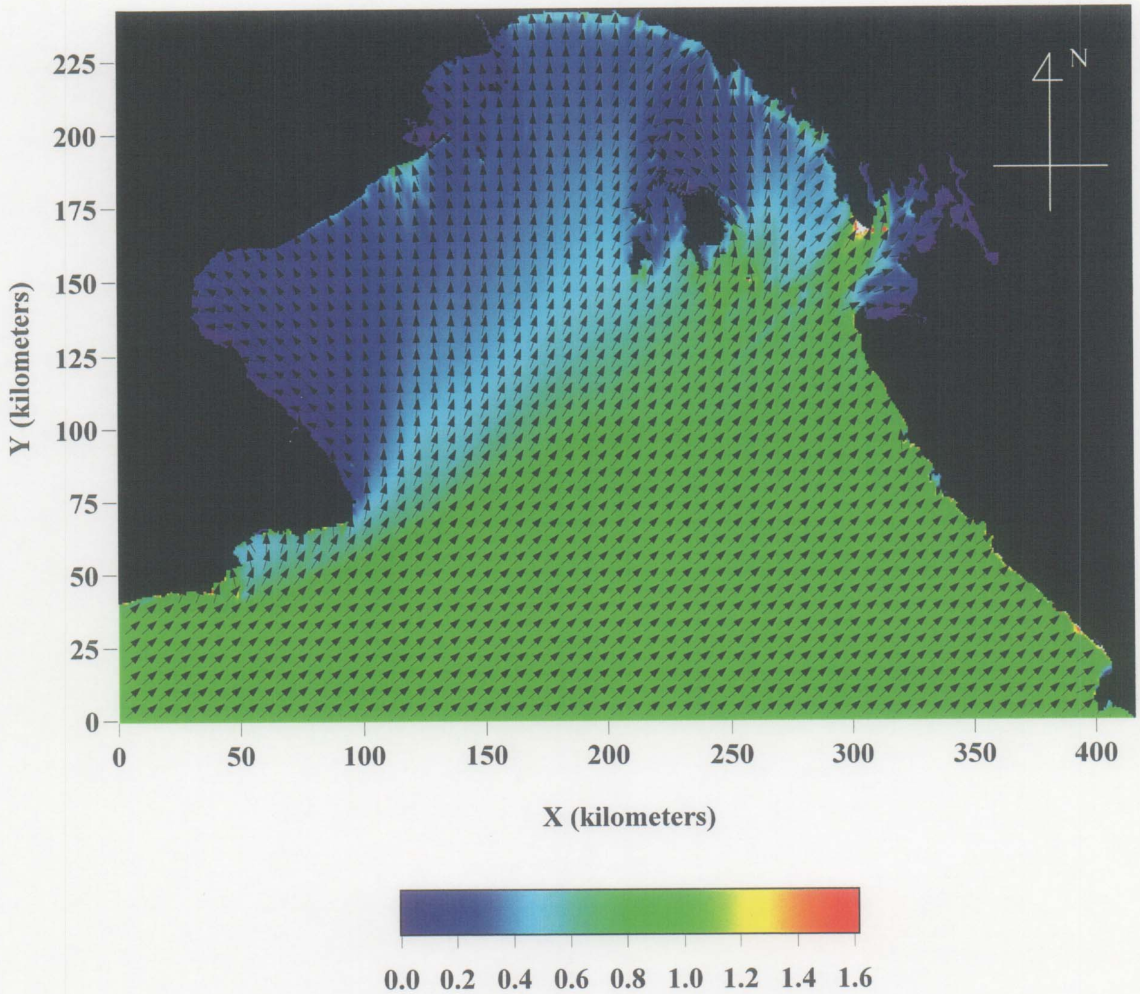


Figure A.2.2.40 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.06_7 ; 16-second-period-waves from 235 degrees)

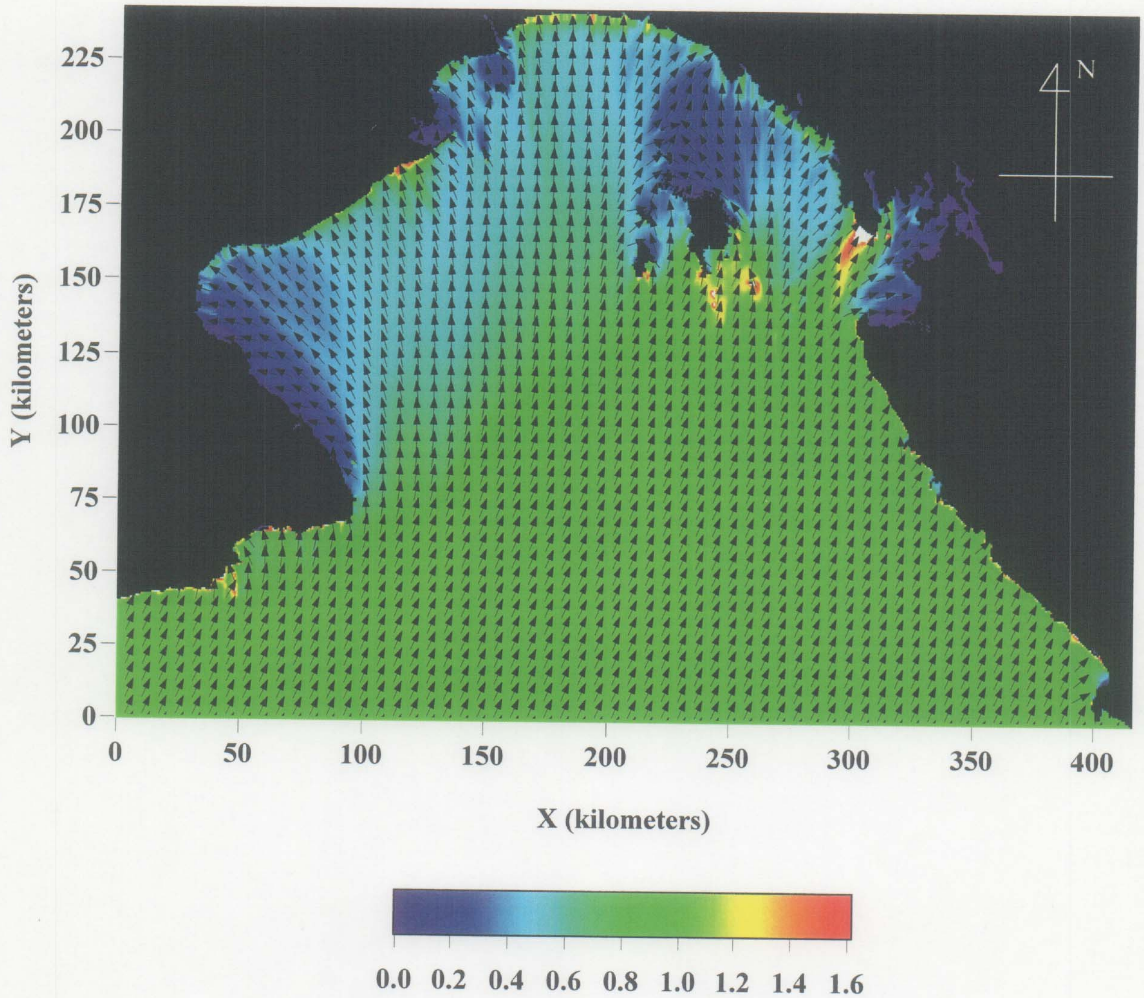


Figure A.2.2.41 Ratio of Wave Height and Mean Wave Directions（Regional Model)

(In the case.07_1 ; 18-second-period-waves from 205 degrees)

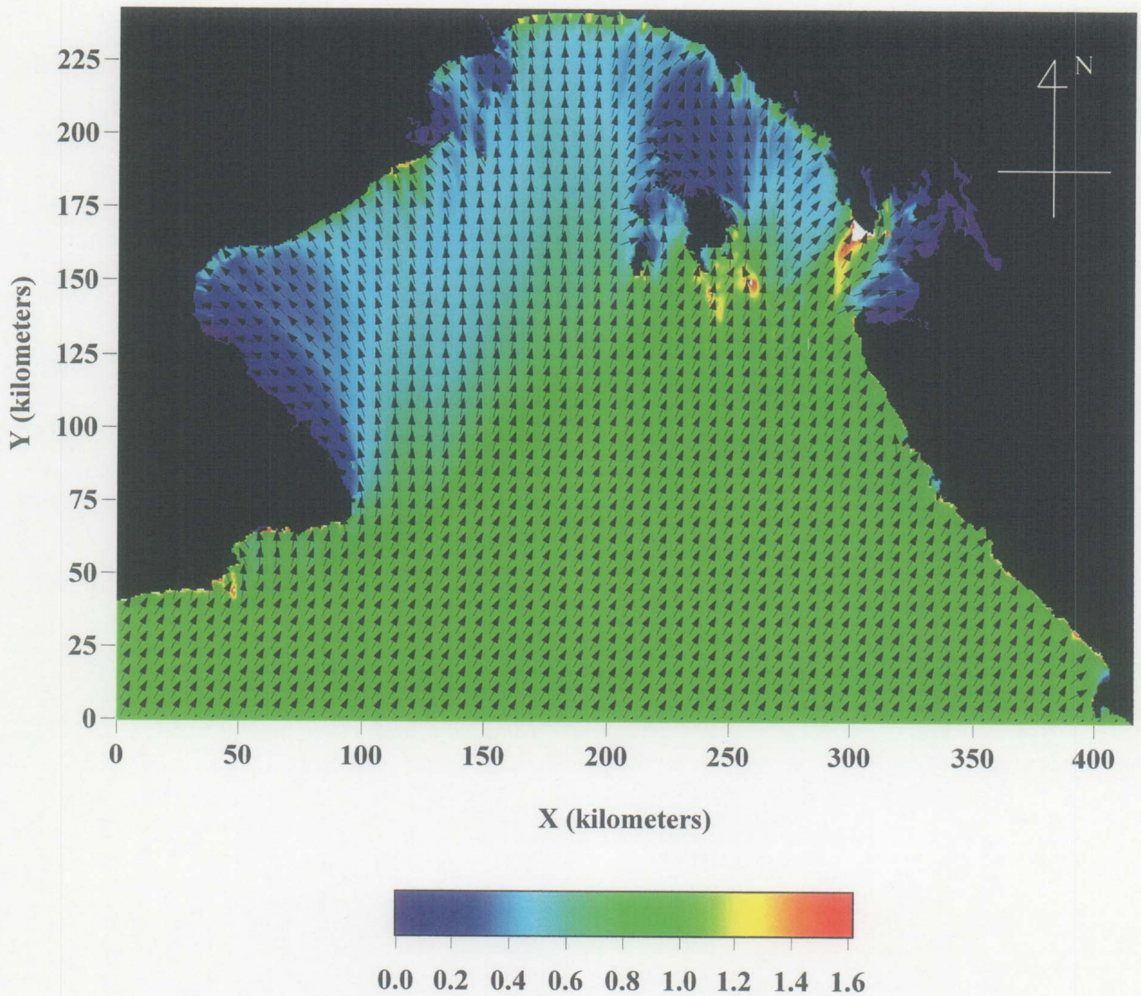


Figure A.2.2.42 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.07_2 ; 18-second-period-waves from 210 degrees)

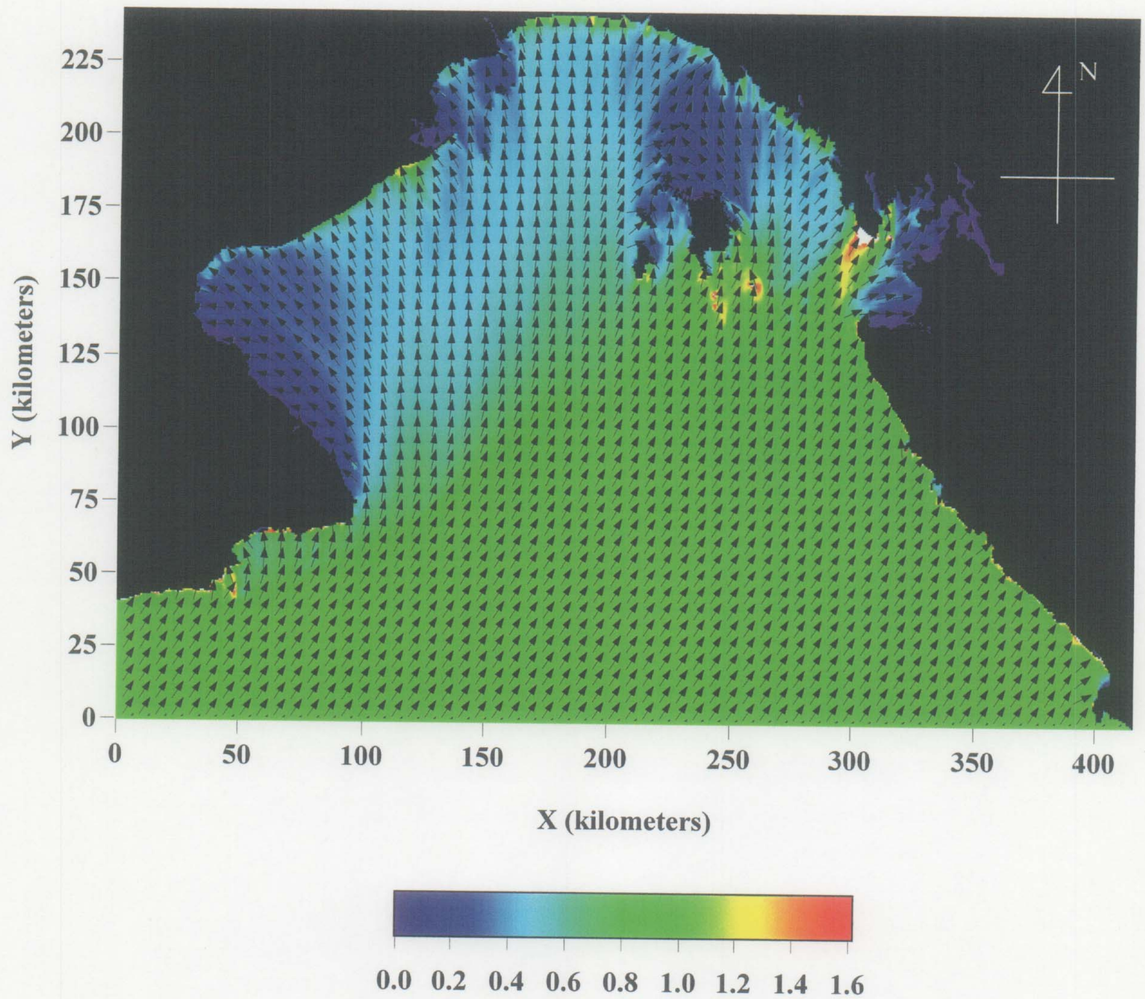


Figure A.2.2.43 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.07_3 ; 18-second-period-waves from 215 degrees)

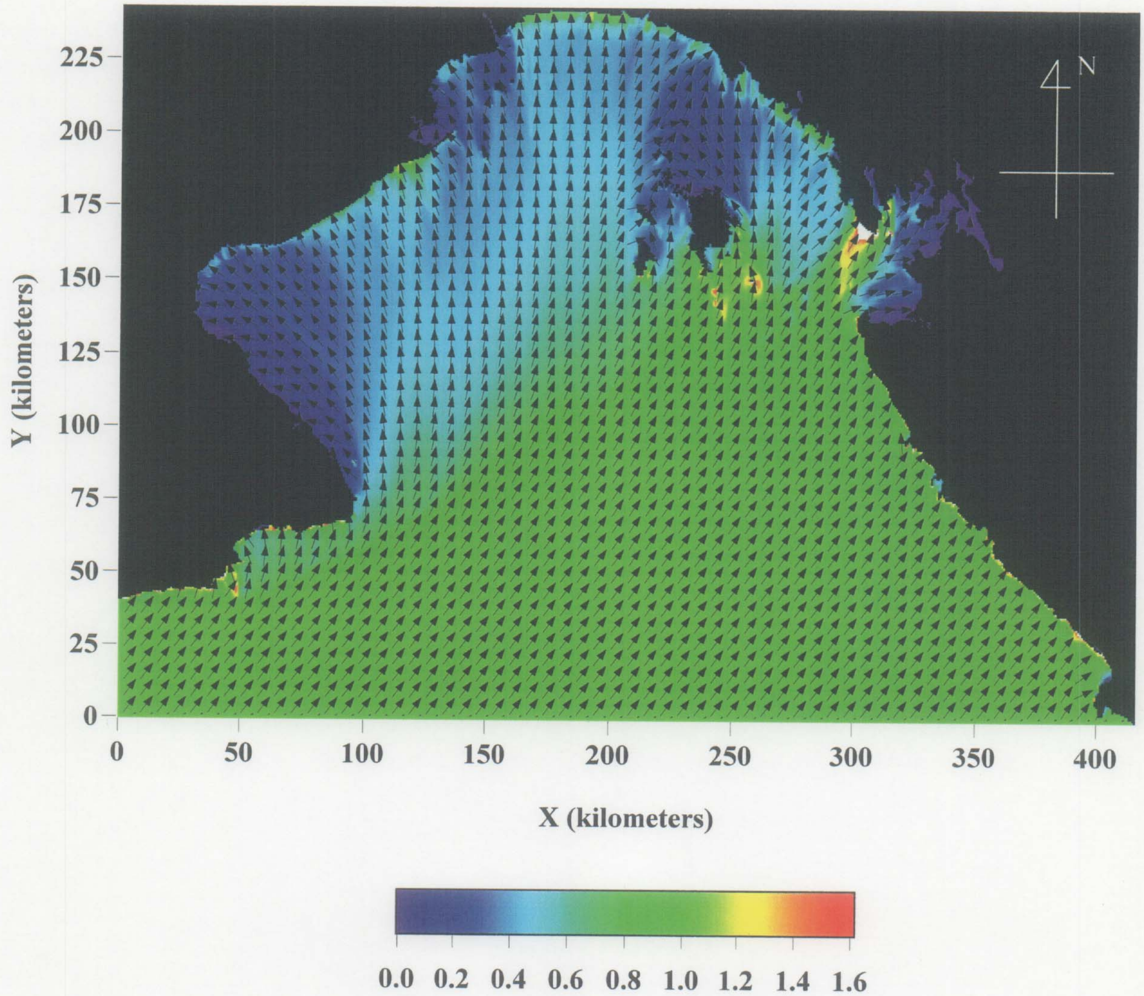


Figure A.2.2.44 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.07_4 ; 18-second-period-waves from 220 degrees)

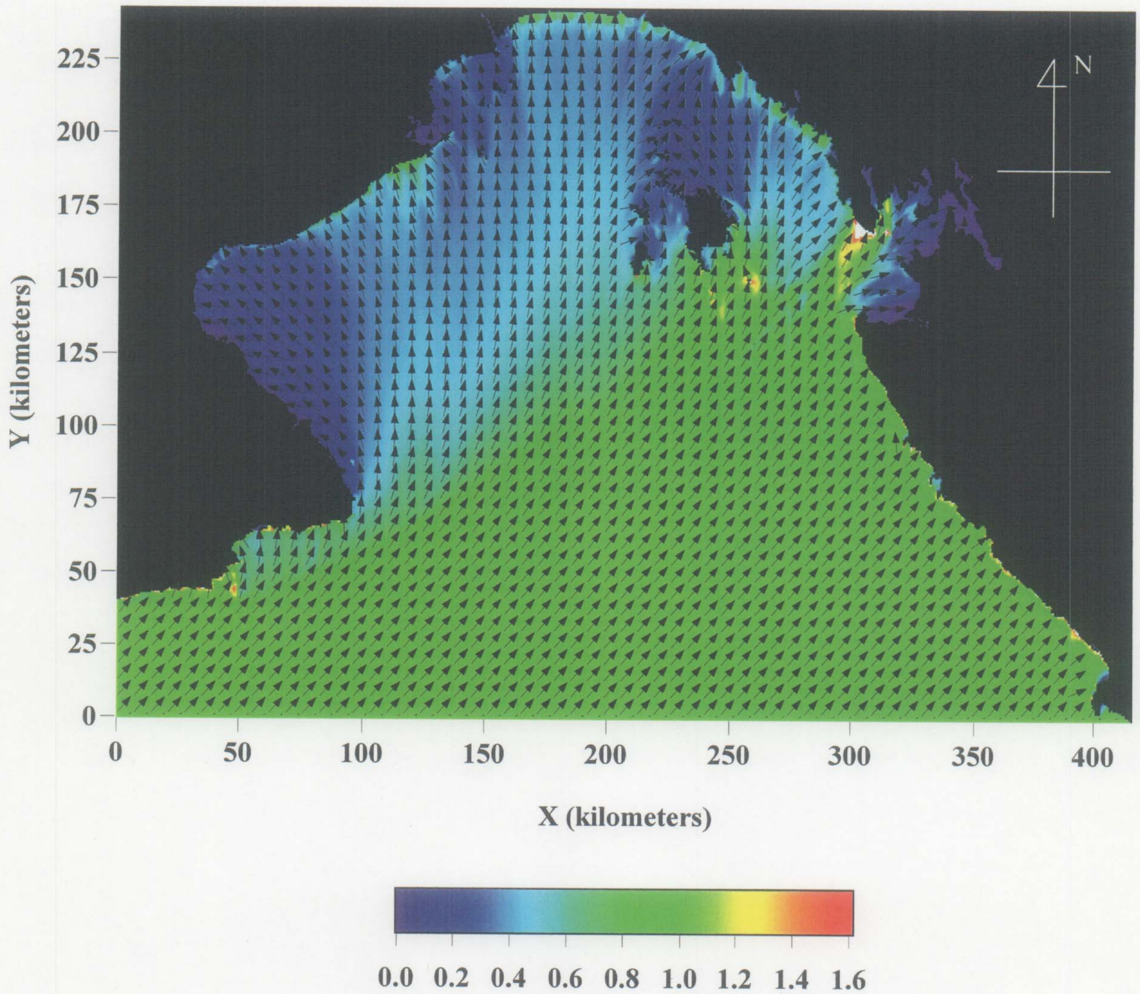


Figure A.2.2.45 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.07_5 ; 18-second-period-waves from 225 degrees)

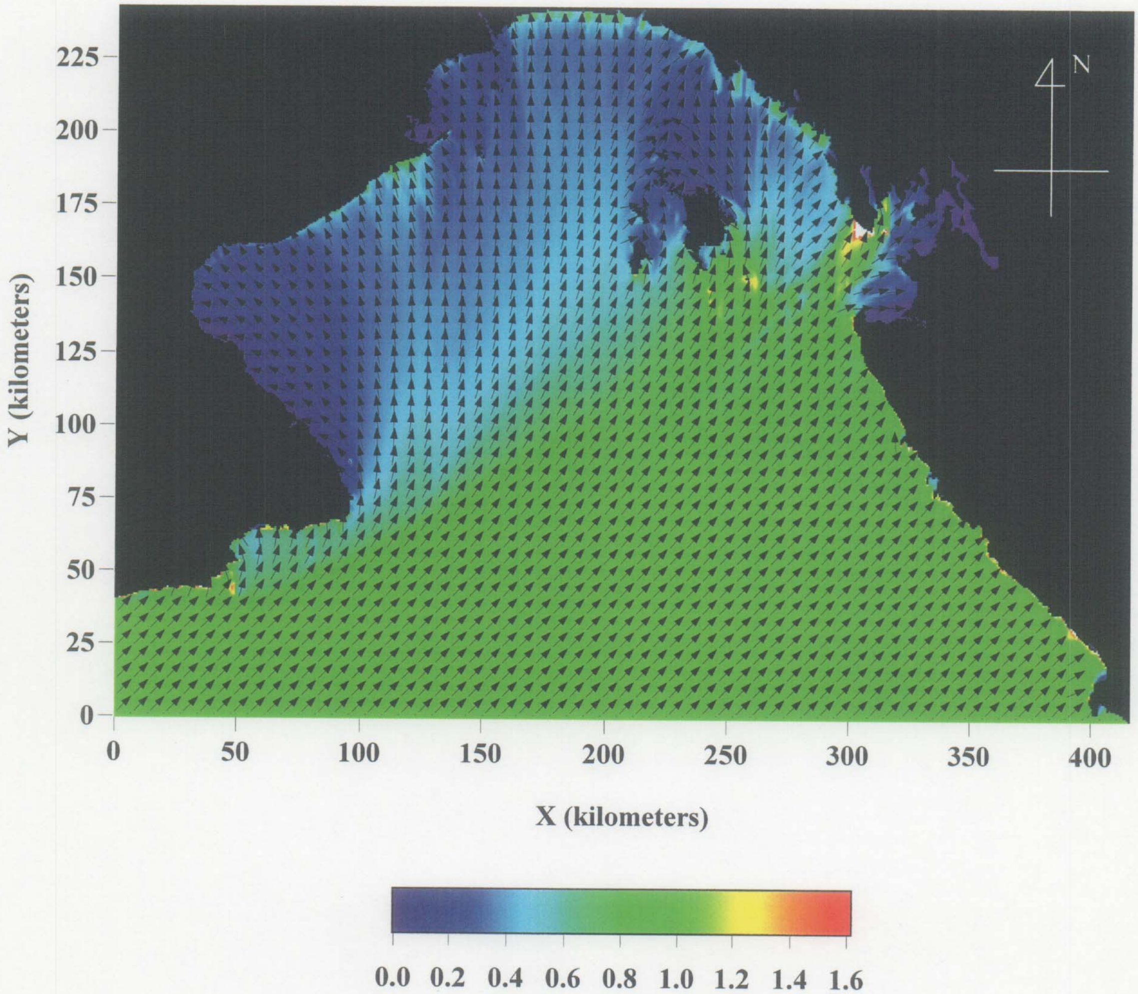


Figure A.2.2.46 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.07_6 ; 18-second-period-waves from 230 degrees)

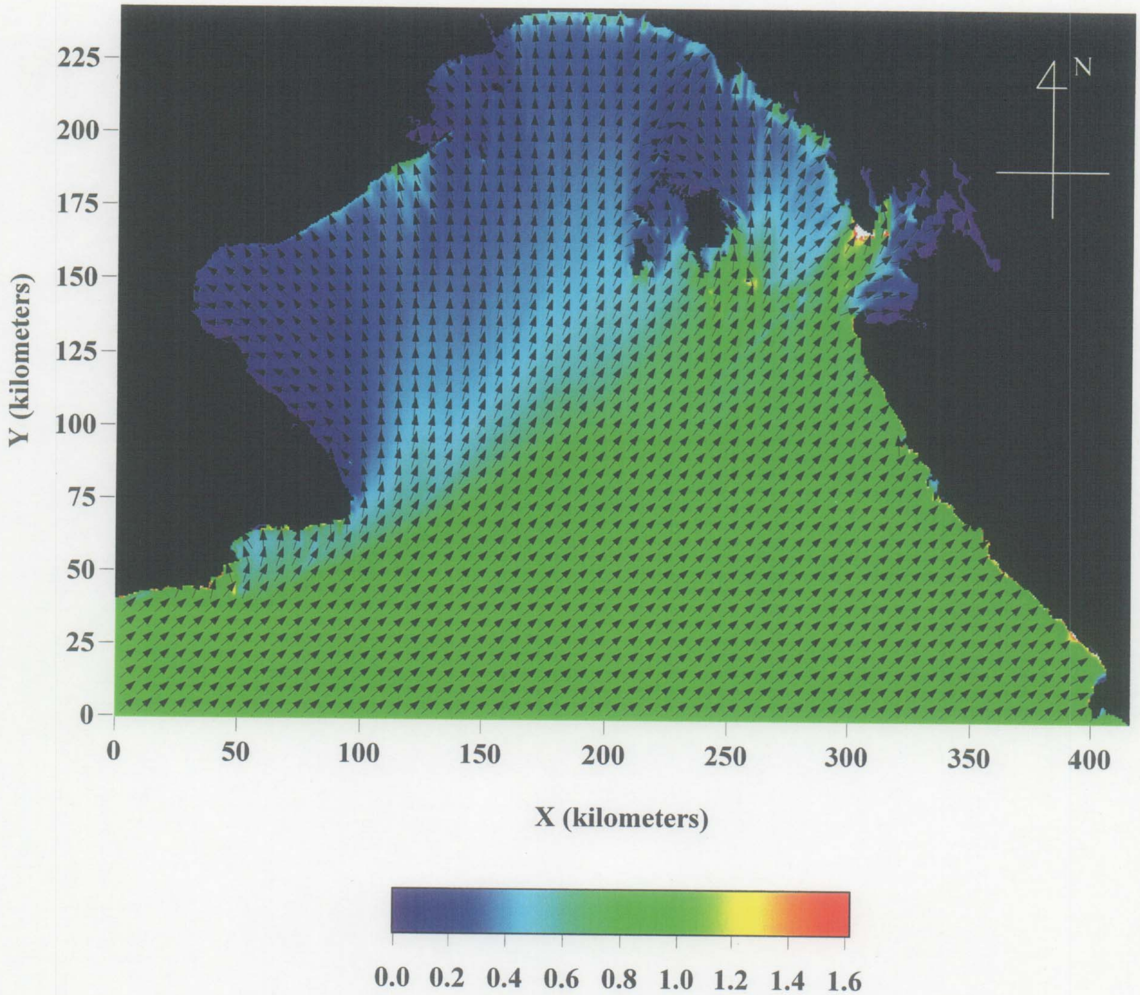


Figure A.2.2.47 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.07_7 ; 18-second-period-waves from 235 degrees)

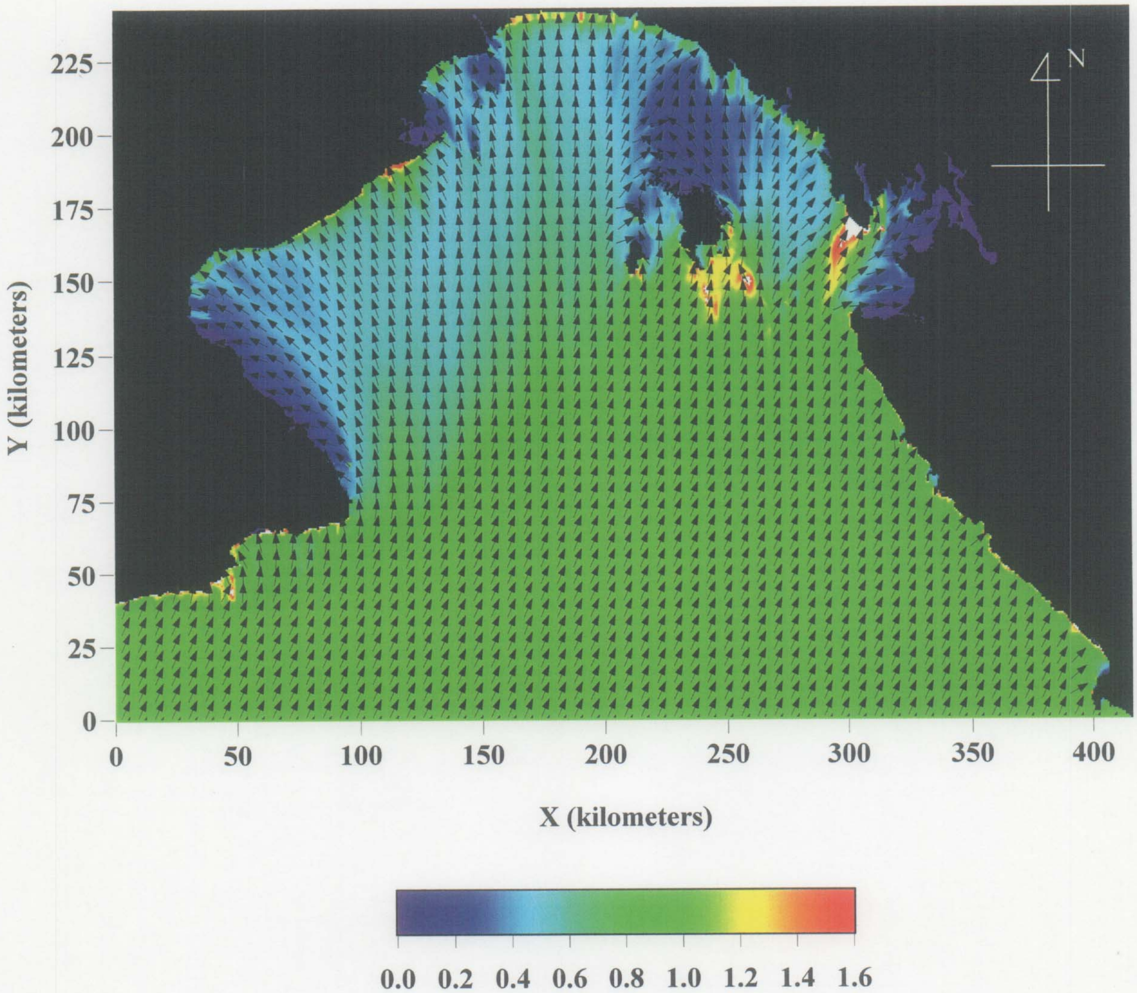


Figure A.2.2.48 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.08_1 ; 20-second-period-waves from 205 degrees)

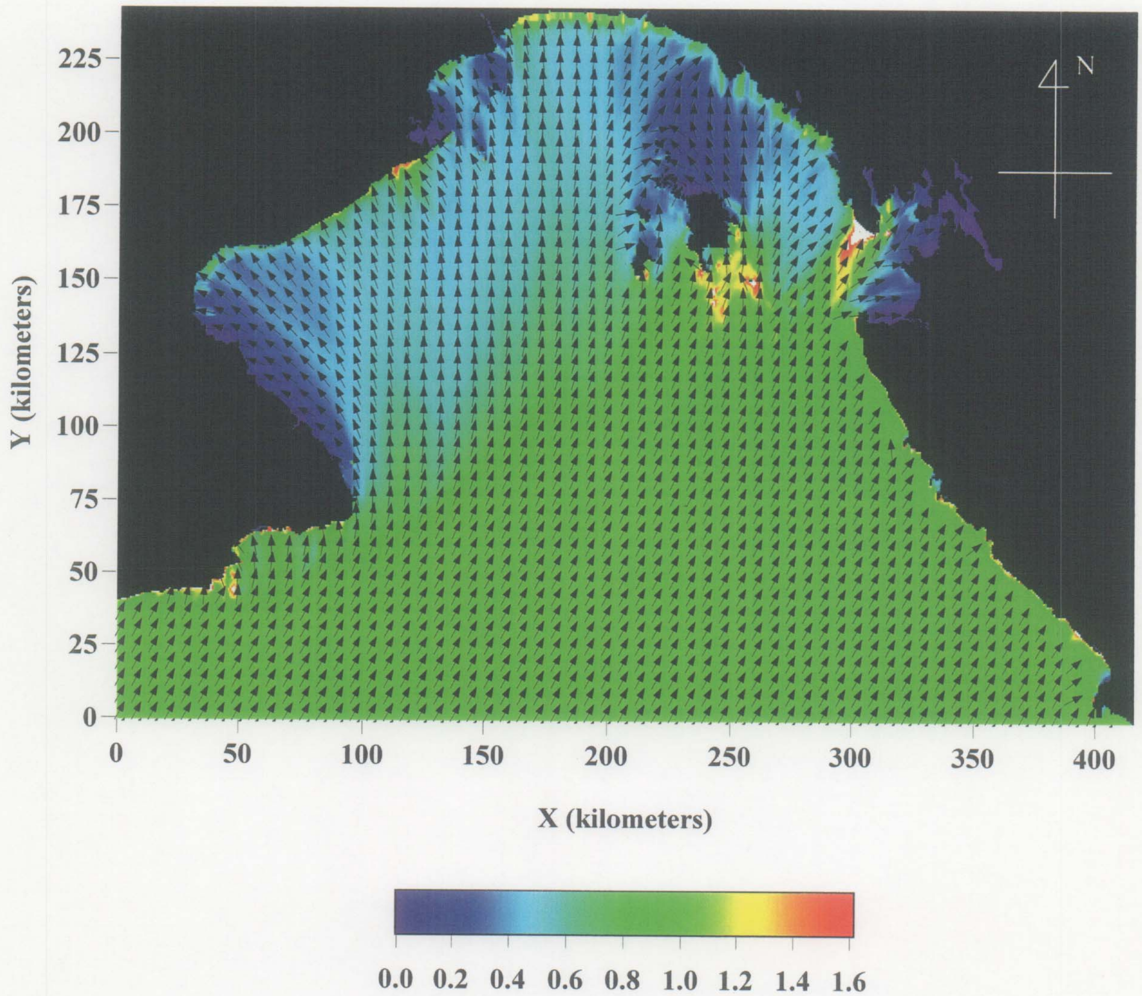


Figure A.2.2.49 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.08_2 ; 20-second-period-waves from 210 degrees)

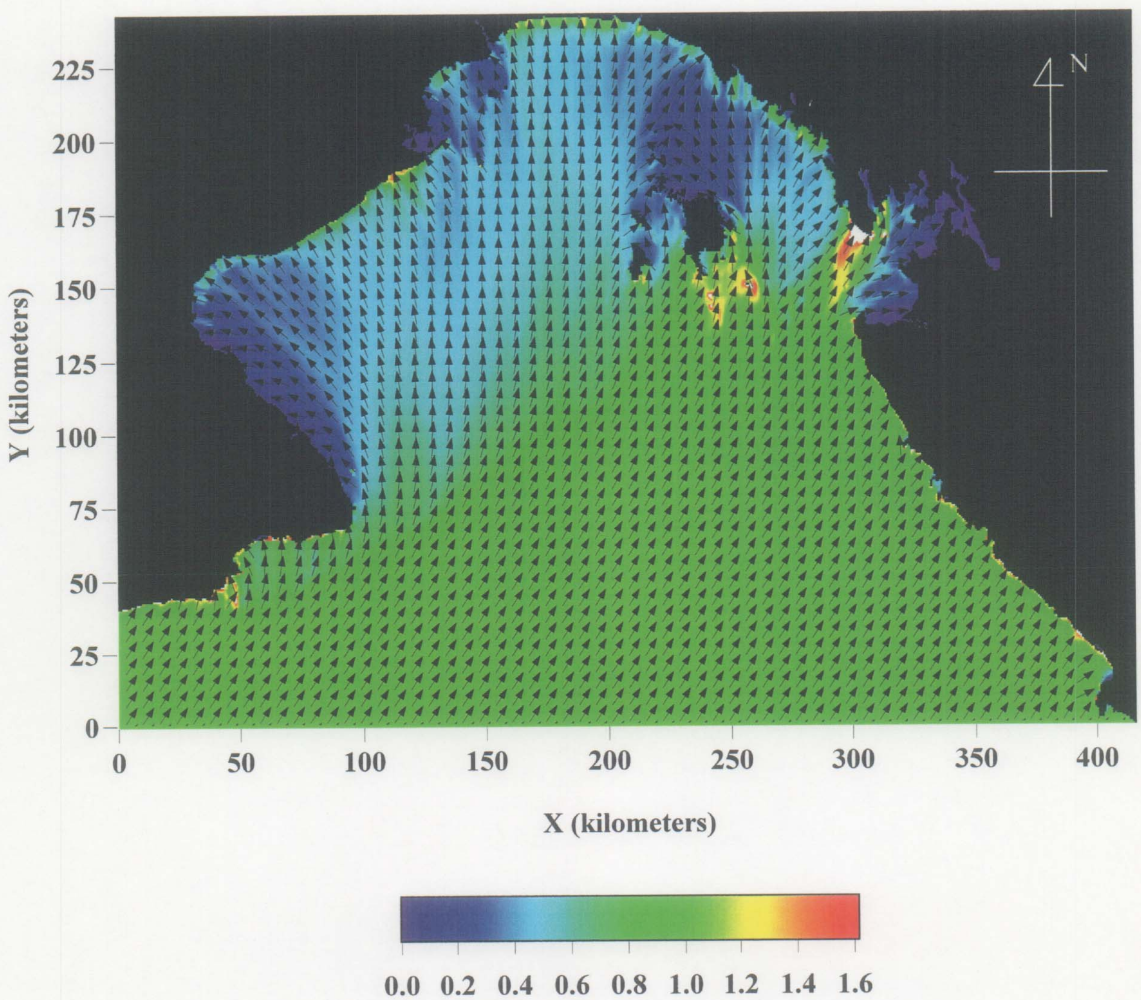


Figure A.2.2.50 Ratio of Wave Height and Mean Wave Directions (Regional Model)
(In the case.08_3 ; 20-second-period-waves from 215 degrees)

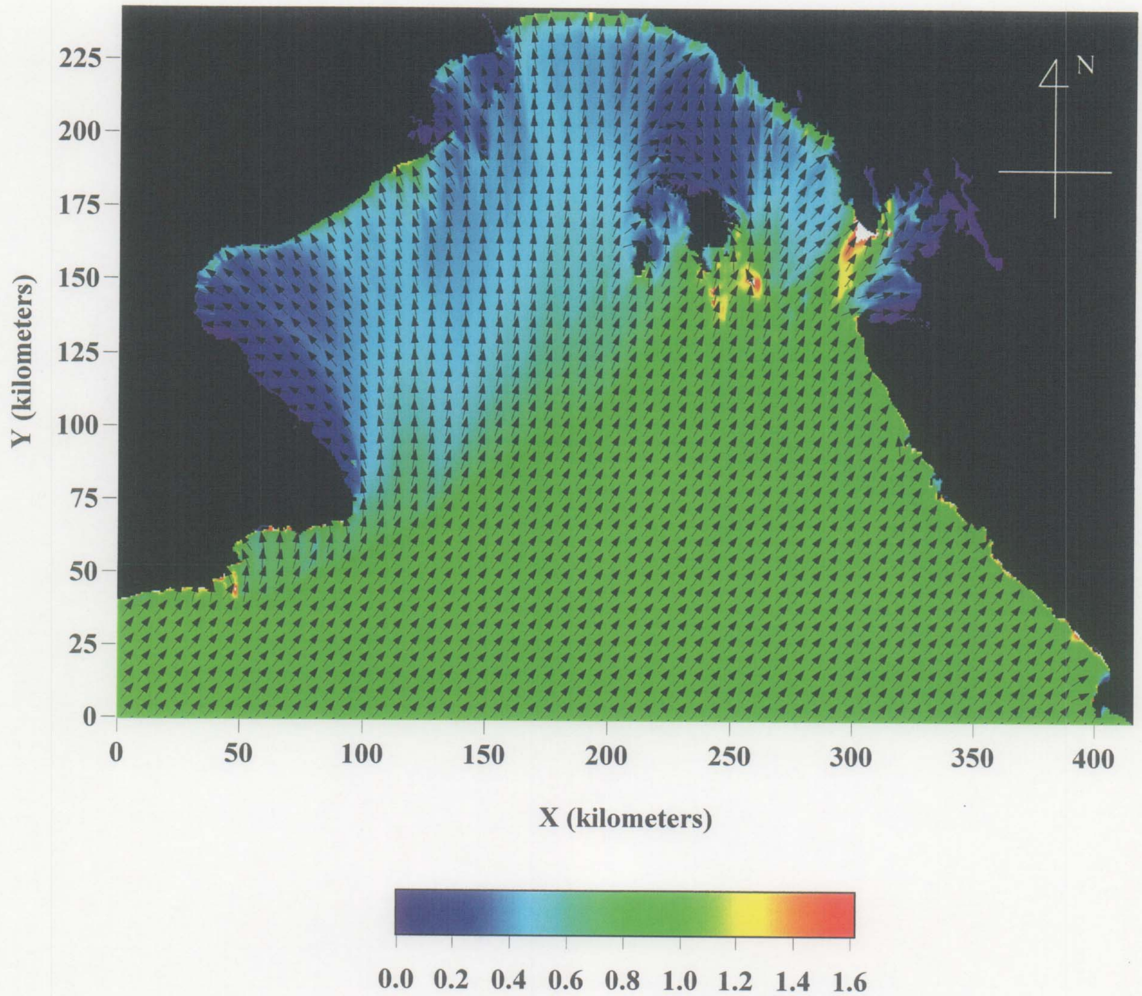


Figure A.2.2.51 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.08_4 ; 20-second-period-waves from 220 degrees)

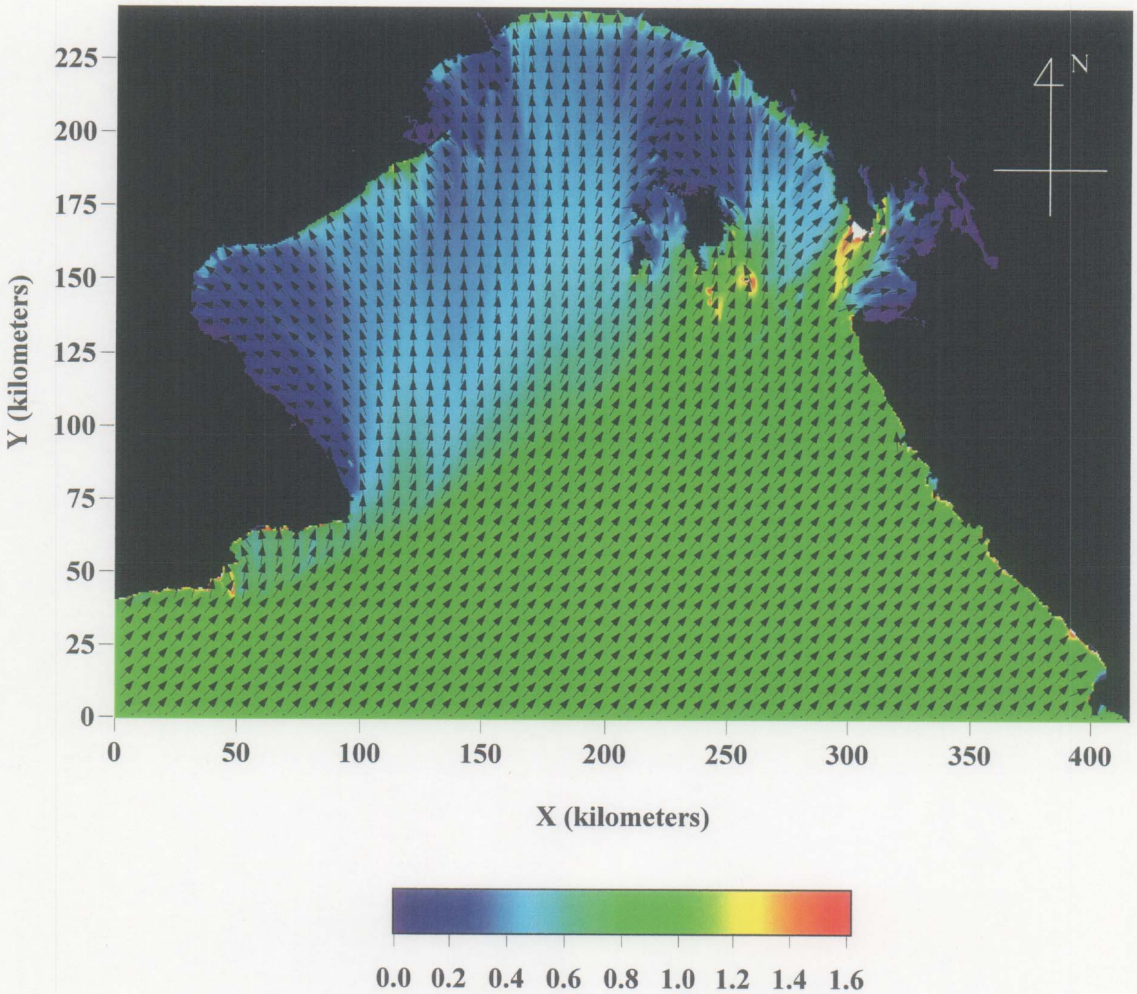


Figure A.2.2.52 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.08_5 ; 20-second-period-waves from 225 degrees)

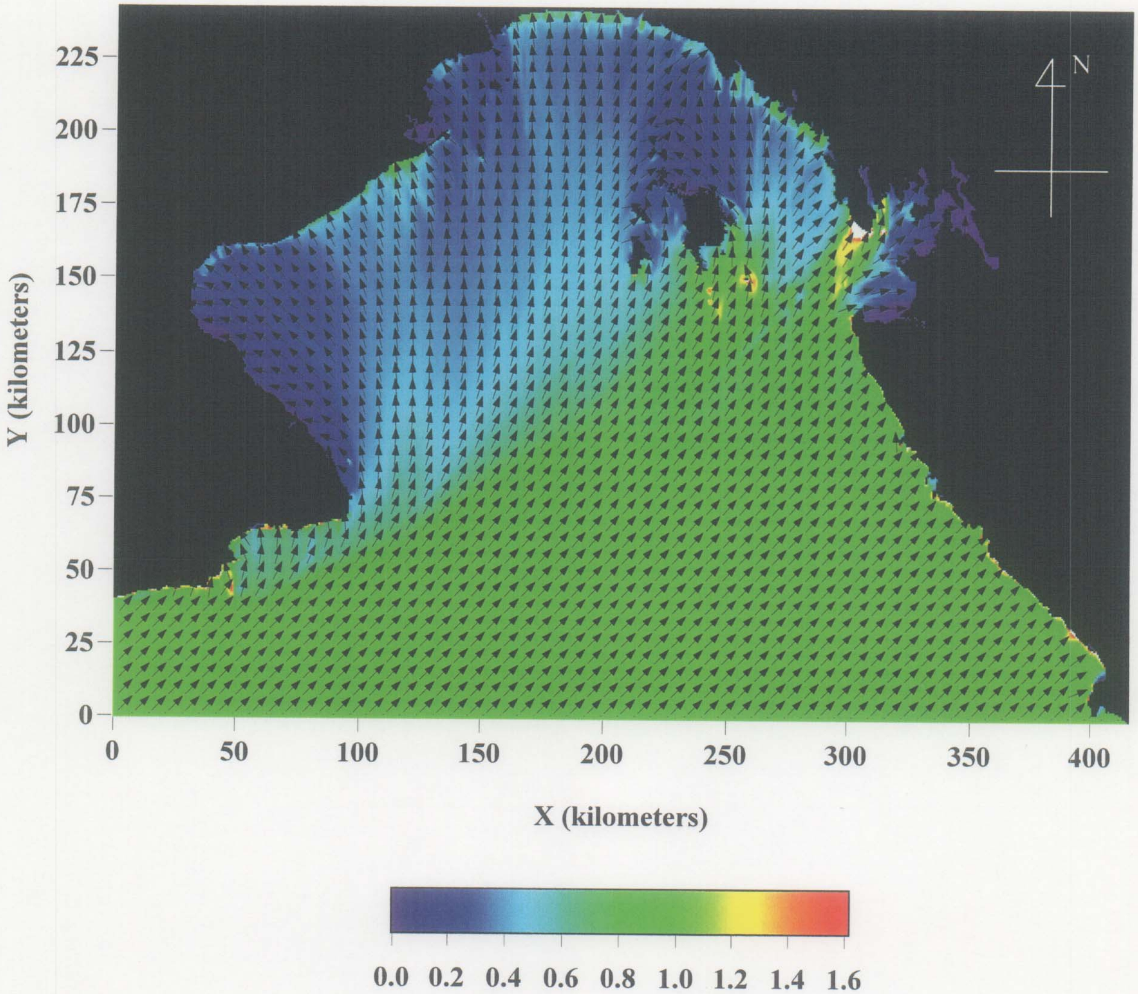


Figure A.2.2.53 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.08_6 ; 20-second-period-waves from 230 degrees)

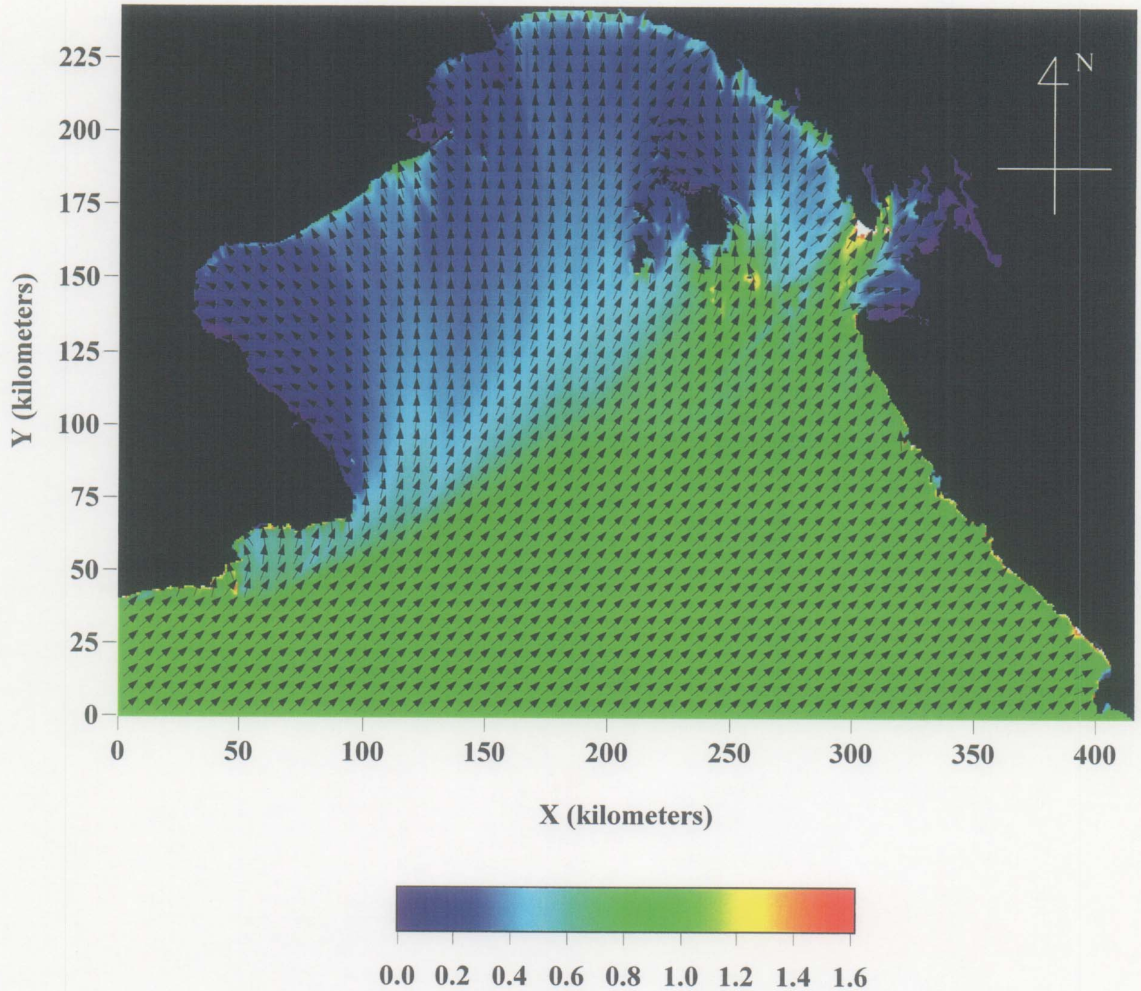


Figure A.2.2.54 Ratio of Wave Height and Mean Wave Directions (Regional Model)

(In the case.08_7 ; 20-second-period-waves from 235 degrees)

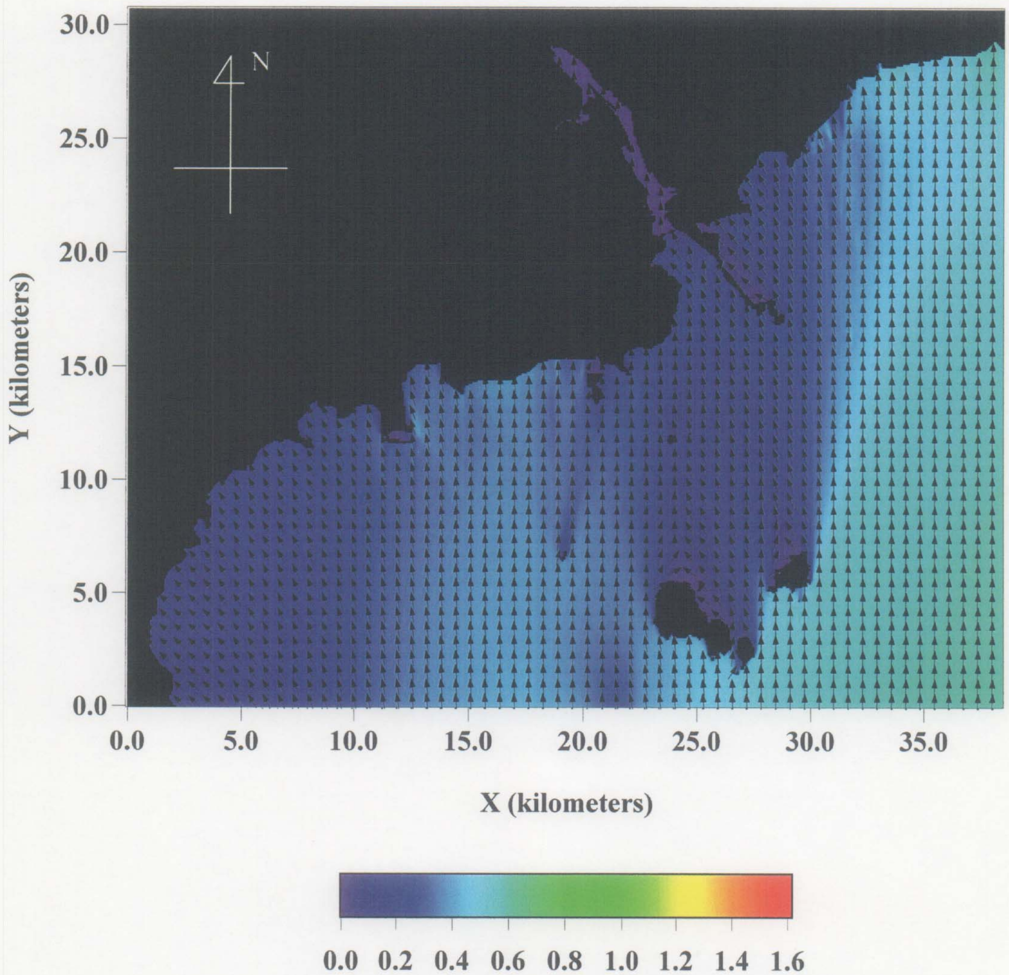


Figure A.2.2.55 Ratio of Wave Height and Mean Wave Directions (Local Model)

(In the case.01_2 ; 6-second-period-waves from 210 degrees)

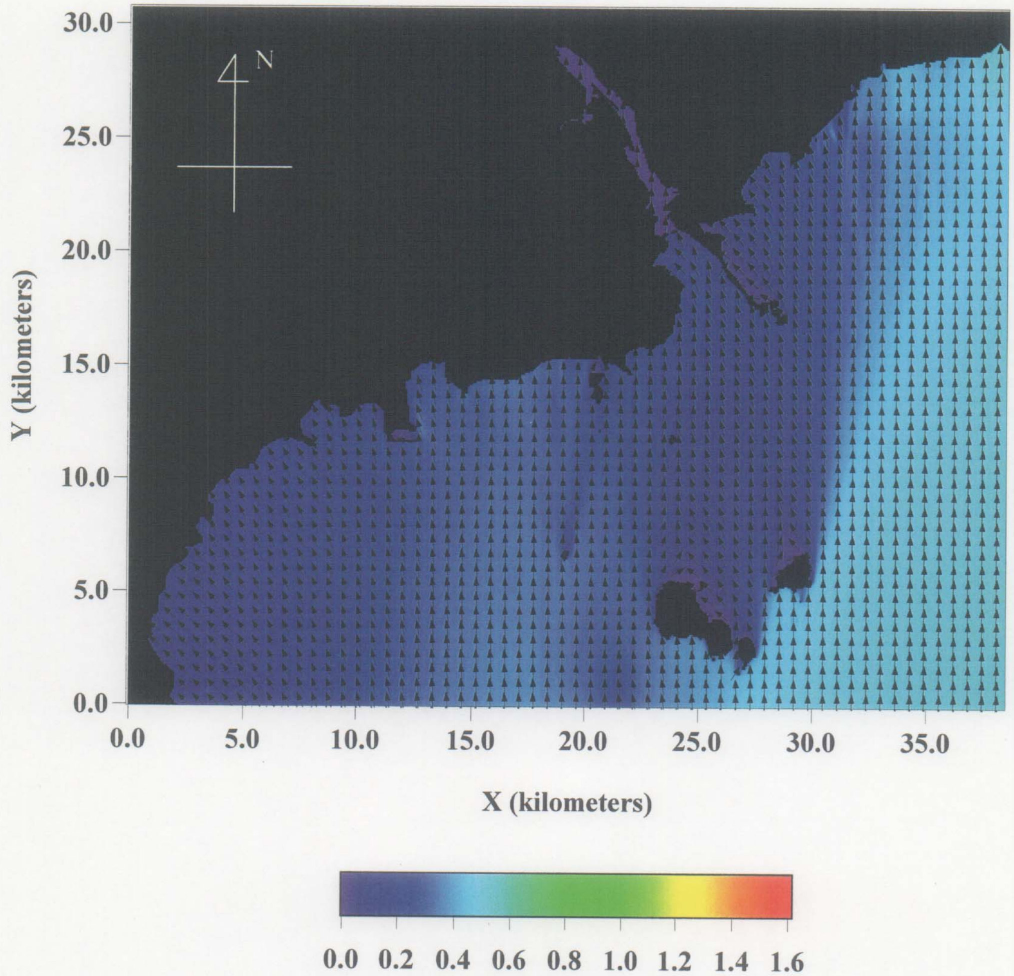


Figure A.2.2.56 Ratio of Wave Height and Mean Wave Directions (Local Model)

(In the case.01_3 ; 6-second-period-waves from 215 degrees)

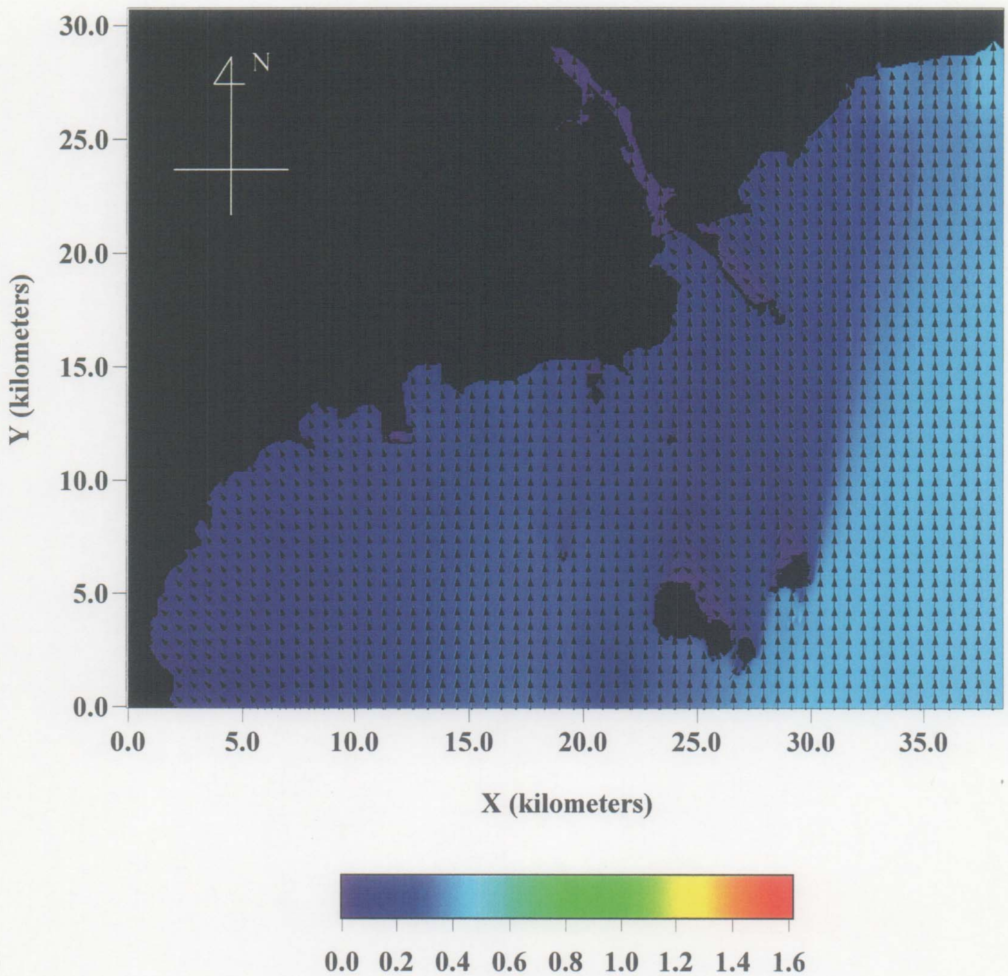


Figure A.2.2.57 Ratio of Wave Height and Mean Wave Directions (Local Model)

(In the case.01_4 ; 6-second-period-waves from 220 degrees)

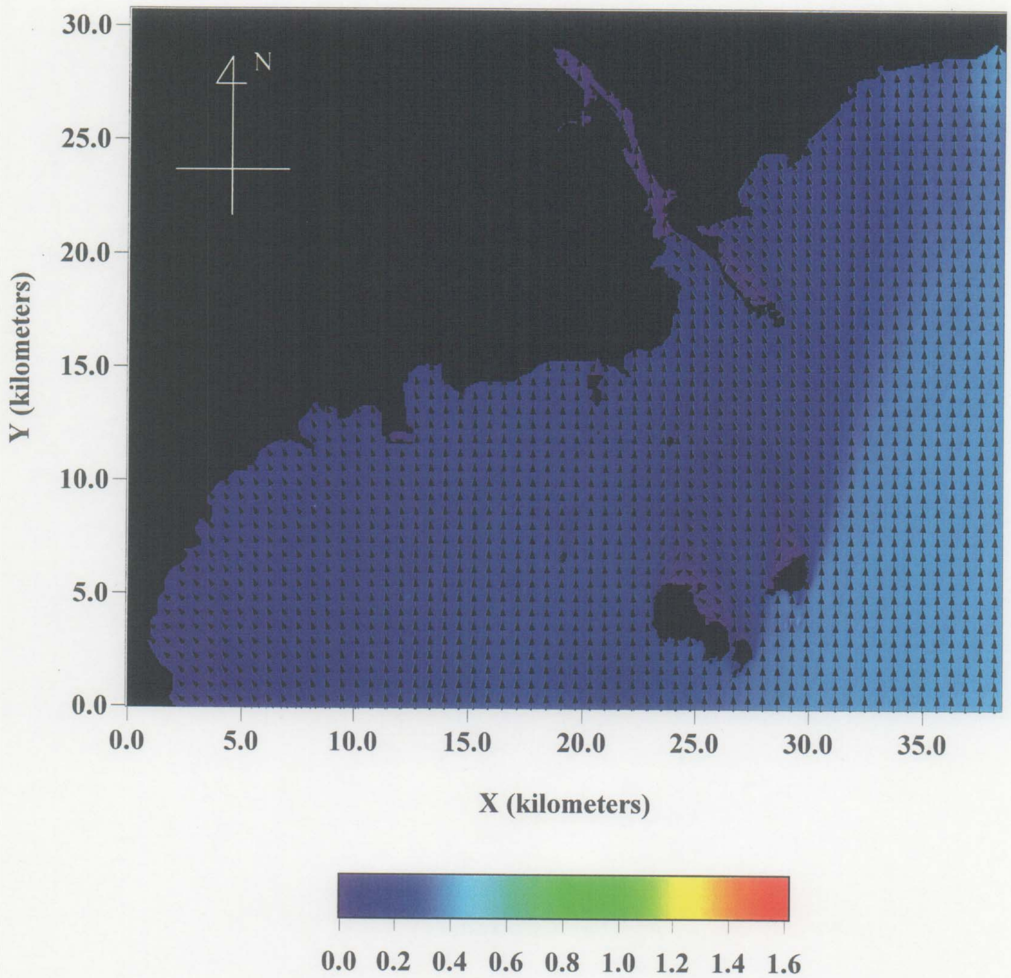


Figure A.2.2.58 Ratio of Wave Height and Mean Wave Directions (Local Model)

(In the case.01_5 ; 6-second-period-waves from 225 degrees)

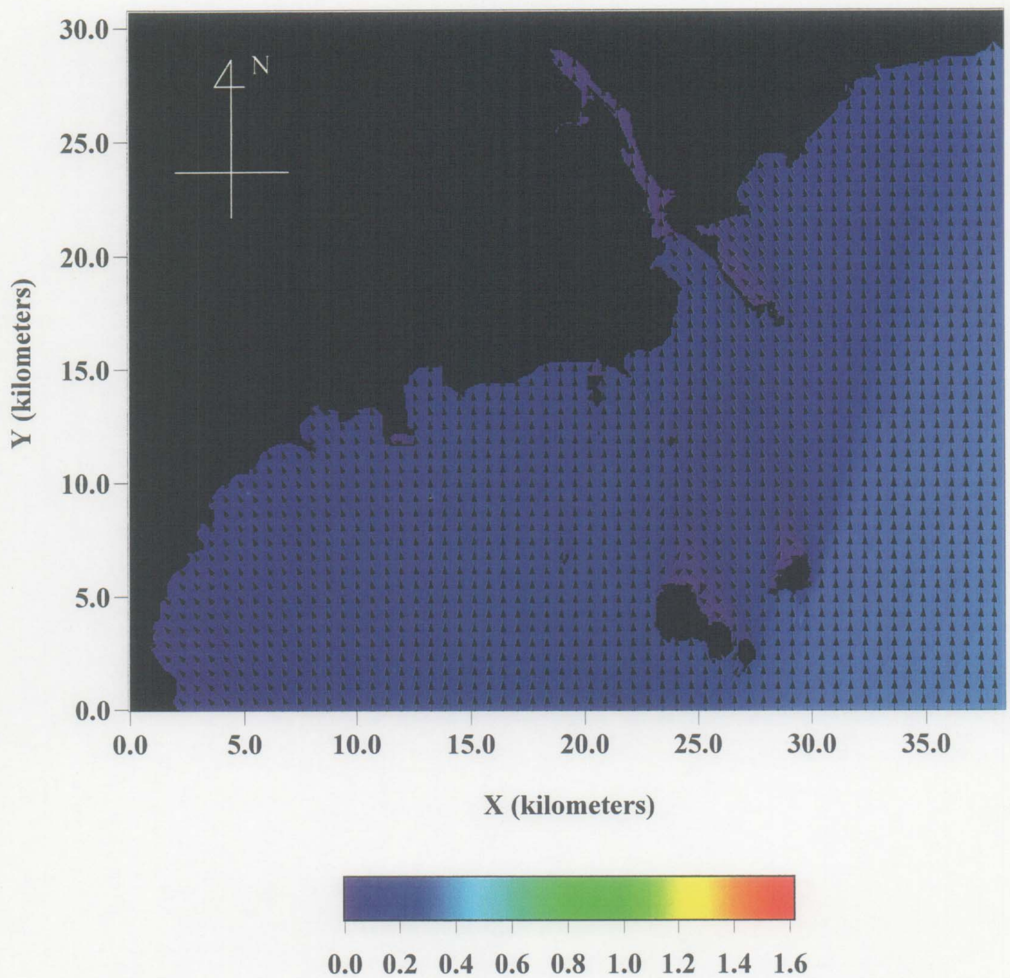


Figure A.2.2.59 Ratio of Wave Height and Mean Wave Directions（Local Model）

（In the case.01_6 ; 6-second-period-waves from 230 degrees）

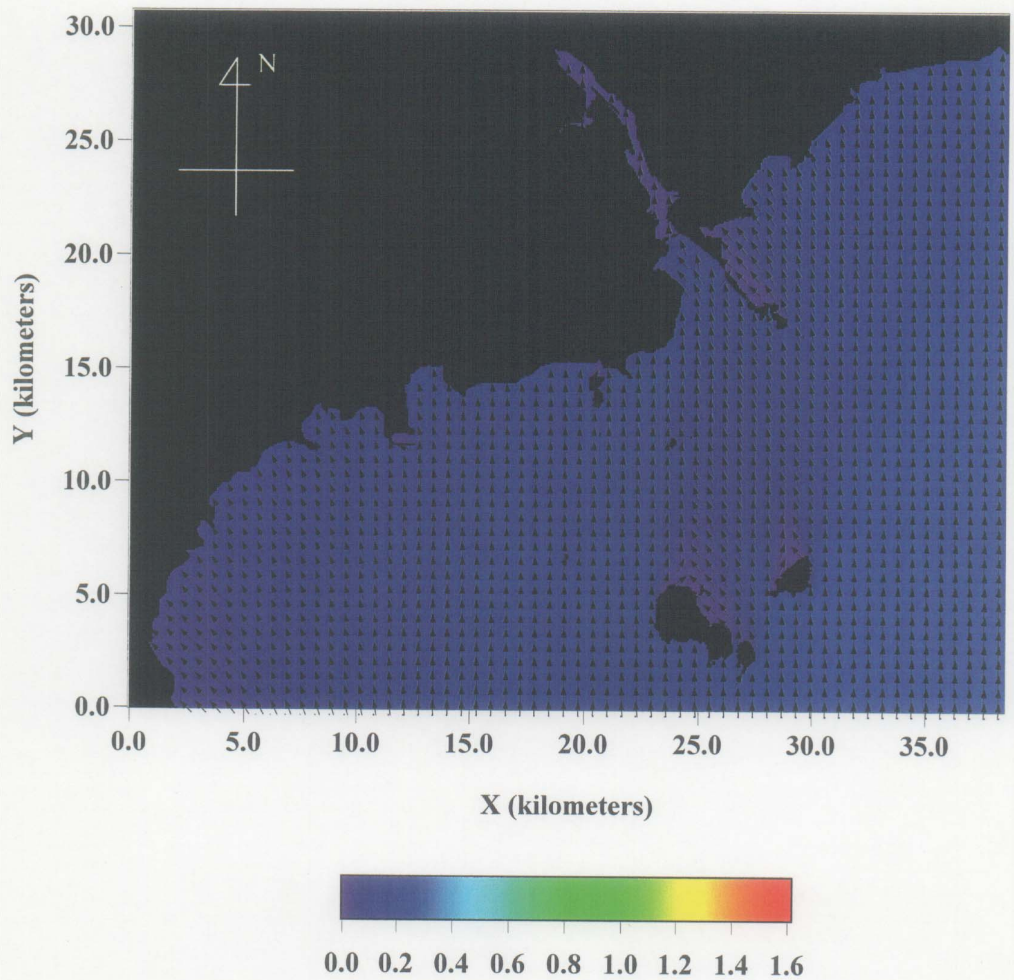


Figure A.2.2.60 Ratio of Wave Height and Mean Wave Directions (Local Model)

(In the case.01_7 ; 6-second-period-waves from 235 degrees)

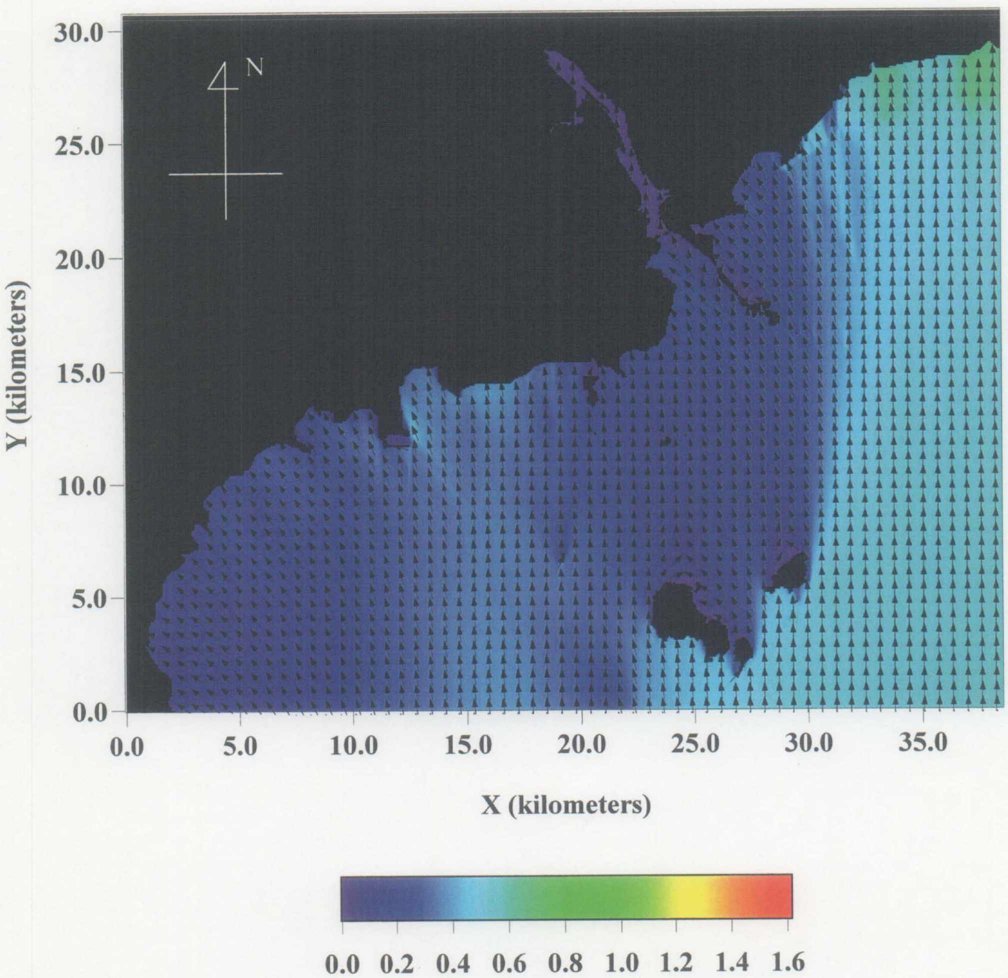


Figure A.2.2.61 Ratio of Wave Height and Mean Wave Directions (Local Model)

(In the case.02_2 ; 8-second-period-waves from 210 degrees)

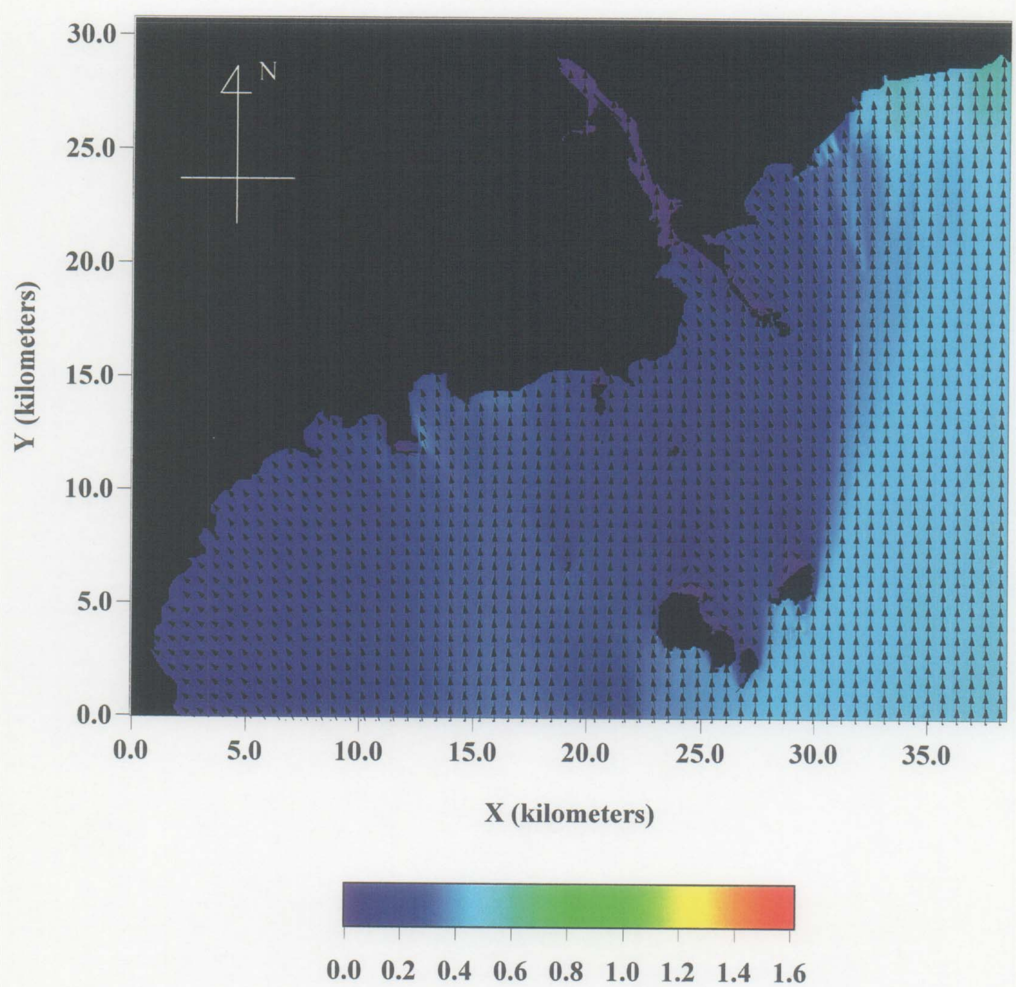


Figure A.2.2.62 Ratio of Wave Height and Mean Wave Directions (Local Model)

(In the case.02_3 ; 8-second-period-waves from 215 degrees)

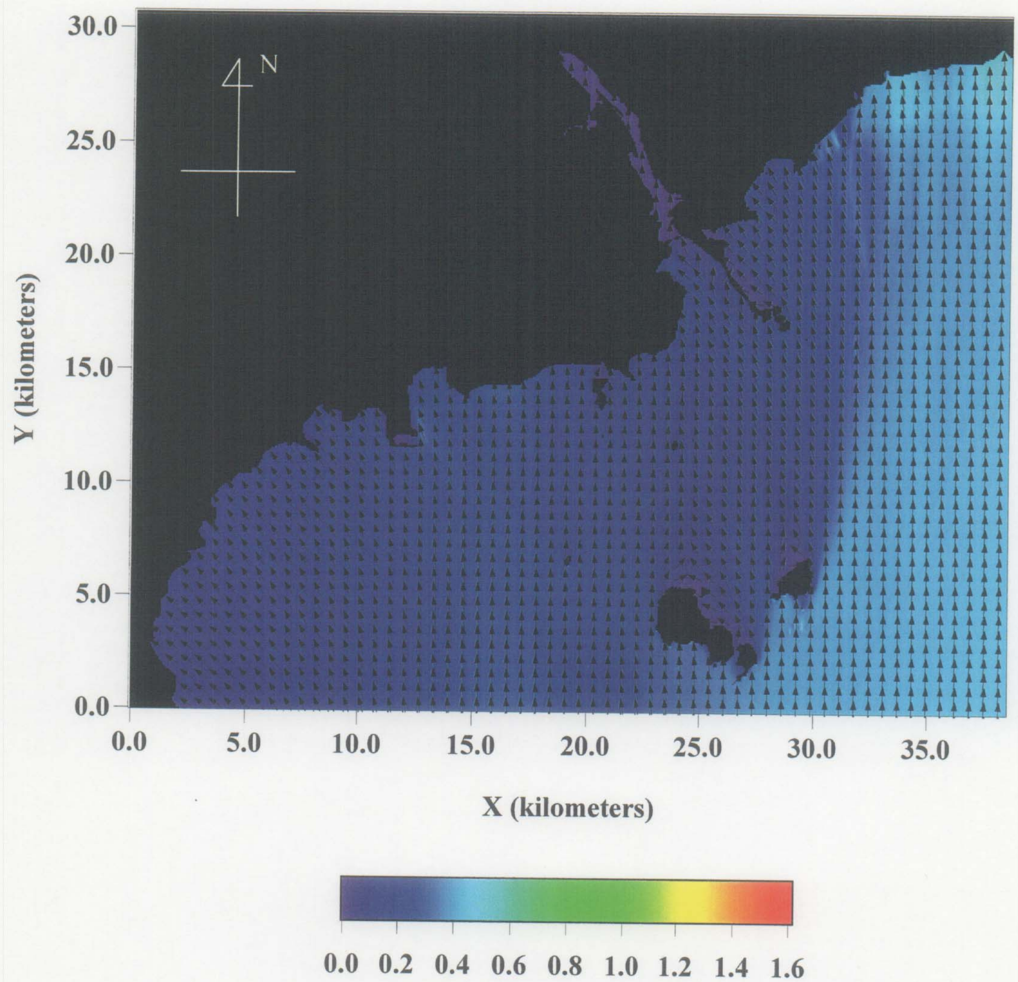


Figure A.2.2.63 Ratio of Wave Height and Mean Wave Directions (Local Model)
(In the case.02_4 ; 8-second-period-waves from 220 degrees)

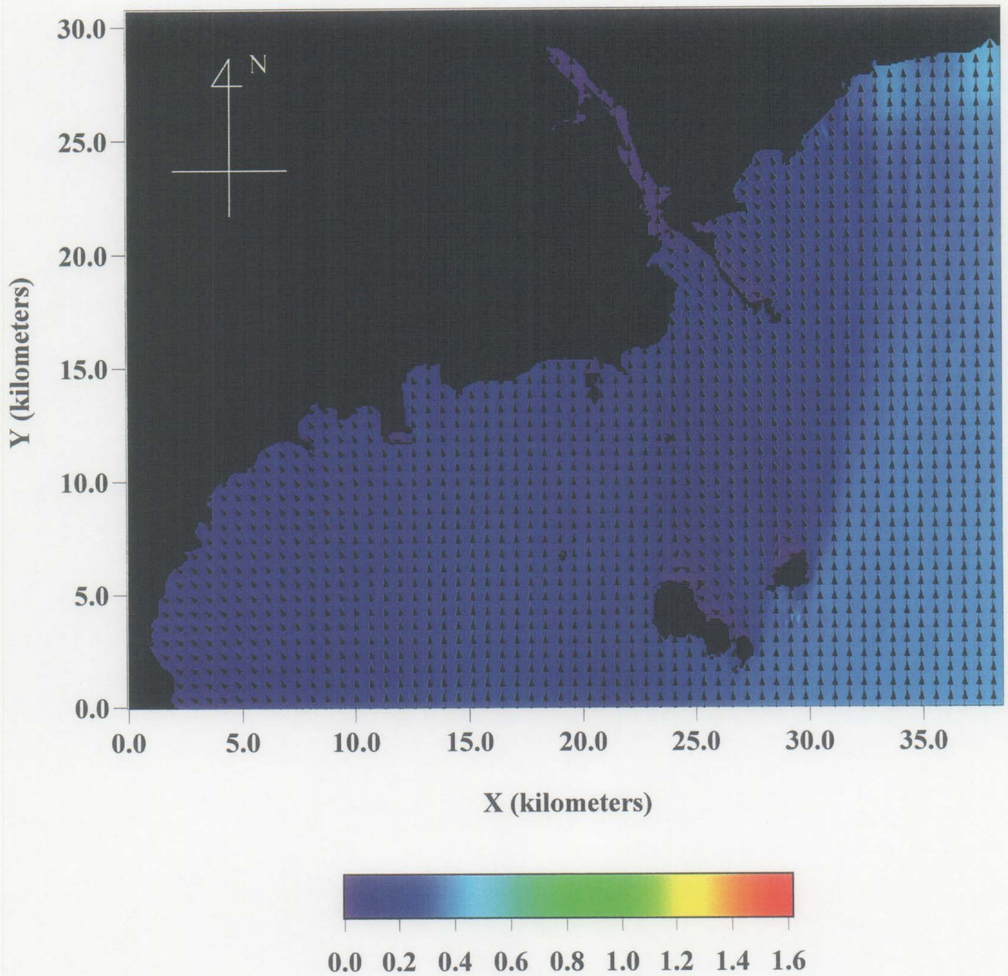


Figure A.2.2.64 Ratio of Wave Height and Mean Wave Directions (Local Model)

(In the case.02_5 ; 8-second-period-waves from 225 degrees)

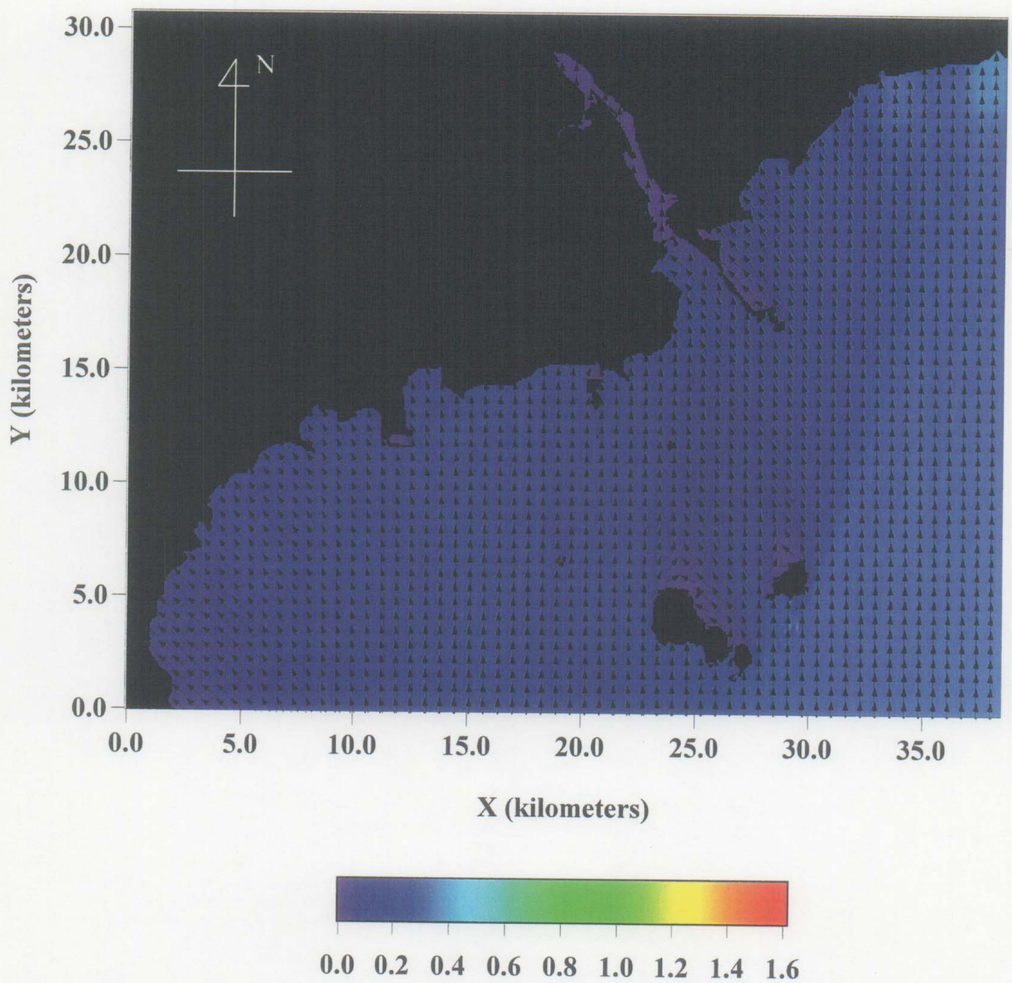


Figure A.2.2.65 Ratio of Wave Height and Mean Wave Directions (Local Model)

(In the case.02_6 ; 8-second-period-waves from 230 degrees)

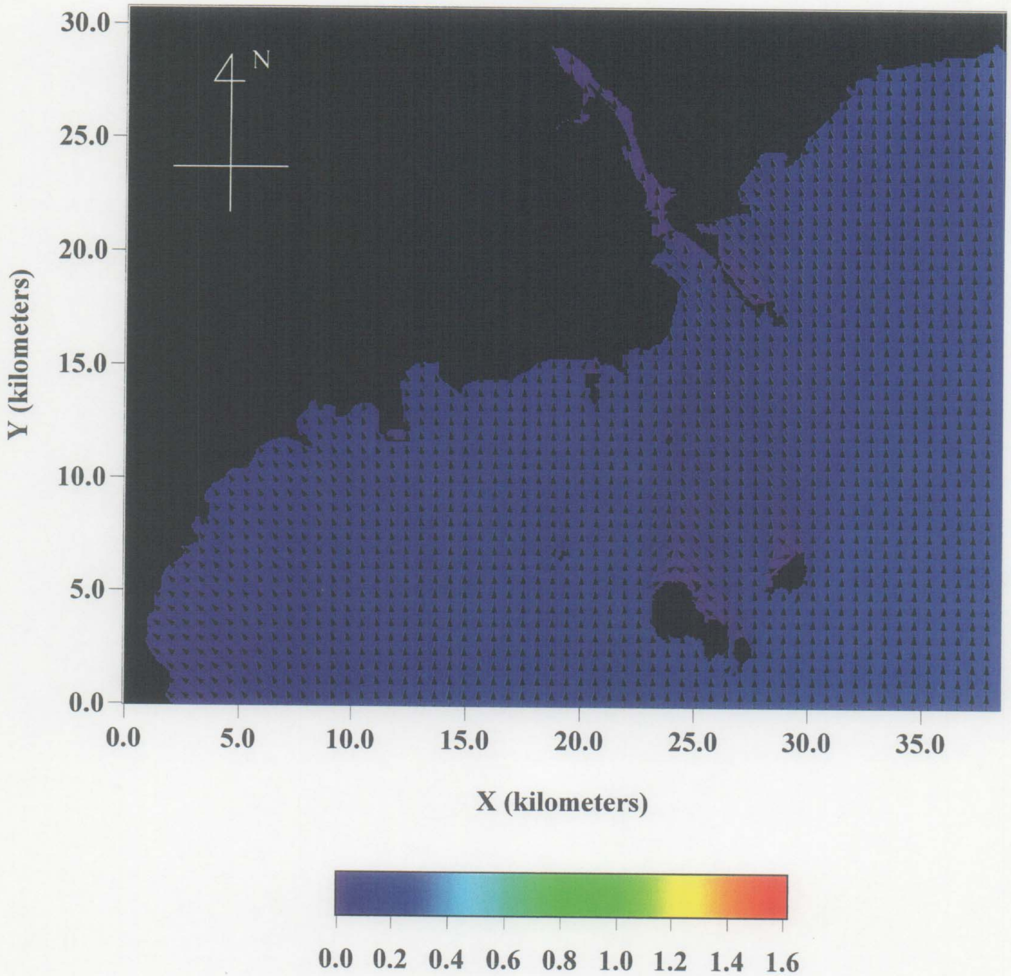


Figure A.2.2.66 Ratio of Wave Height and Mean Wave Directions (Local Model)

(In the case.02_7 ; 8-second-period-waves from 235 degrees)

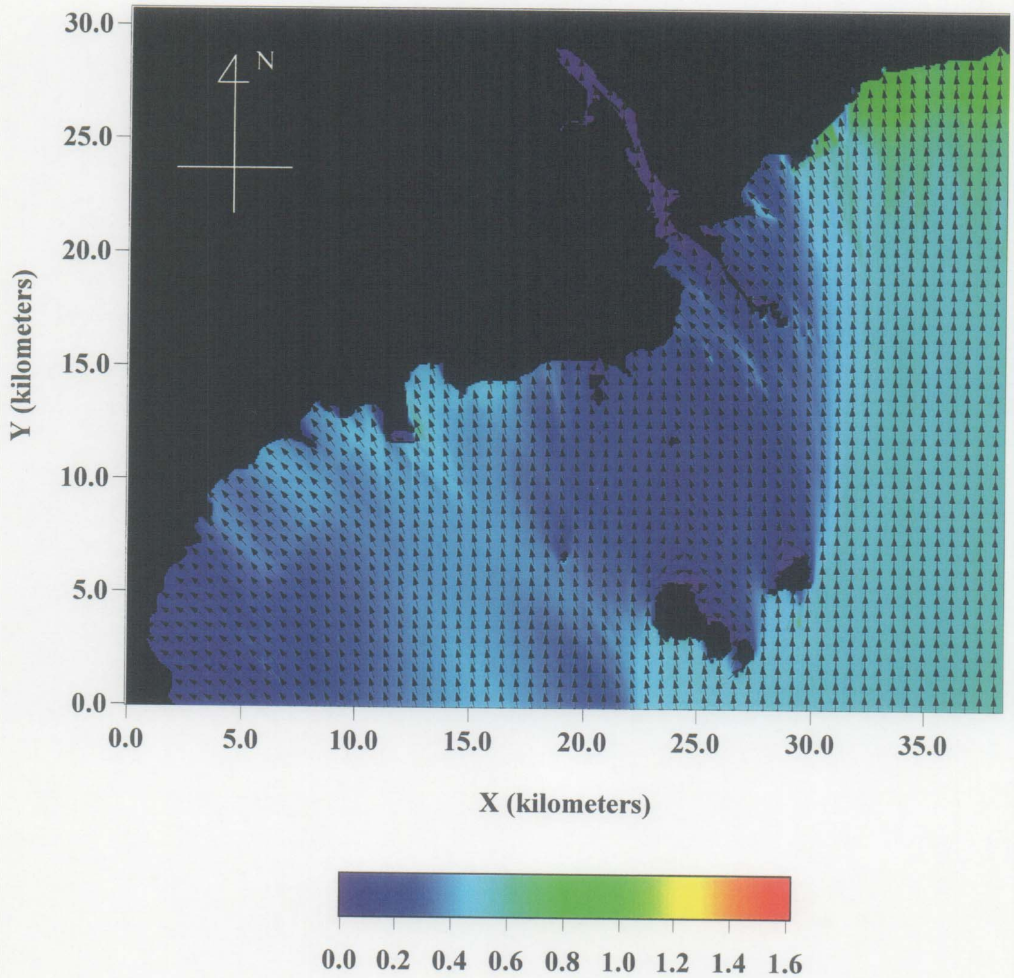


Figure A.2.2.67 Ratio of Wave Height and Mean Wave Directions (Local Model)

(In the case.03_1 ; 10-second-period-waves from 205 degrees)

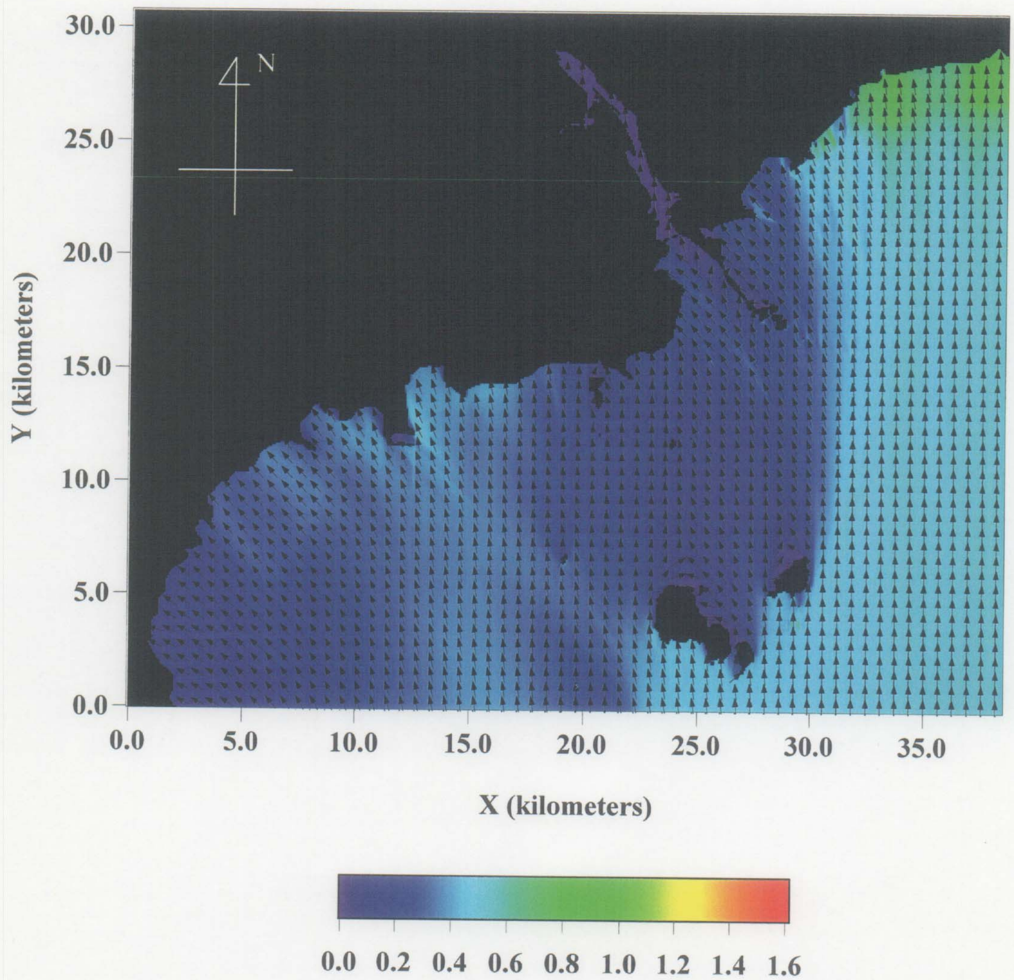


Figure A.2.2.68 Ratio of Wave Height and Mean Wave Directions（Local Model)

(In the case.03_2 ; 10-second-period-waves from 210 degrees)

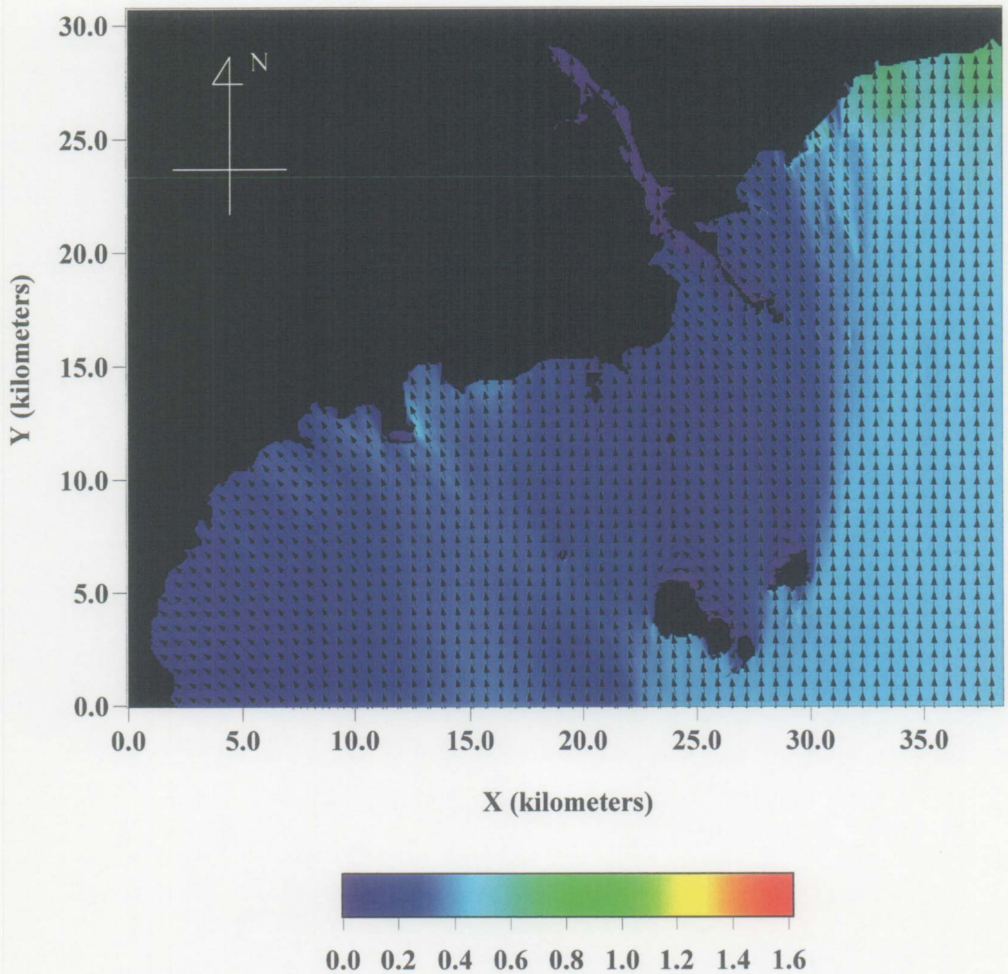


Figure A.2.2.69 Ratio of Wave Height and Mean Wave Directions (Local Model)

(In the case.03_3 ; 10-second-period-waves from 215 degrees)

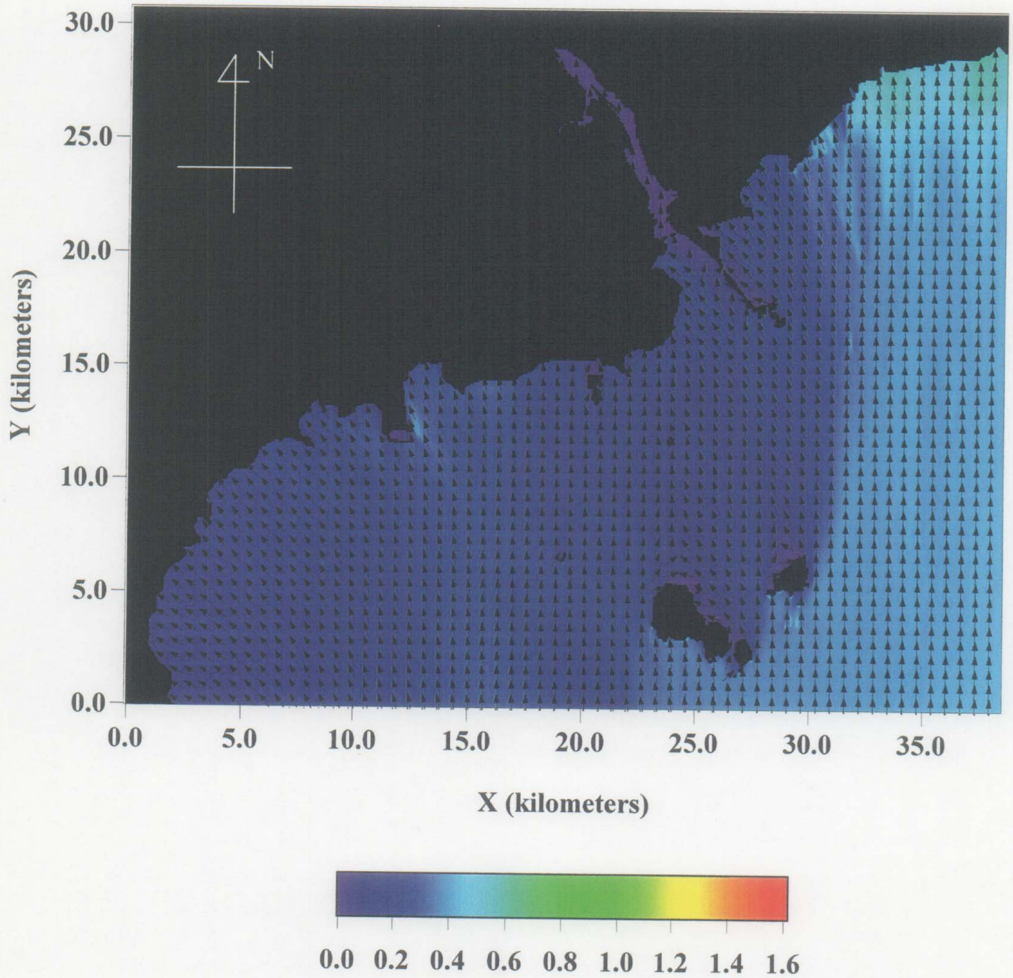


Figure A.2.2.70 Ratio of Wave Height and Mean Wave Directions (Local Model)

(In the case.03_4 ; 10-second-period-waves from 220 degrees)

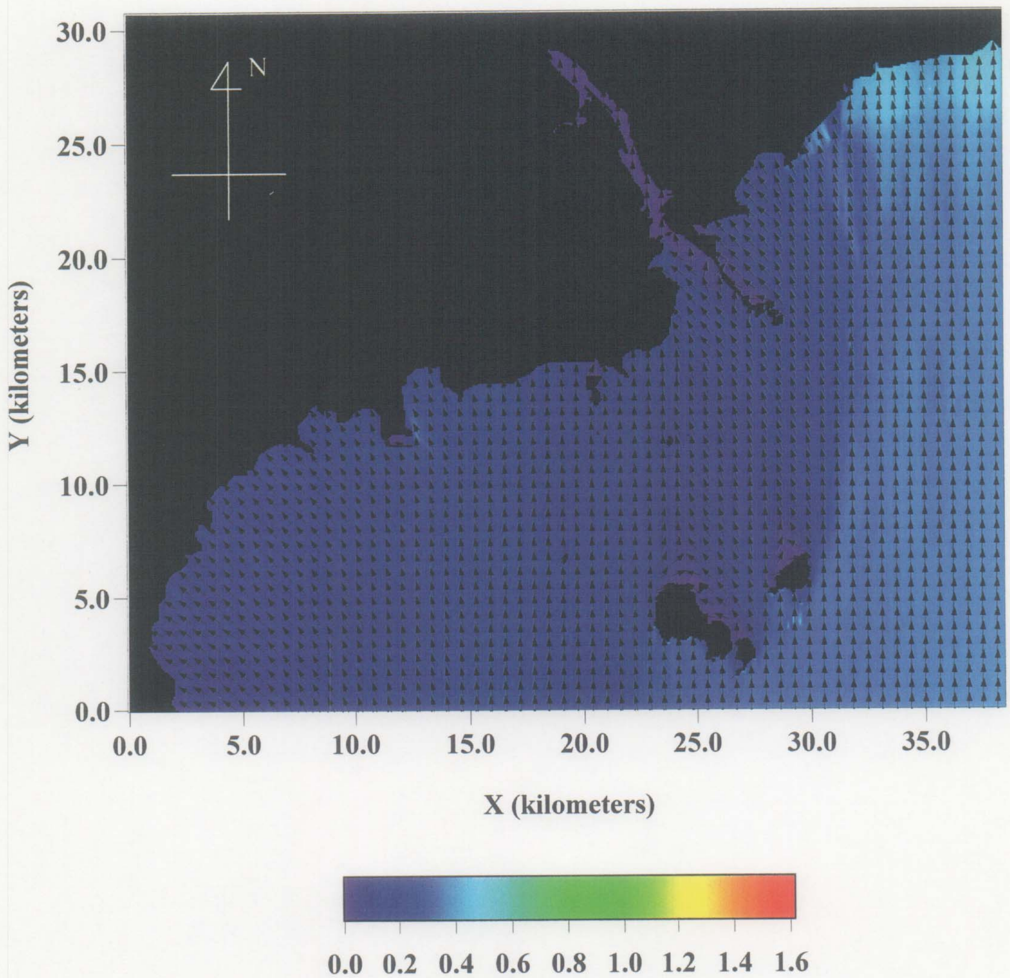


Figure A.2.2.71 Ratio of Wave Height and Mean Wave Directions（Local Model）

（In the case.03_5 ; 10-second-period-waves from 225 degrees）

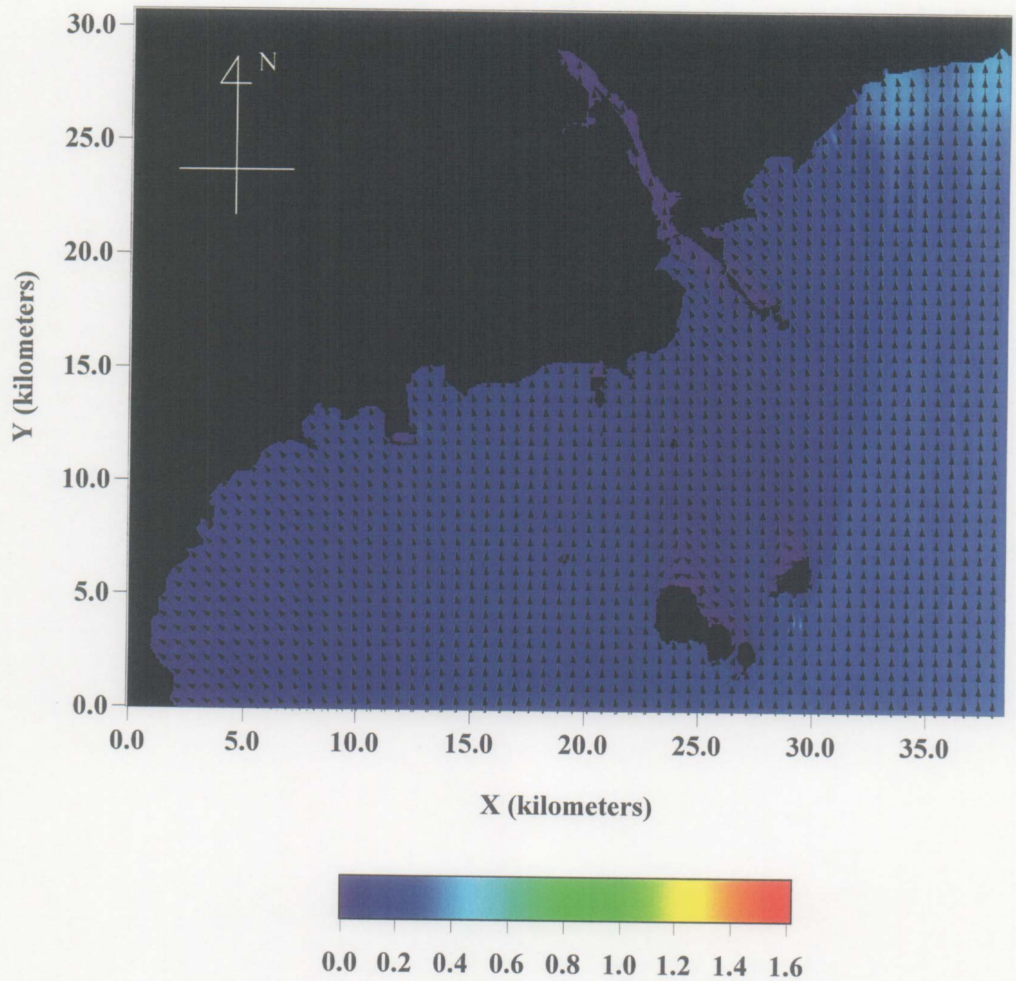


Figure A.2.2.72 Ratio of Wave Height and Mean Wave Directions (Local Model)

(In the case.03_6 ; 10-second-period-waves from 230 degrees)

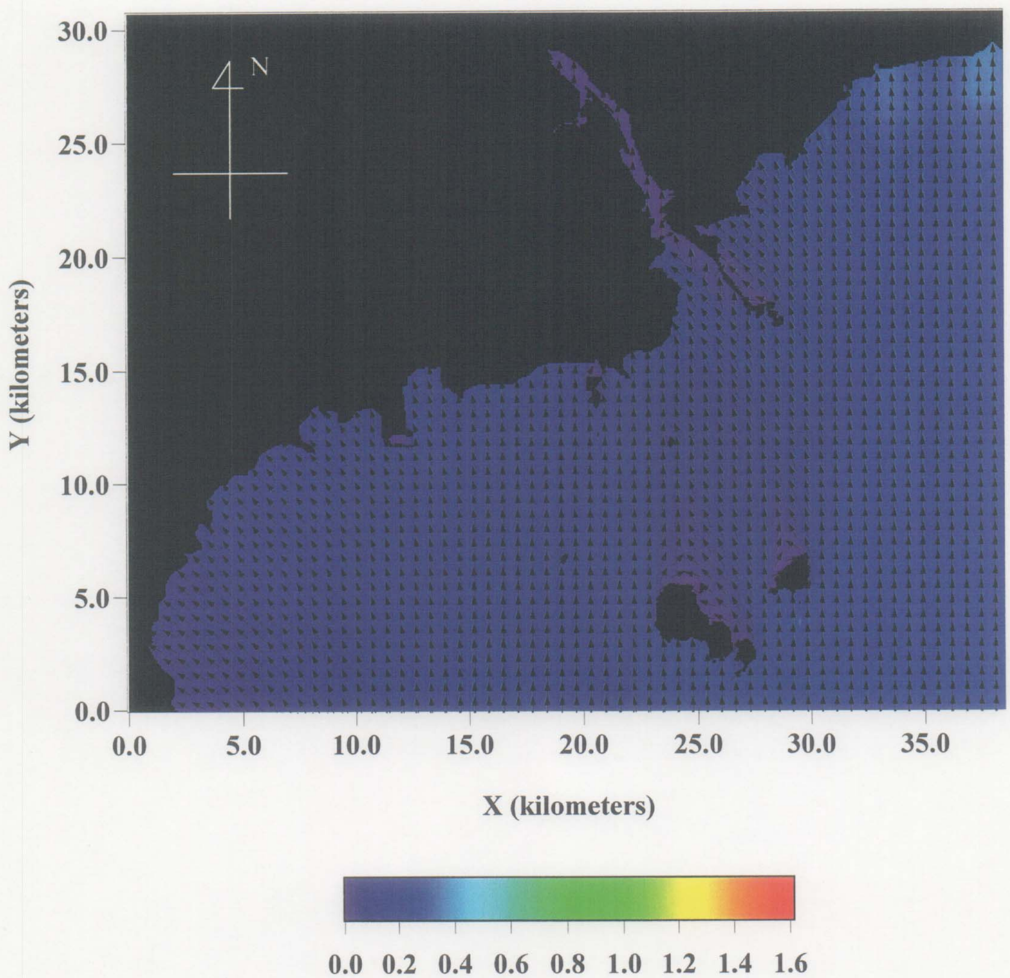


Figure A.2.2.73 Ratio of Wave Height and Mean Wave Directions（Local Model）

（In the case.03_7 ; 10-second-period-waves from 235 degrees）

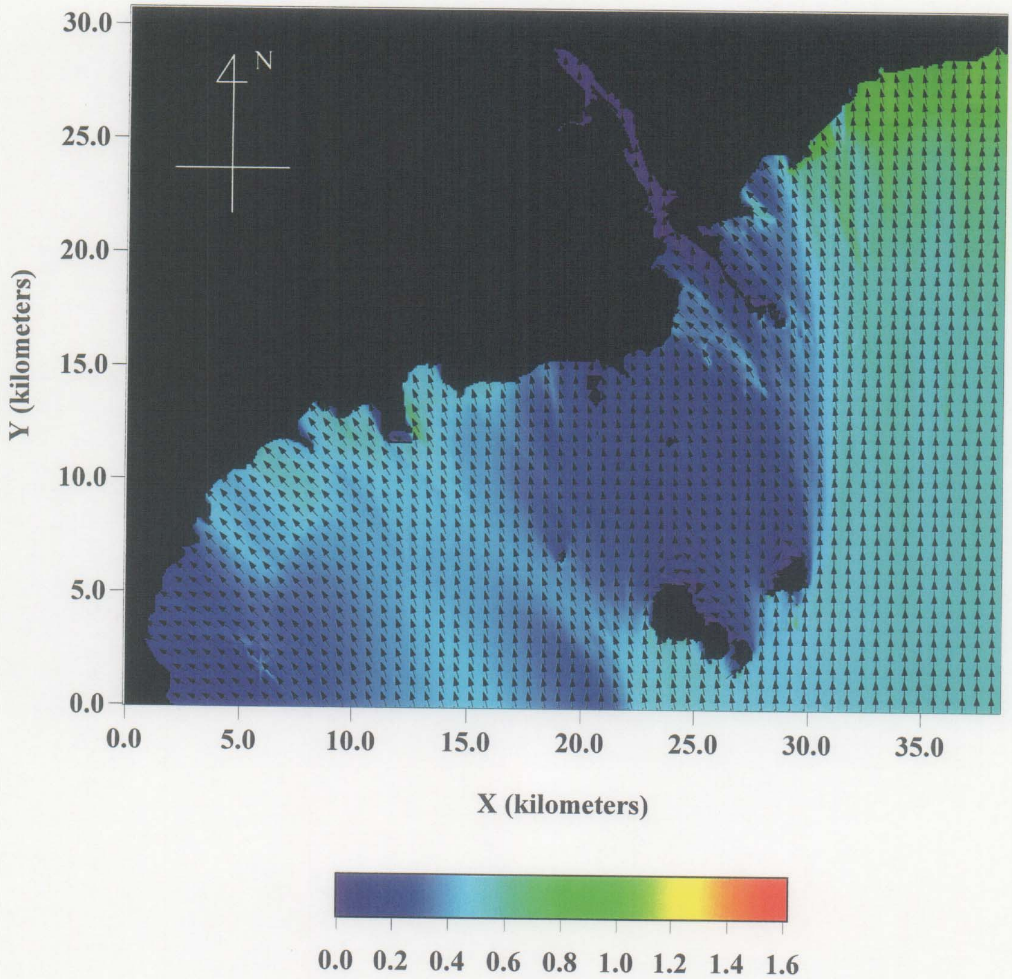


Figure A.2.2.74 Ratio of Wave Height and Mean Wave Directions (Local Model)
(In the case.04_1 ; 12-second-period-waves from 205 degrees)

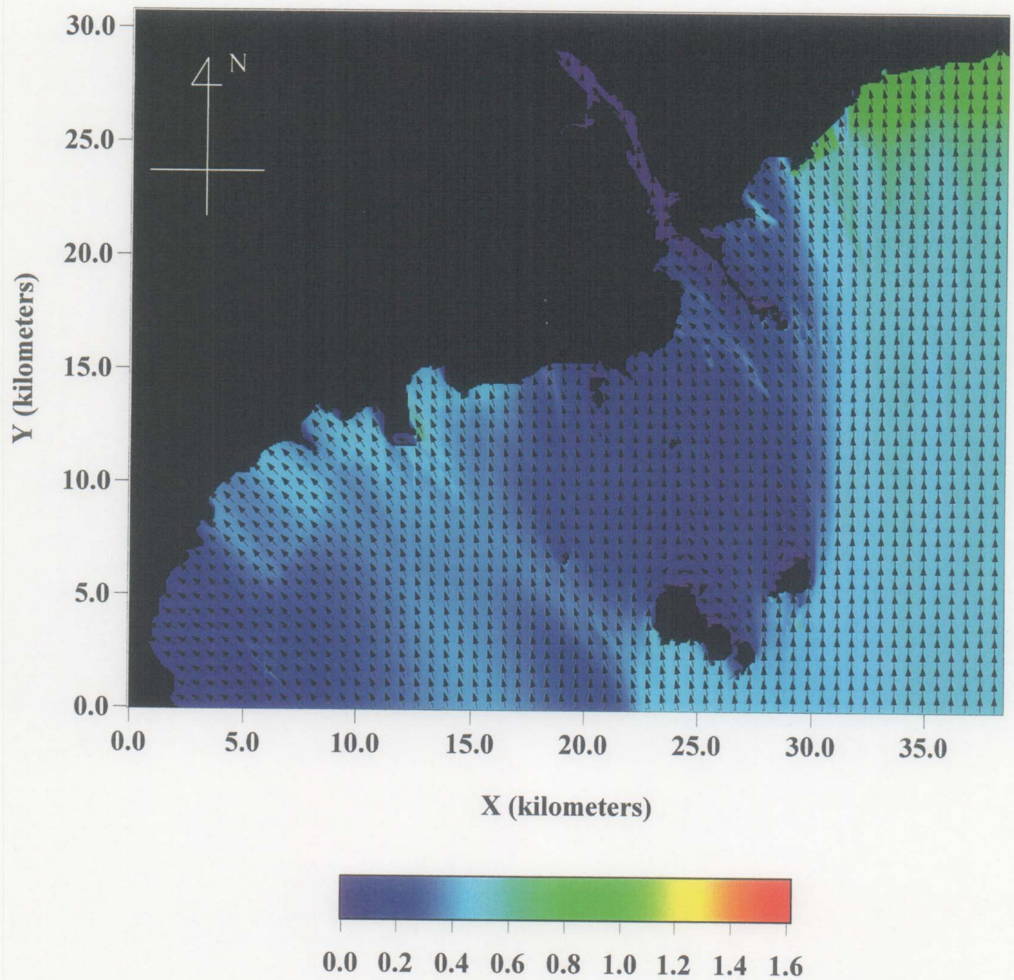


Figure A.2.2.75 Ratio of Wave Height and Mean Wave Directions (Local Model)

(In the case.04_2 ; 12-second-period-waves from 210 degrees)

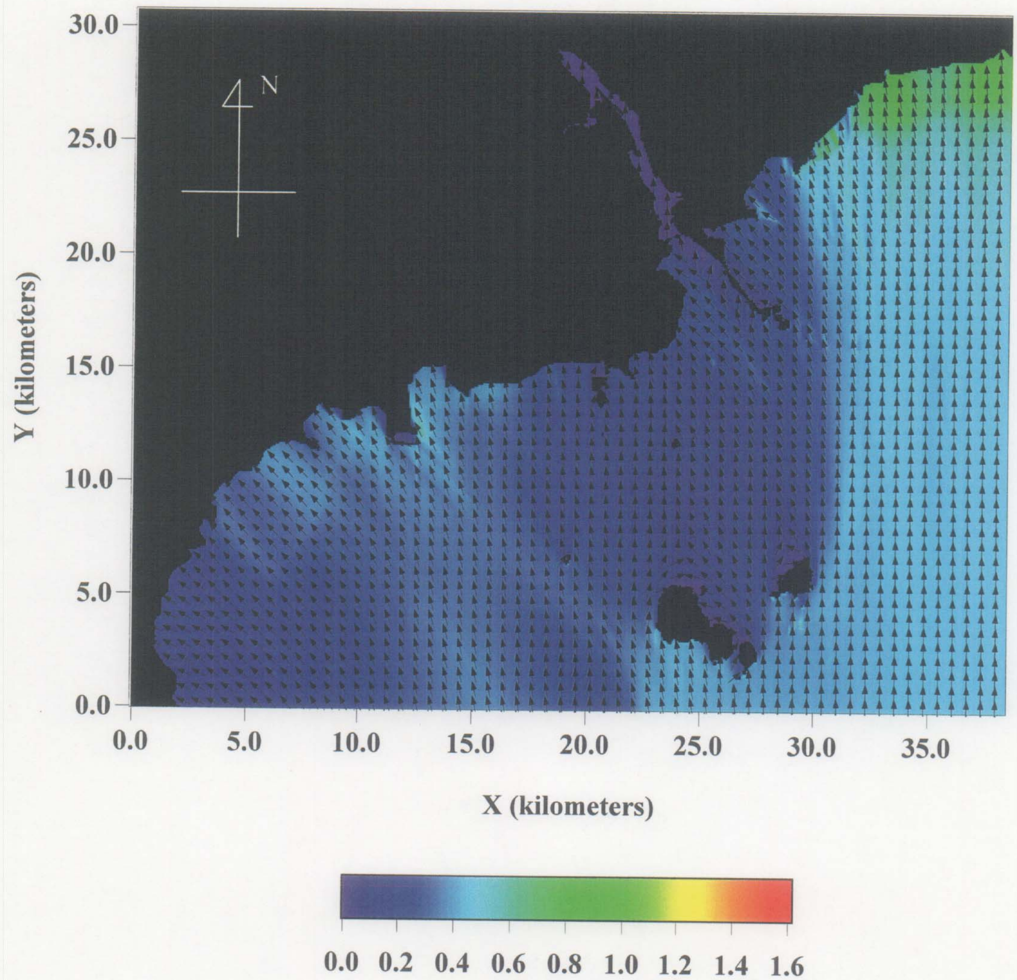


Figure A.2.2.76 Ratio of Wave Height and Mean Wave Directions (Local Model)

(In the case.04_3 ; 12-second-period-waves from 215 degrees)

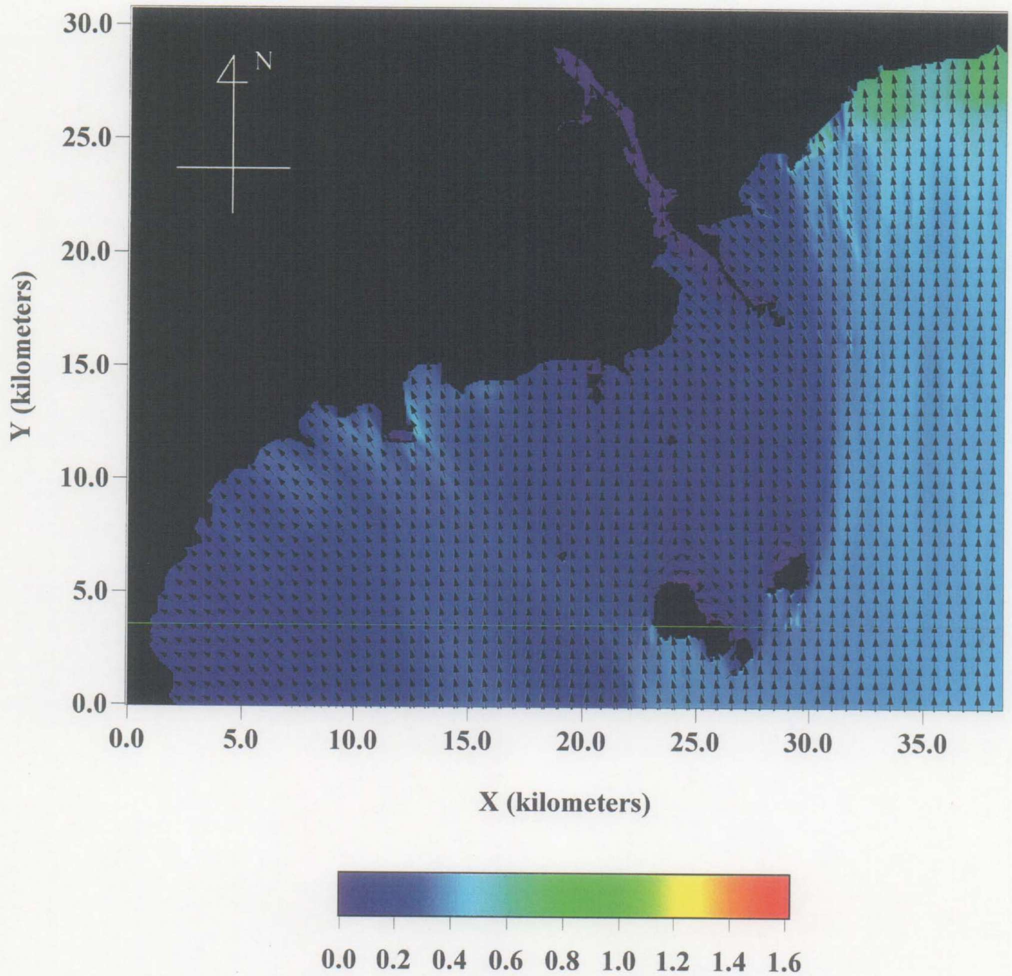


Figure A.2.2.77 Ratio of Wave Height and Mean Wave Directions (Local Model)

(In the case.04_4 ; 12-second-period-waves from 220 degrees)

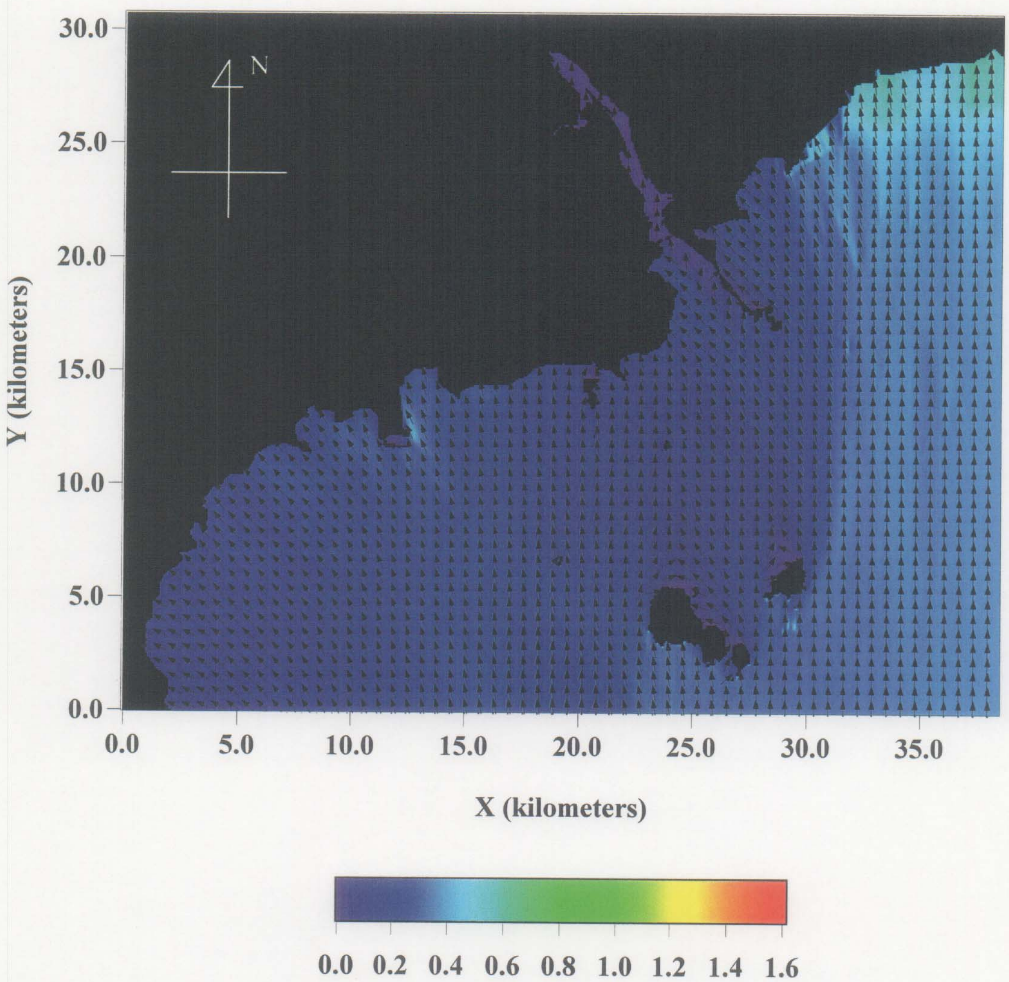


Figure A.2.2.78 Ratio of Wave Height and Mean Wave Directions (Local Model)

(In the case.04_5 ; 12-second-period-waves from 225 degrees)

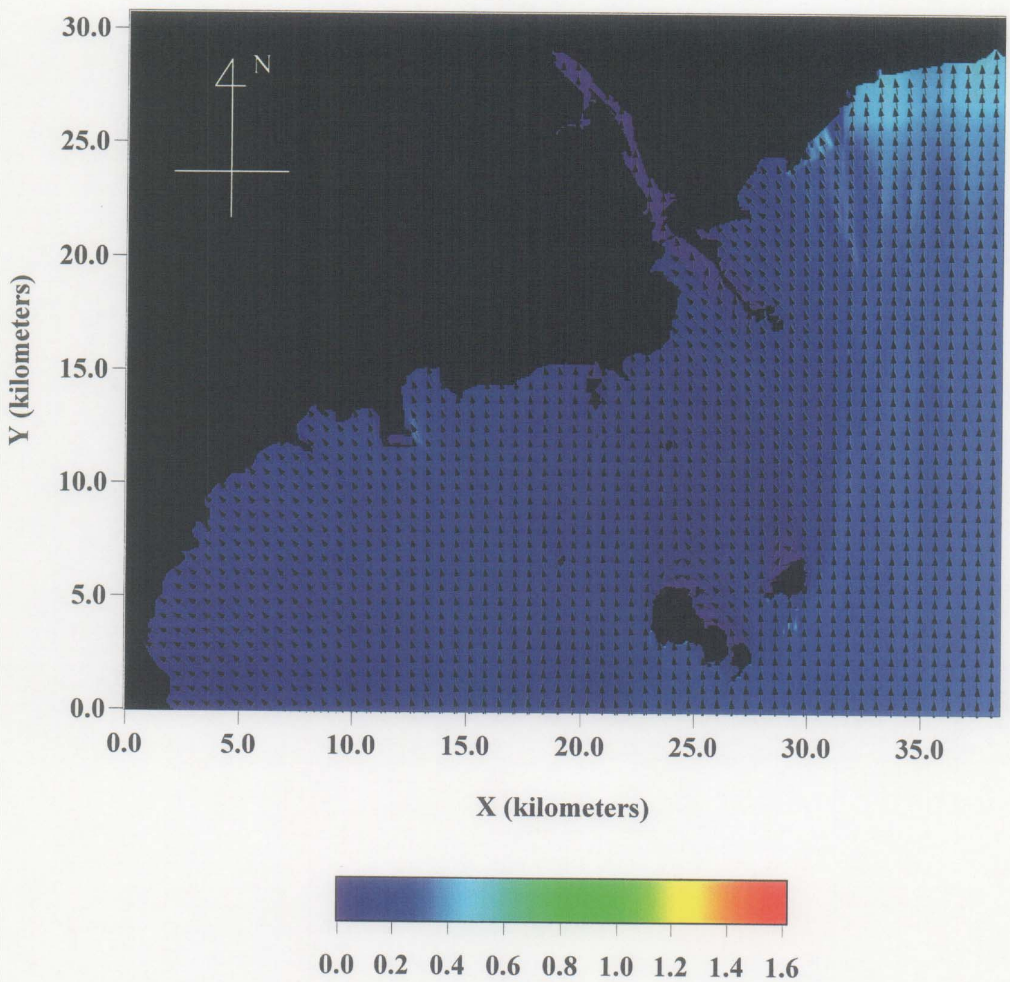


Figure A.2.2.79 Ratio of Wave Height and Mean Wave Directions (Local Model)

(In the case.04_6 ; 12-second-period-waves from 230 degrees)

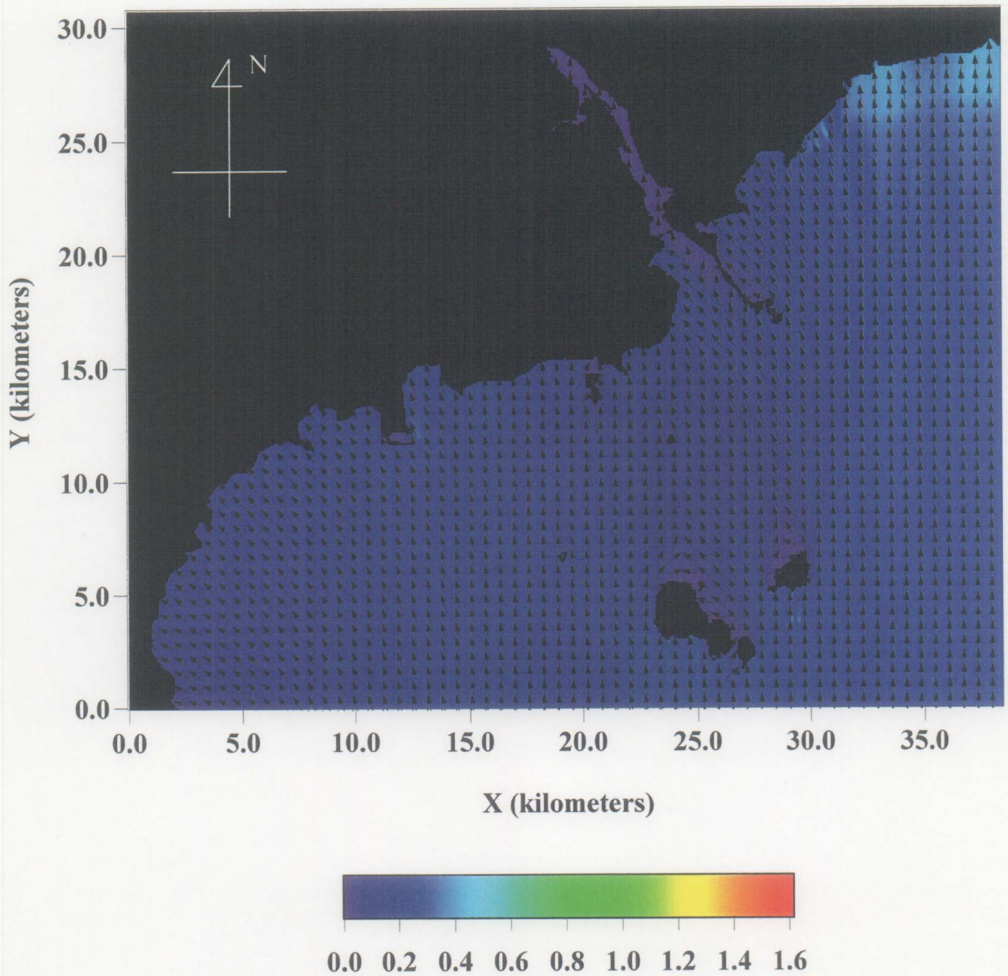


Figure A.2.2.80 Ratio of Wave Height and Mean Wave Directions (Local Model)

(In the case.04_7 ; 12-second-period-waves from 235 degrees)

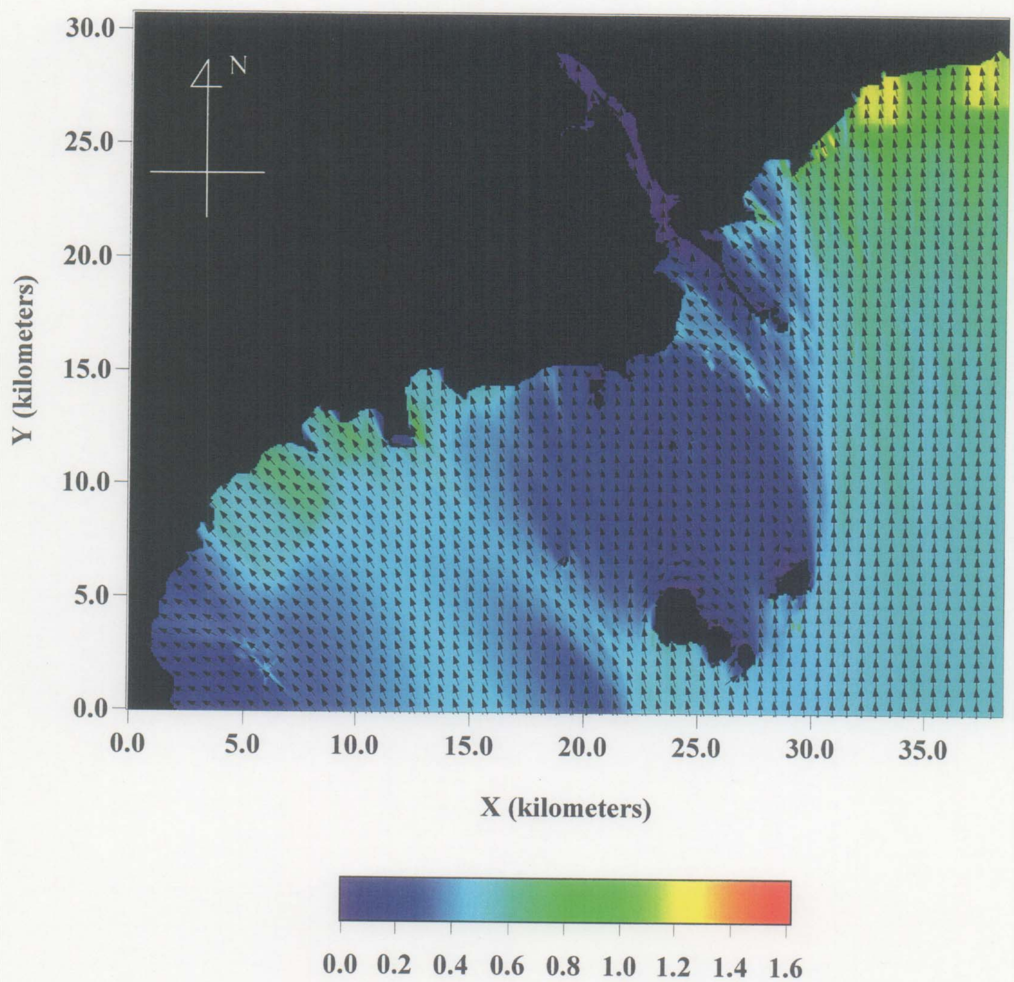


Figure A.2.2.81 Ratio of Wave Height and Mean Wave Directions (Local Model)

(In the case.05_1 ; 14-second-period-waves from 205 degrees)

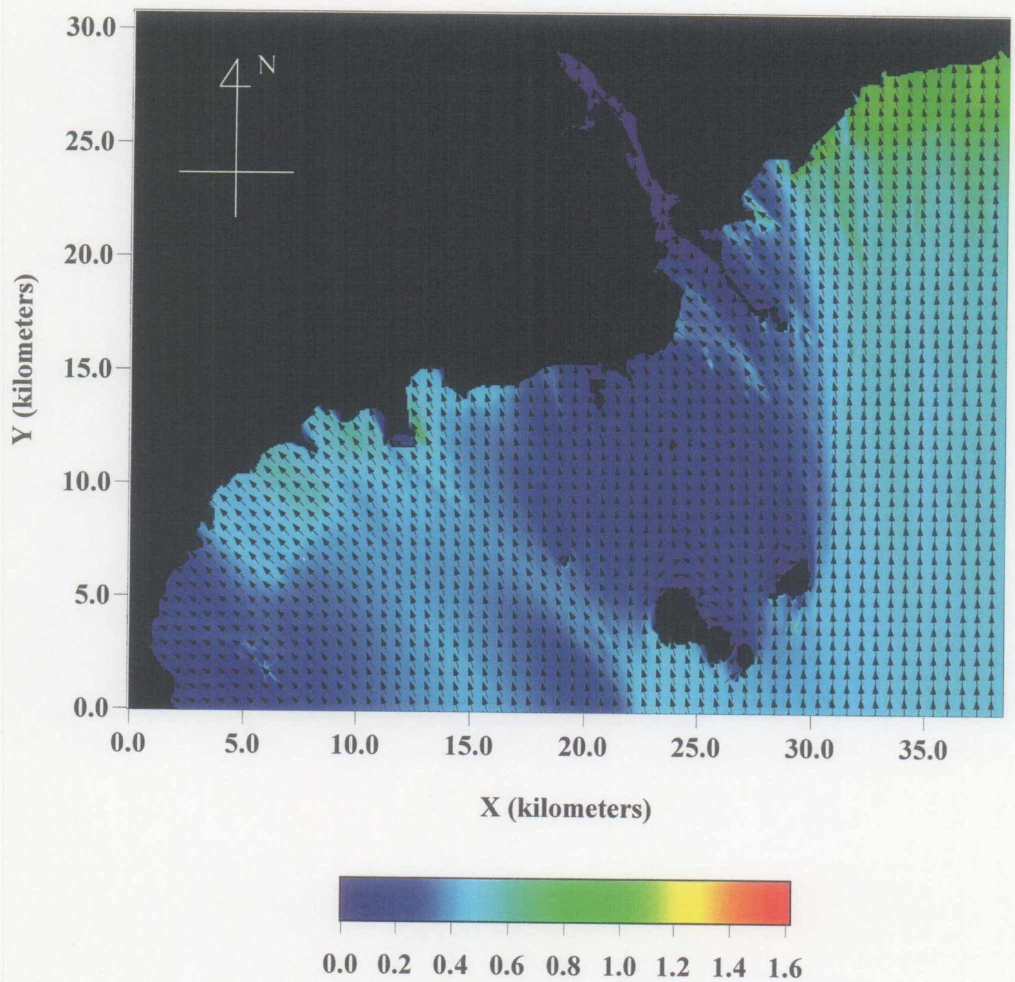


Figure A.2.2.82 Ratio of Wave Height and Mean Wave Directions (Local Model)

(In the case.05_2 ; 14-second-period-waves from 210 degrees)

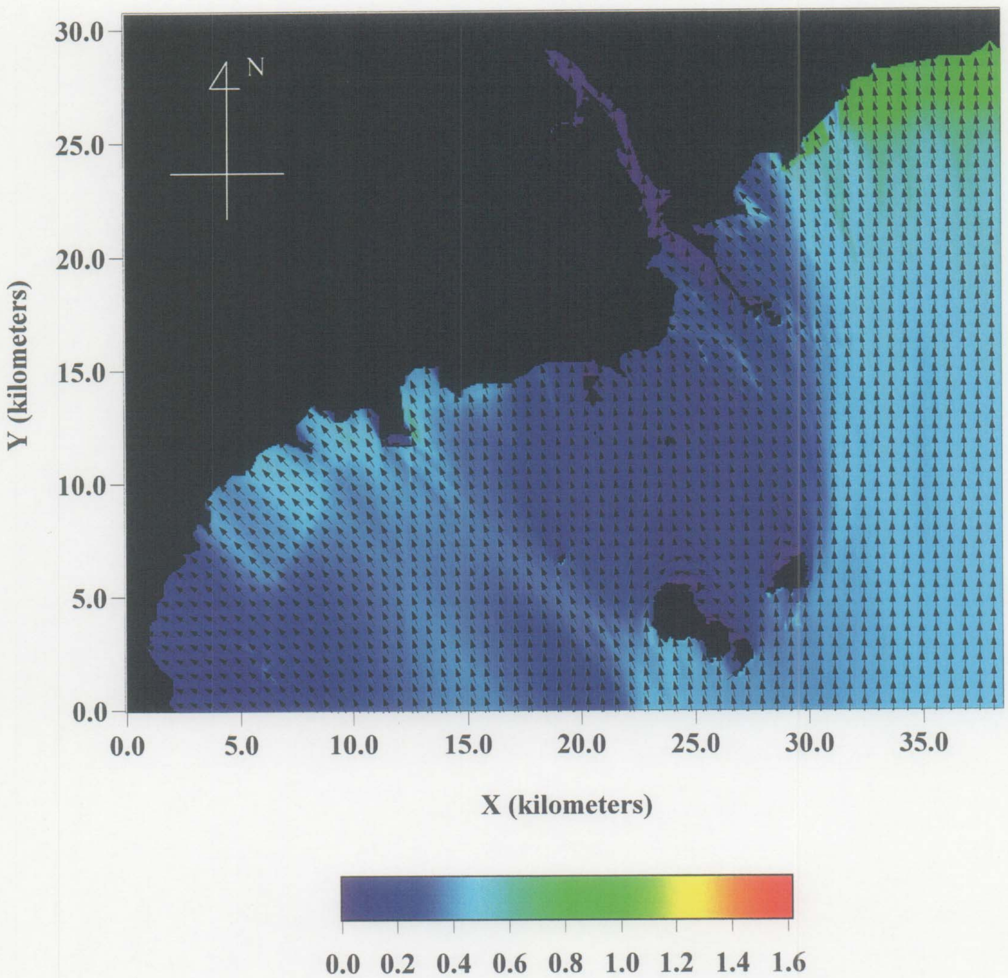


Figure A.2.2.83 Ratio of Wave Height and Mean Wave Directions（Local Model）

（In the case.05_3 ; 14-second-period-waves from 215 degrees）

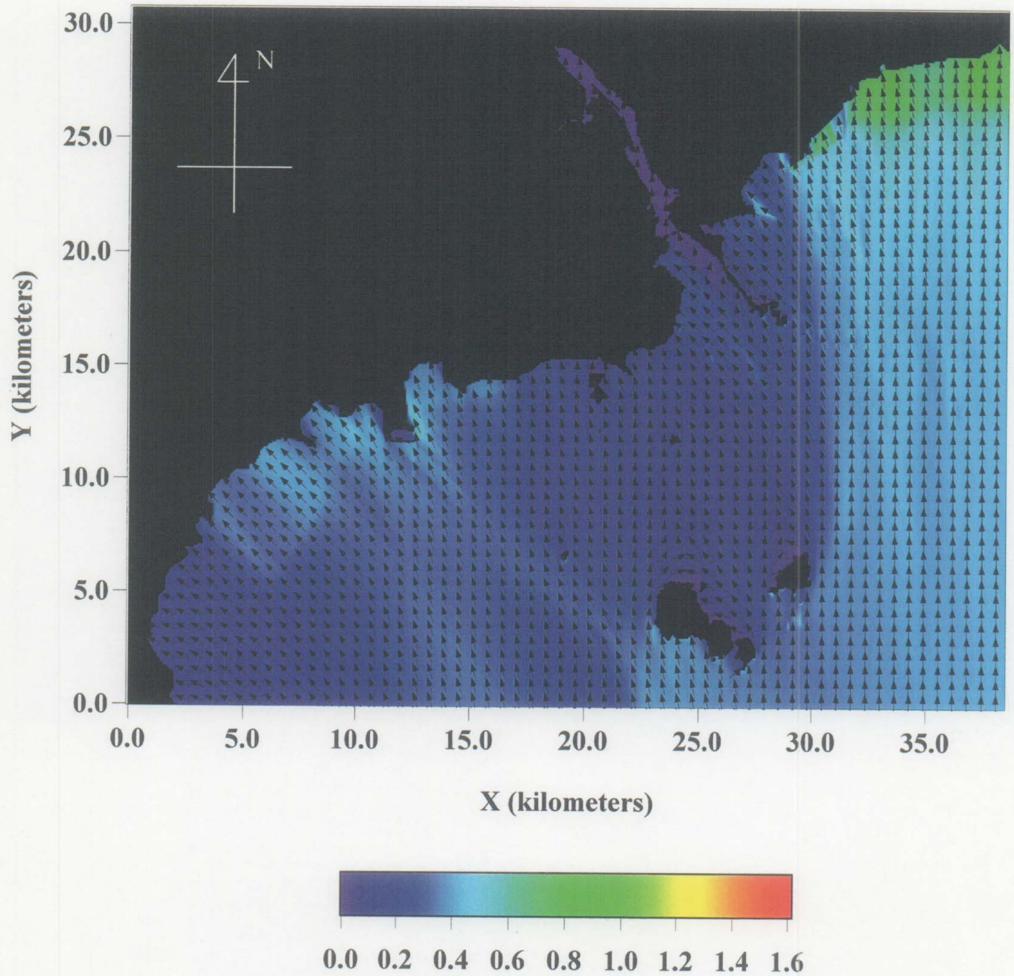


Figure A.2.2.84 Ratio of Wave Height and Mean Wave Directions (Local Model)
(In the case.05_4 ; 14-second-period-waves from 220 degrees)

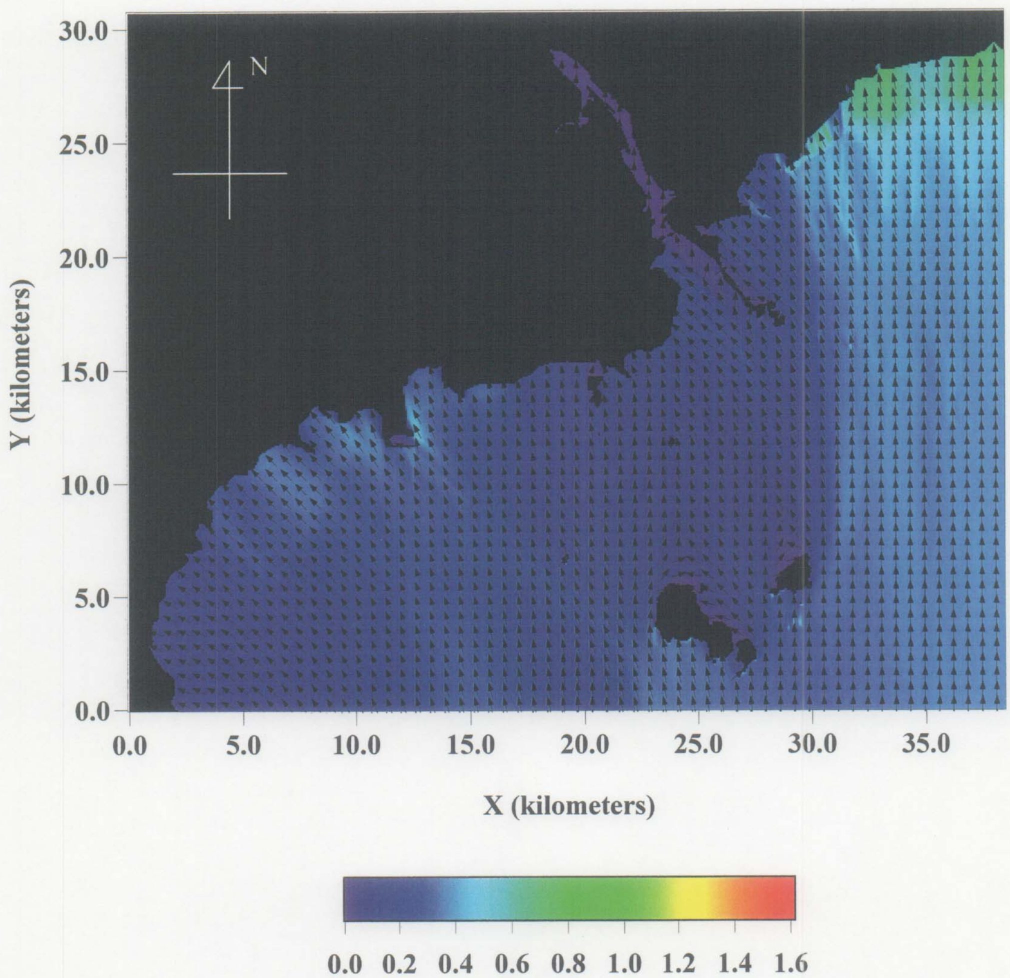


Figure A.2.2.85 Ratio of Wave Height and Mean Wave Directions (Local Model)

(In the case.05_5 ; 14-second-period-waves from 225 degrees)

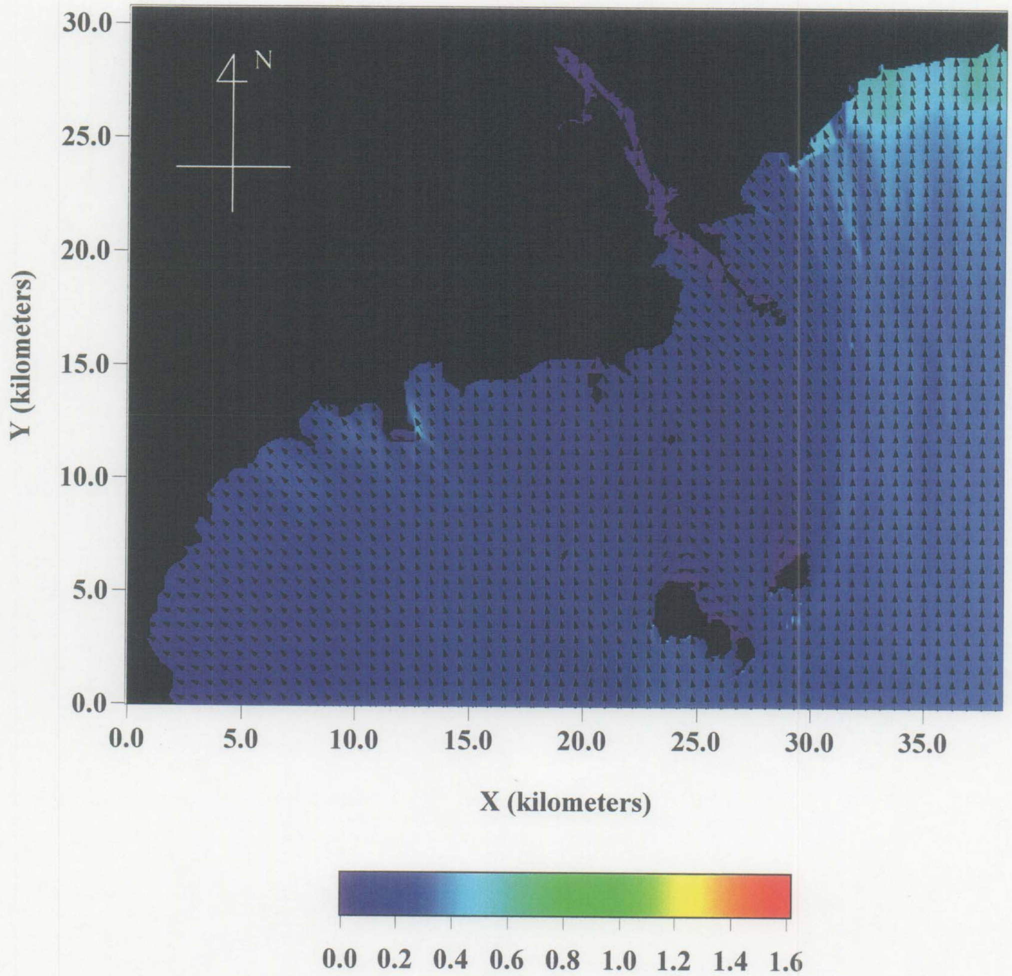


Figure A.2.2.86 Ratio of Wave Height and Mean Wave Directions (Local Model)

(In the case.05_6 ; 14-second-period-waves from 230 degrees)

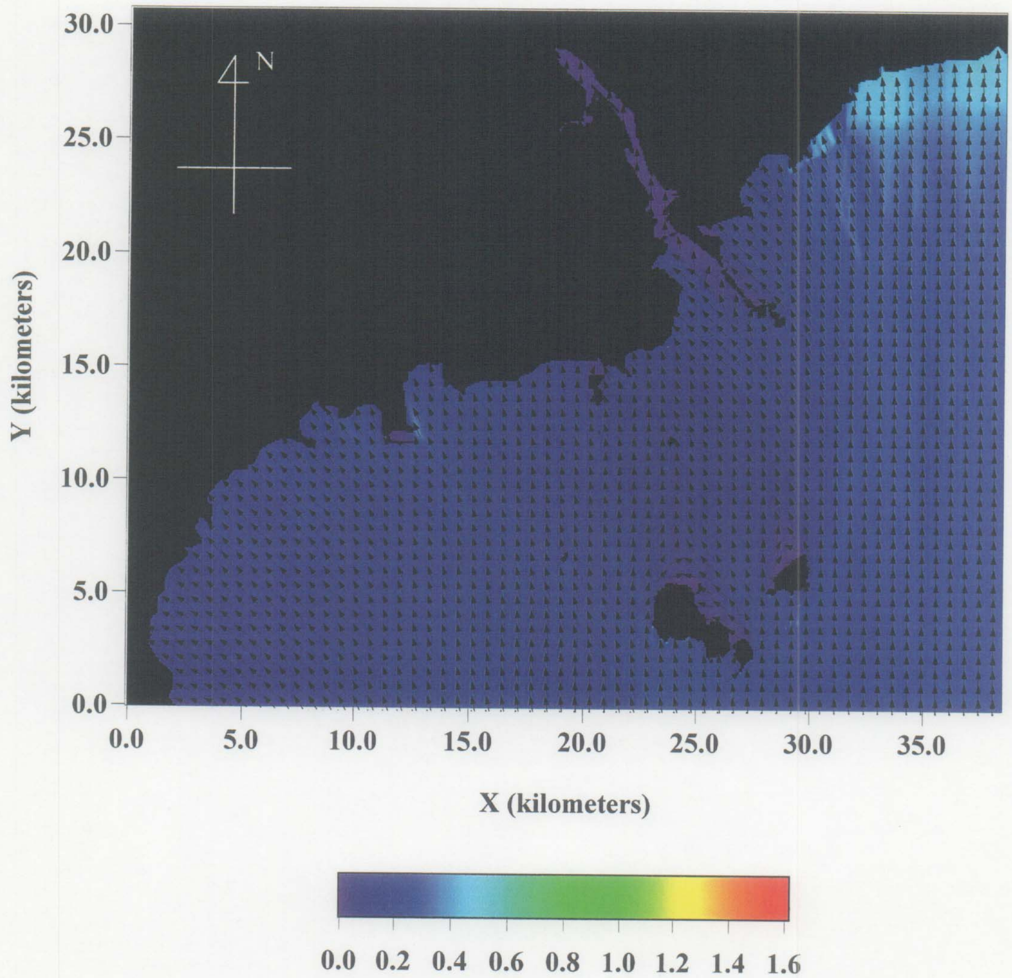


Figure A.2.2.87 Ratio of Wave Height and Mean Wave Directions (Local Model)

(In the case.05_7 ; 14-second-period-waves from 235 degrees)

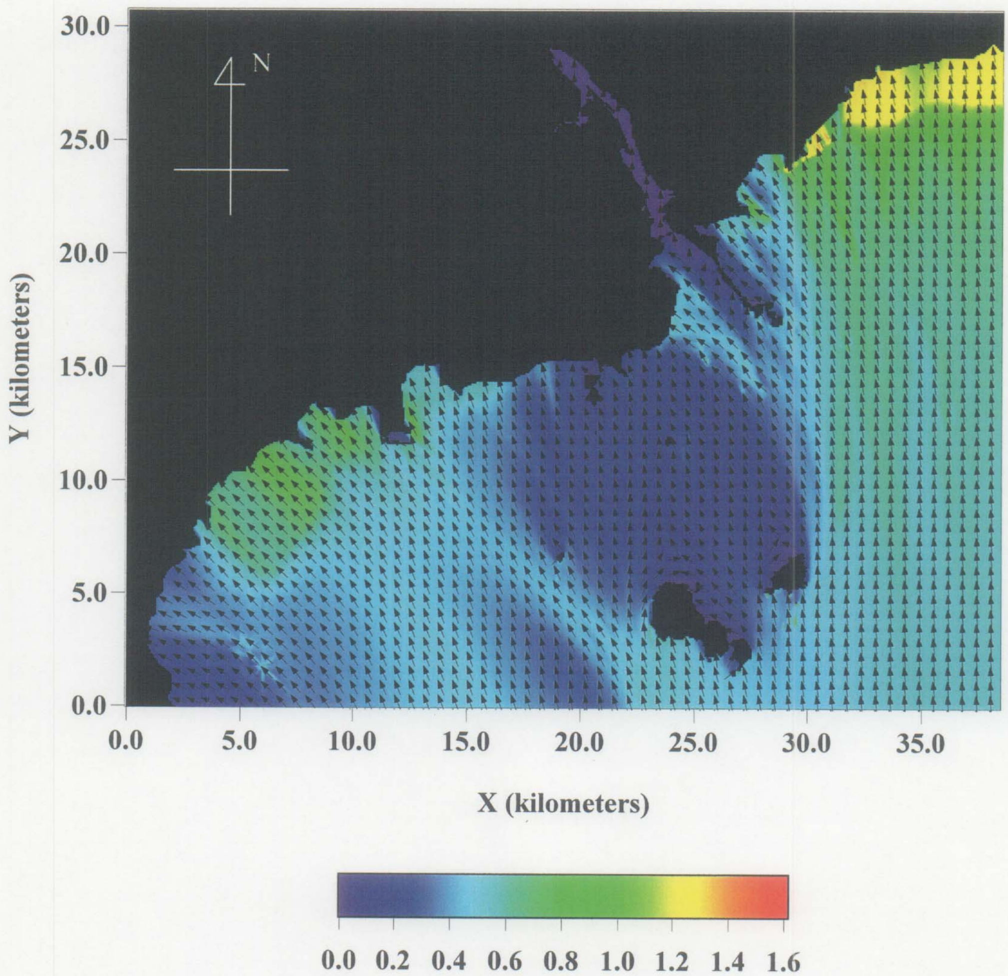


Figure A.2.2.88 Ratio of Wave Height and Mean Wave Directions (Local Model)

(In the case.06_1 ; 16-second-period-waves from 205 degrees)

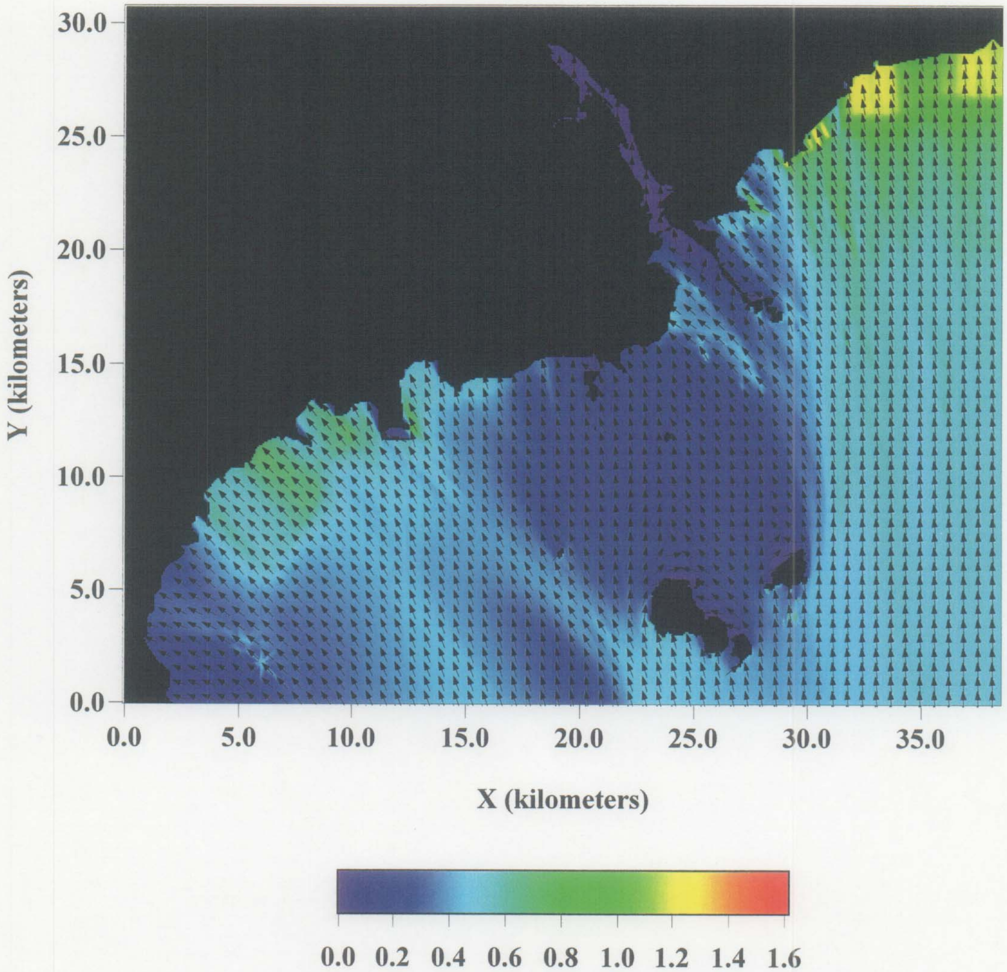


Figure A.2.2.89 Ratio of Wave Height and Mean Wave Directions (Local Model)

(In the case.06_2 ; 16-second-period-waves from 210 degrees)

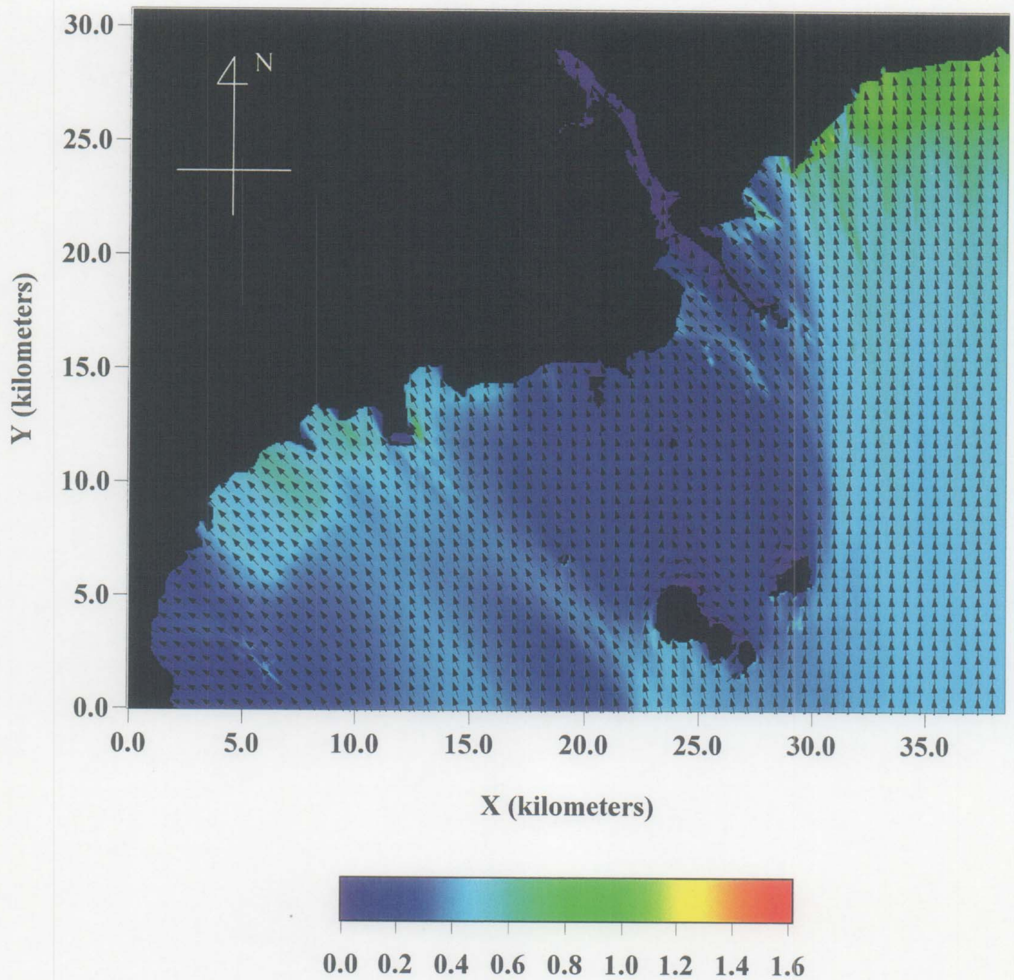


Figure A.2.2.90 Ratio of Wave Height and Mean Wave Directions (Local Model)

(In the case.06_3 ; 16-second-period-waves from 215 degrees)

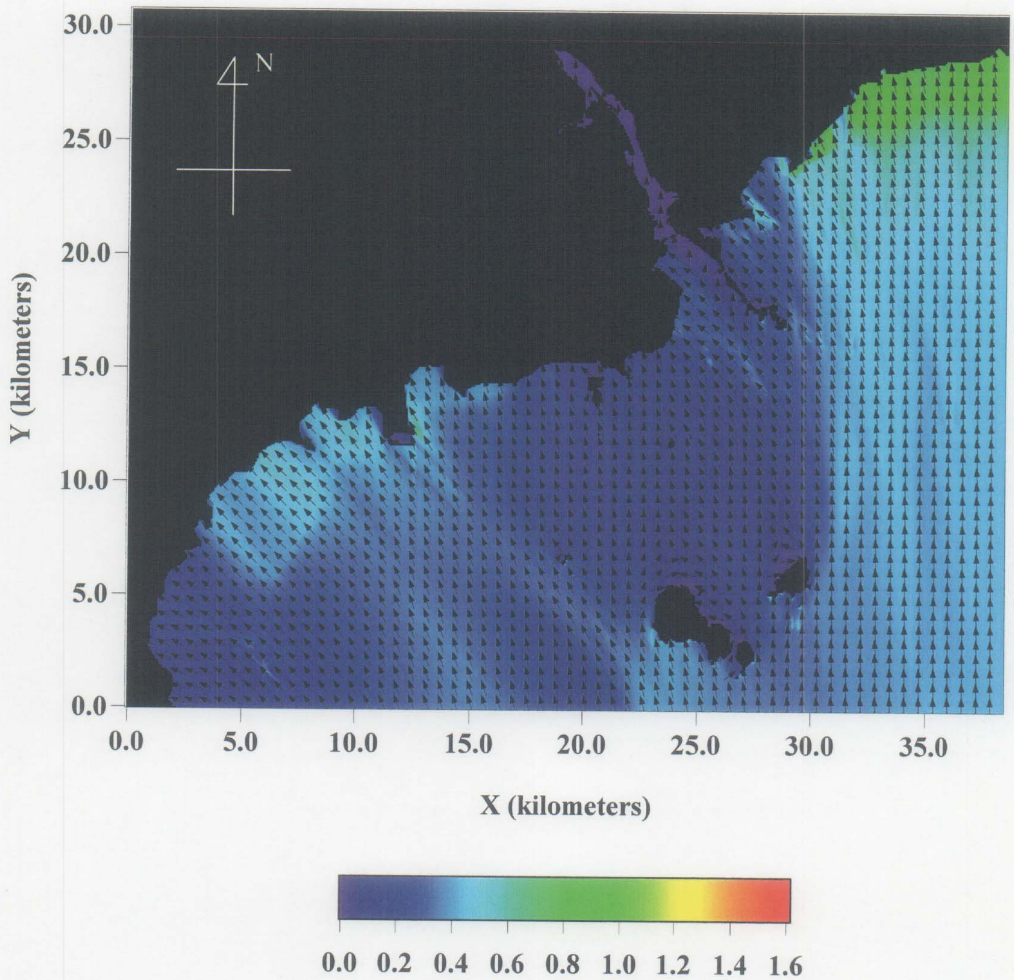


Figure A.2.2.91 Ratio of Wave Height and Mean Wave Directions (Local Model)

(In the case.06_4 ; 16-second-period-waves from 220 degrees)

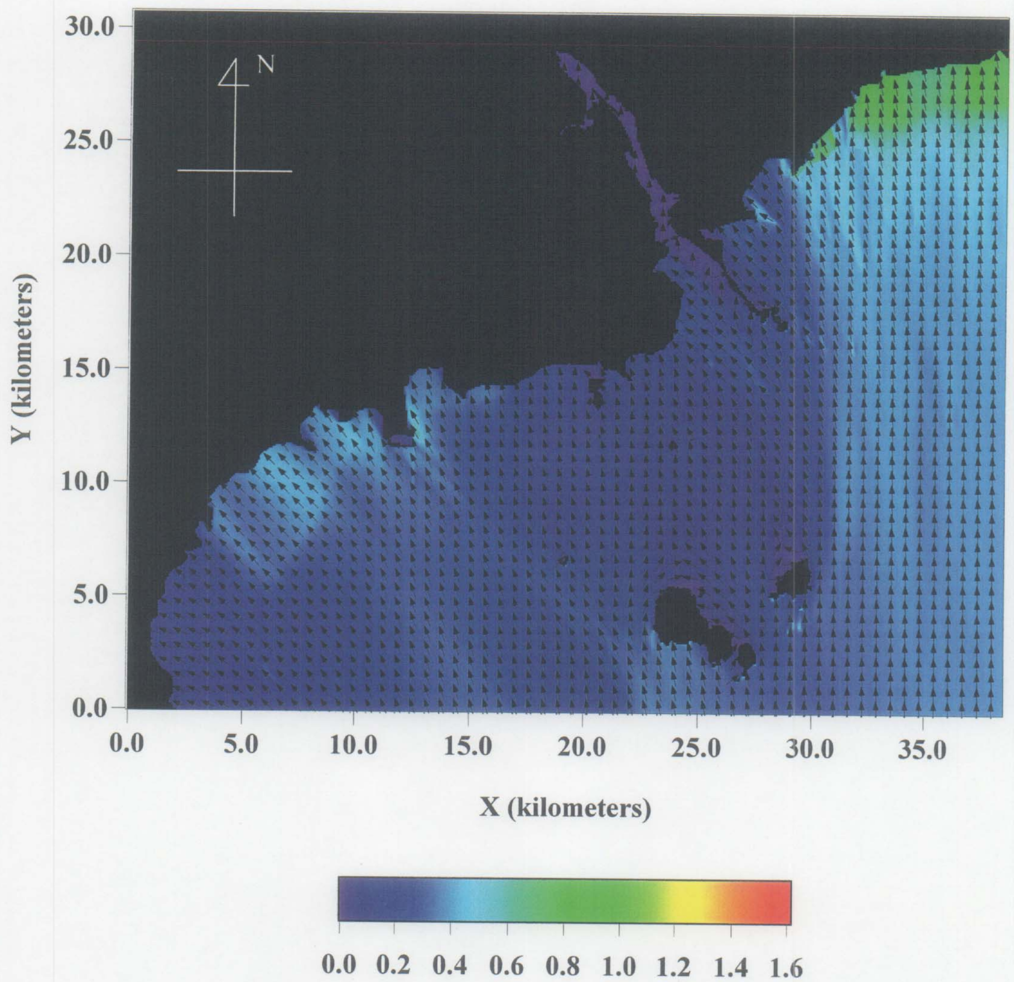


Figure A.2.2.92 Ratio of Wave Height and Mean Wave Directions（Local Model）

（In the case.06_5 ; 16-second-period-waves from 225 degrees）

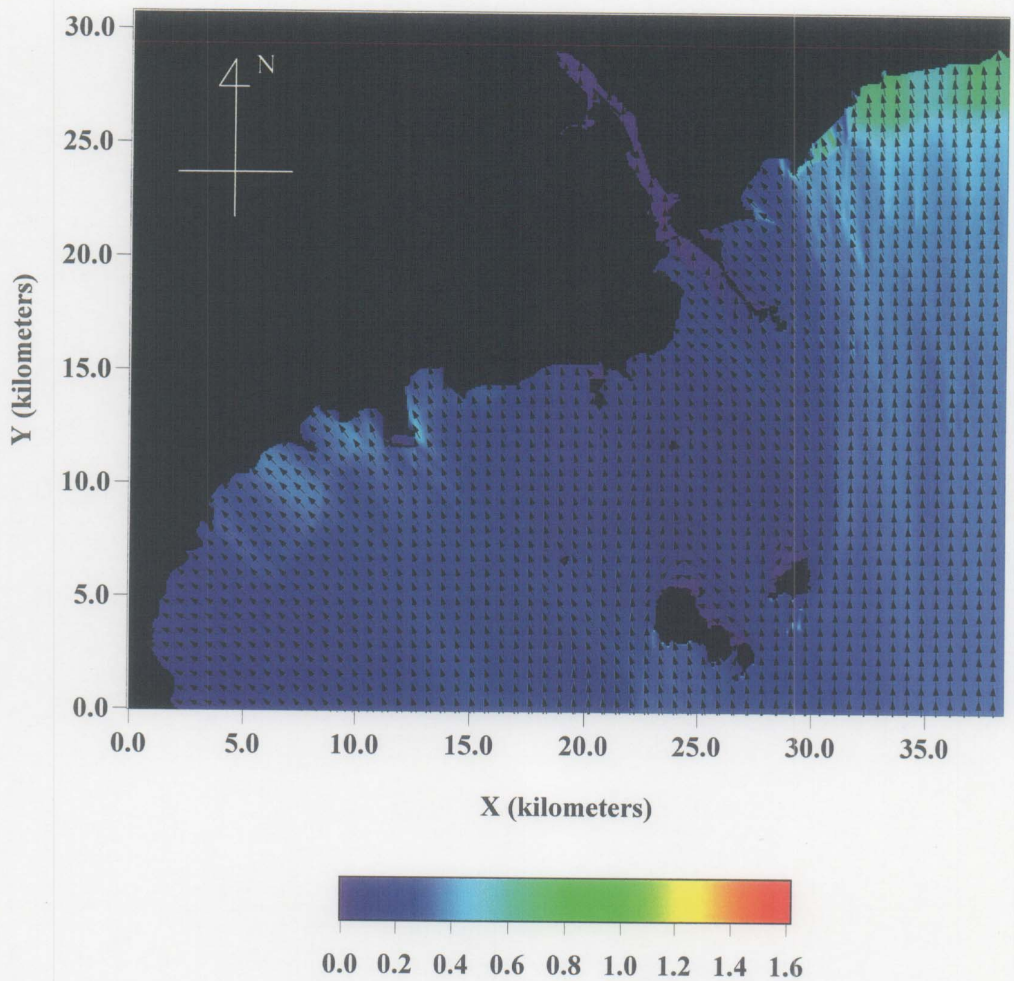


Figure A.2.2.93 Ratio of Wave Height and Mean Wave Directions (Local Model)

(In the case.06_6 ; 16-second-period-waves from 230 degrees)

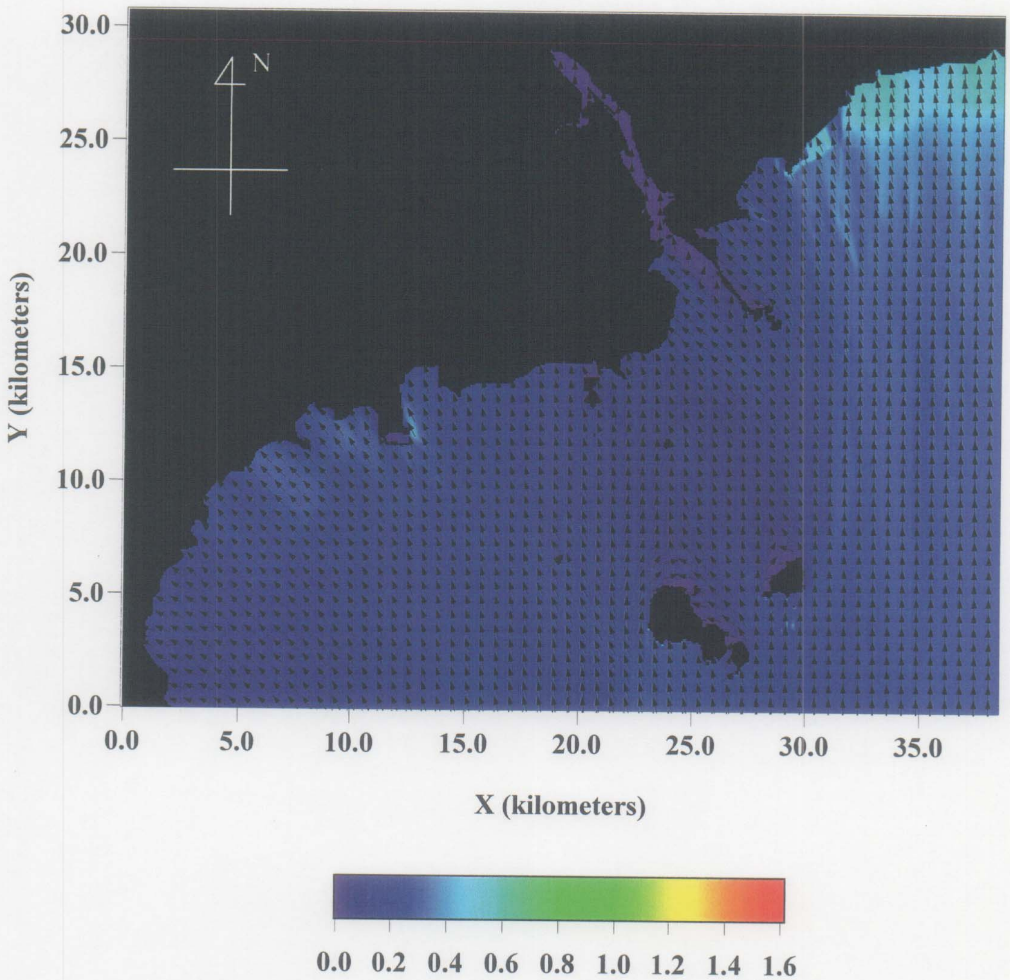


Figure A.2.2.94 Ratio of Wave Height and Mean Wave Directions (Local Model)

(In the case.06_7 ; 16-second-period-waves from 235 degrees)

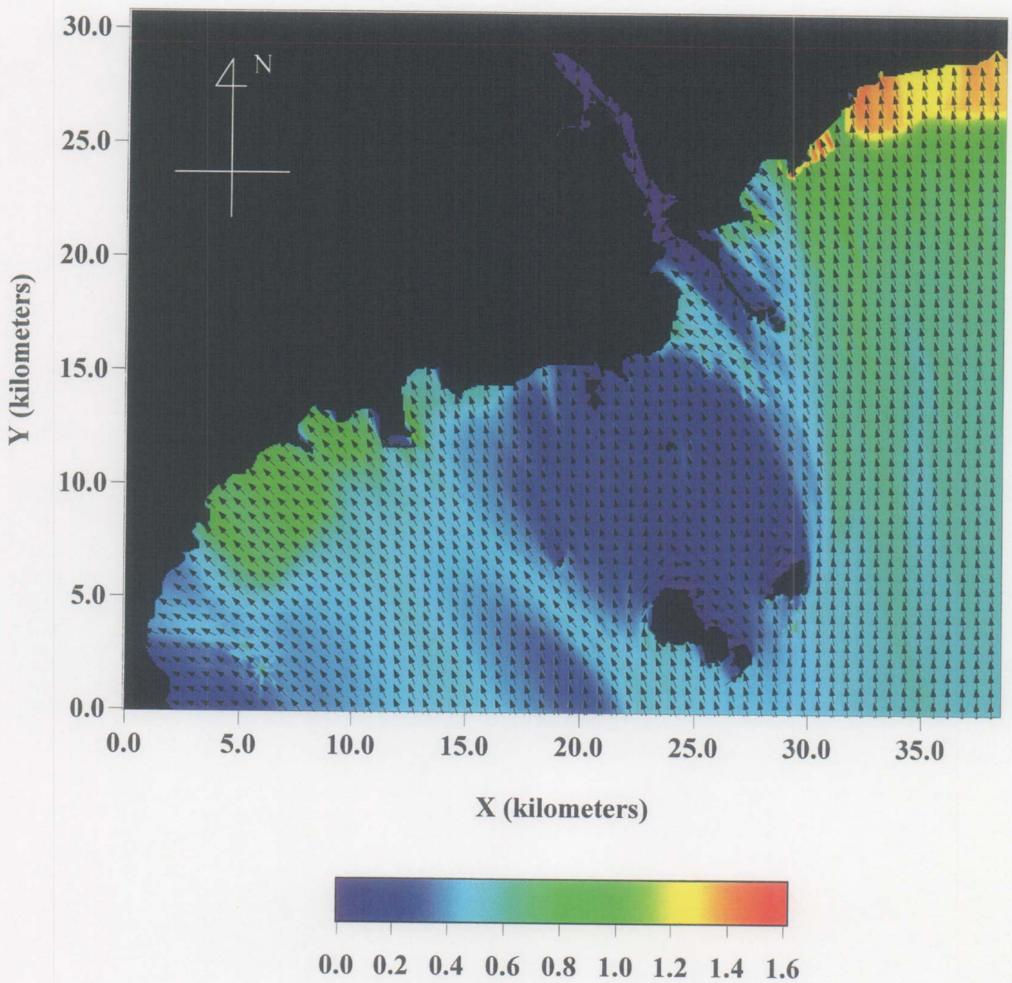


Figure A.2.2.95 Ratio of Wave Height and Mean Wave Directions (Local Model)

(In the case.07_1 ; 18-second-period-waves from 205 degrees)

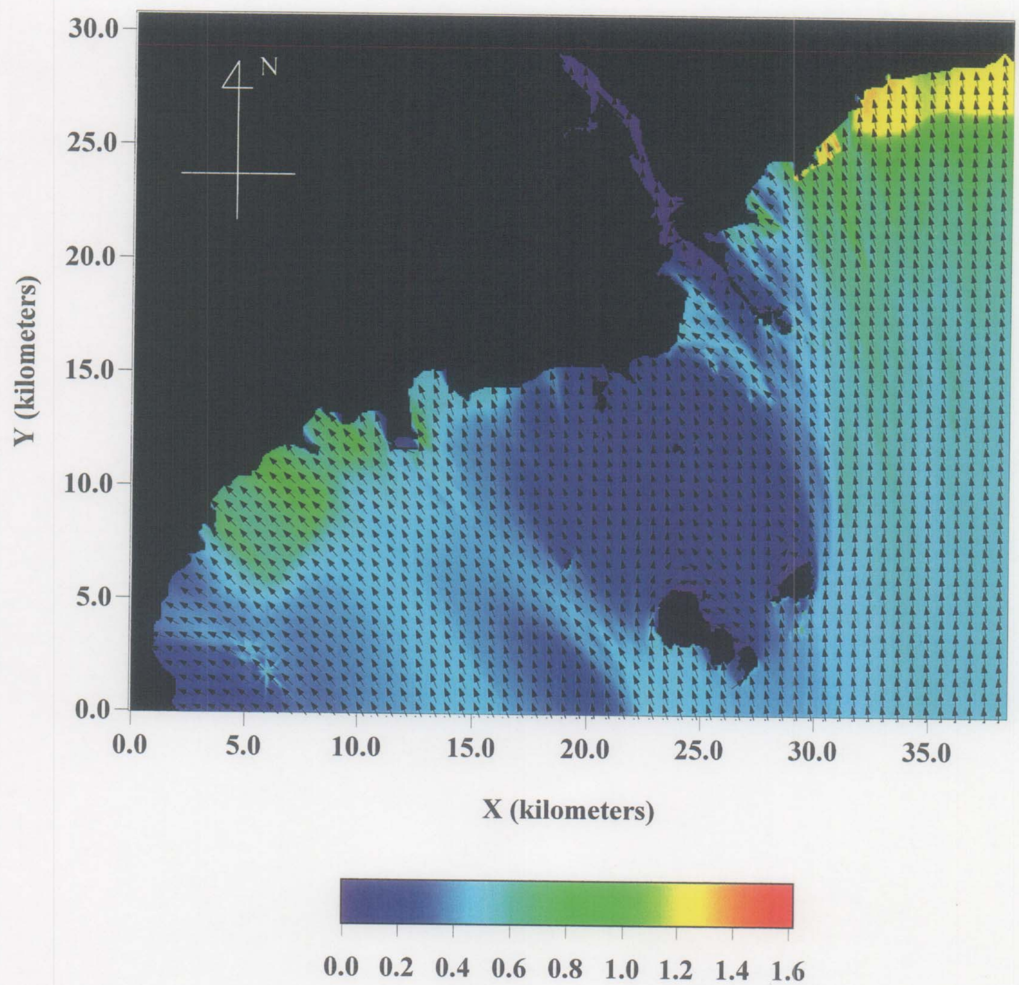


Figure A.2.2.96 Ratio of Wave Height and Mean Wave Directions (Local Model)

(In the case.07_2 ; 18-second-period-waves from 210 degrees)

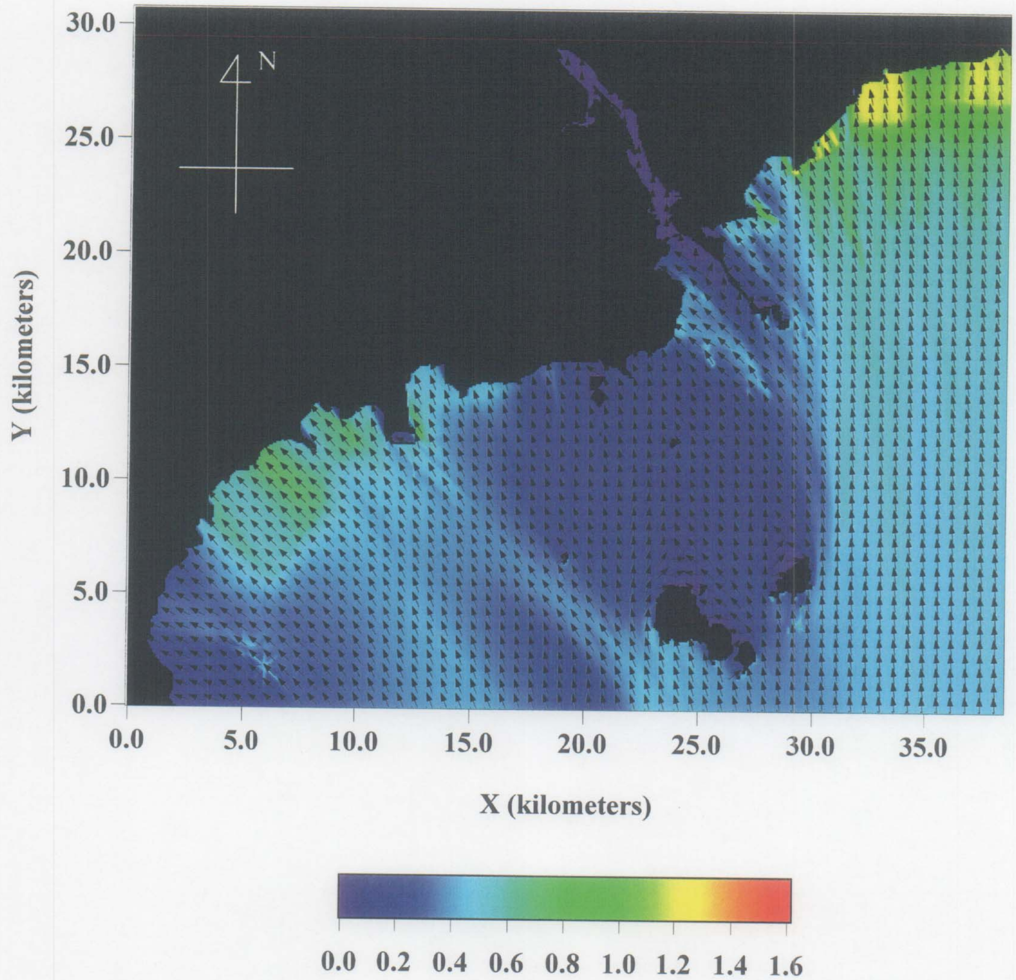


Figure A.2.2.97 Ratio of Wave Height and Mean Wave Directions (Local Model)

(In the case.07_3 ; 18-second-period-waves from 215 degrees)

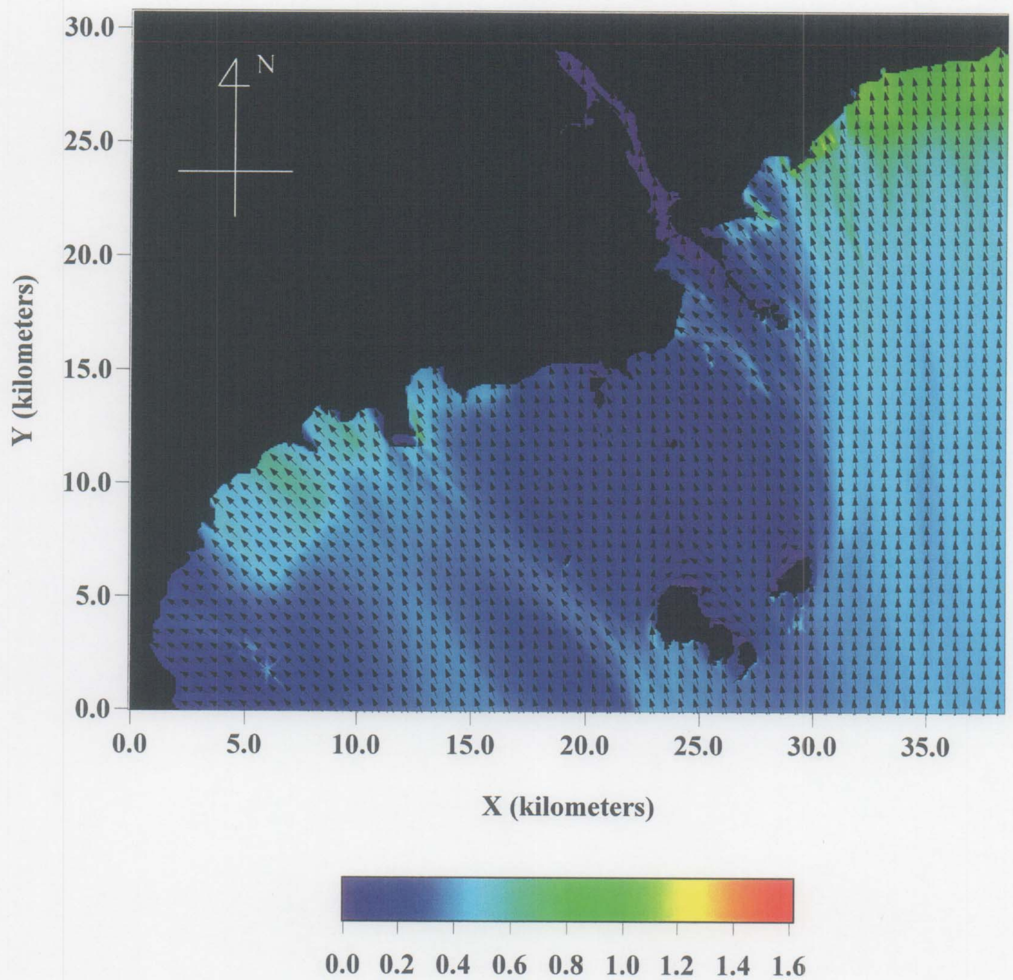


Figure A.2.2.98 Ratio of Wave Height and Mean Wave Directions (Local Model)

(In the case.07_4 ; 18-second-period-waves from 220 degrees)

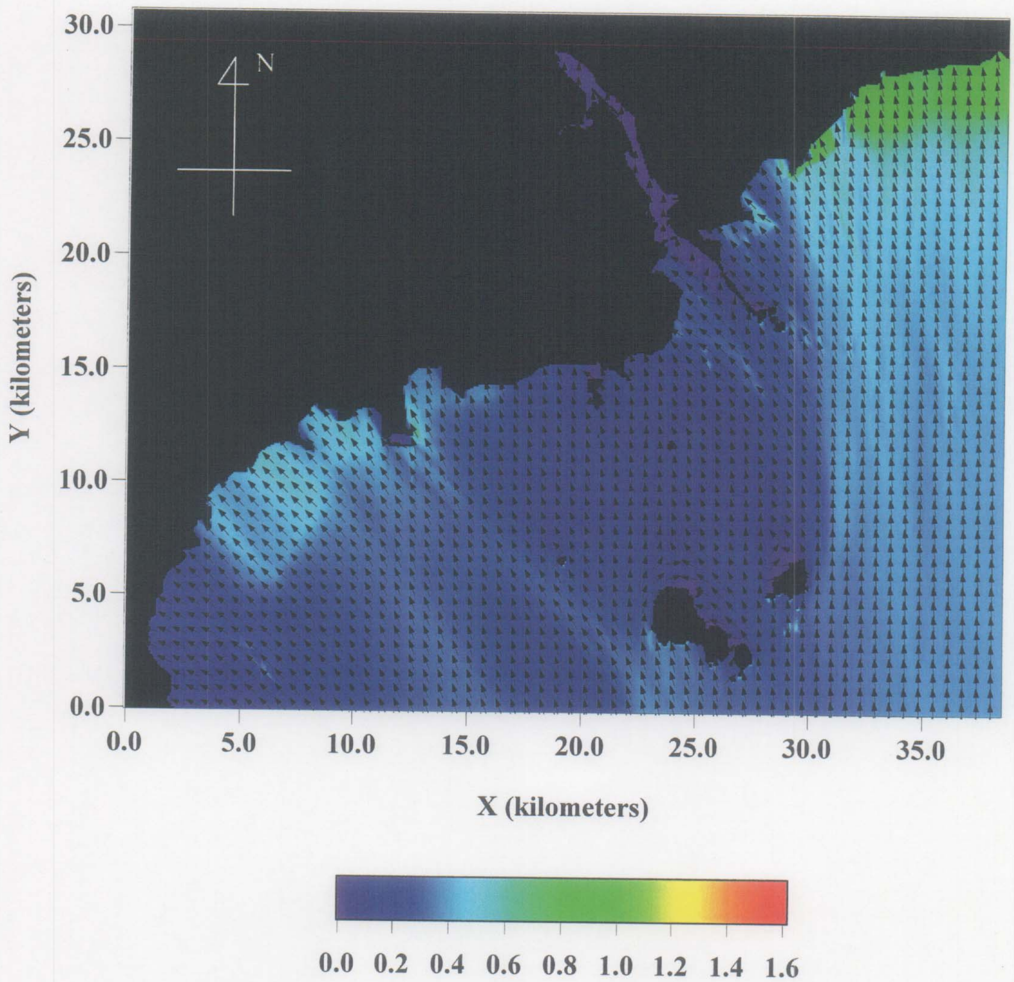


Figure A.2.2.99 Ratio of Wave Height and Mean Wave Directions (Local Model)

(In the case.07_5 ; 18-second-period-waves from 225 degrees)

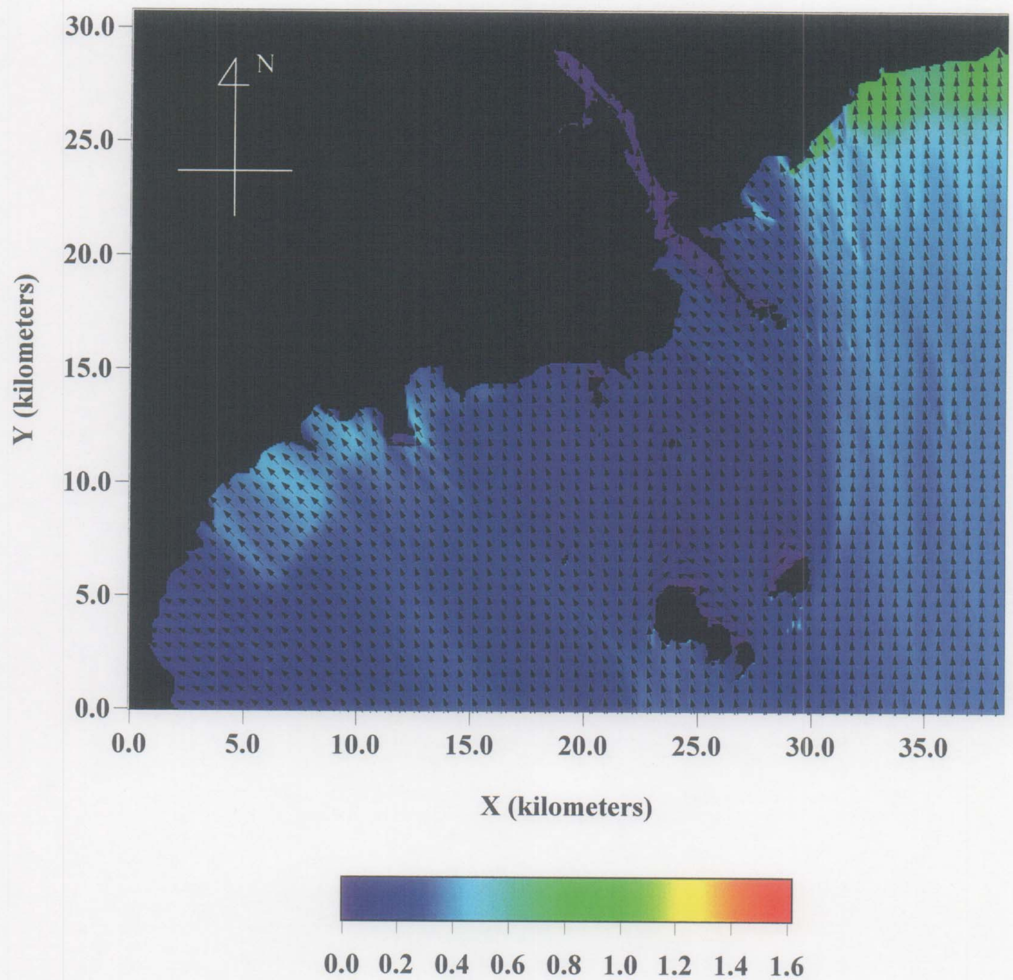


Figure A.2.2.100 Ratio of Wave Height and Mean Wave Directions（Local Model）

（In the case.07_6 ; 18-second-period-waves from 230 degrees）

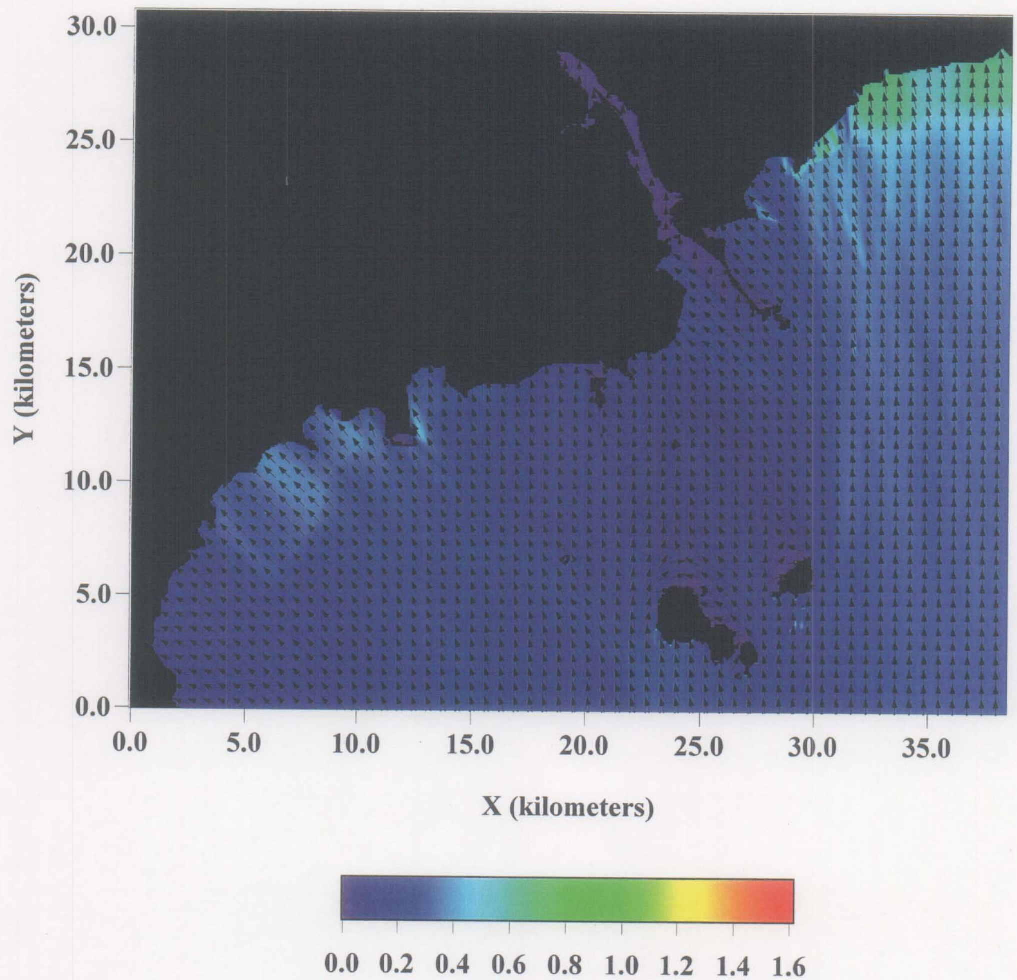


Figure A.2.2.101 Ratio of Wave Height and Mean Wave Directions (Local Model)

(In the case.07_7 ; 18-second-period-waves from 235 degrees)

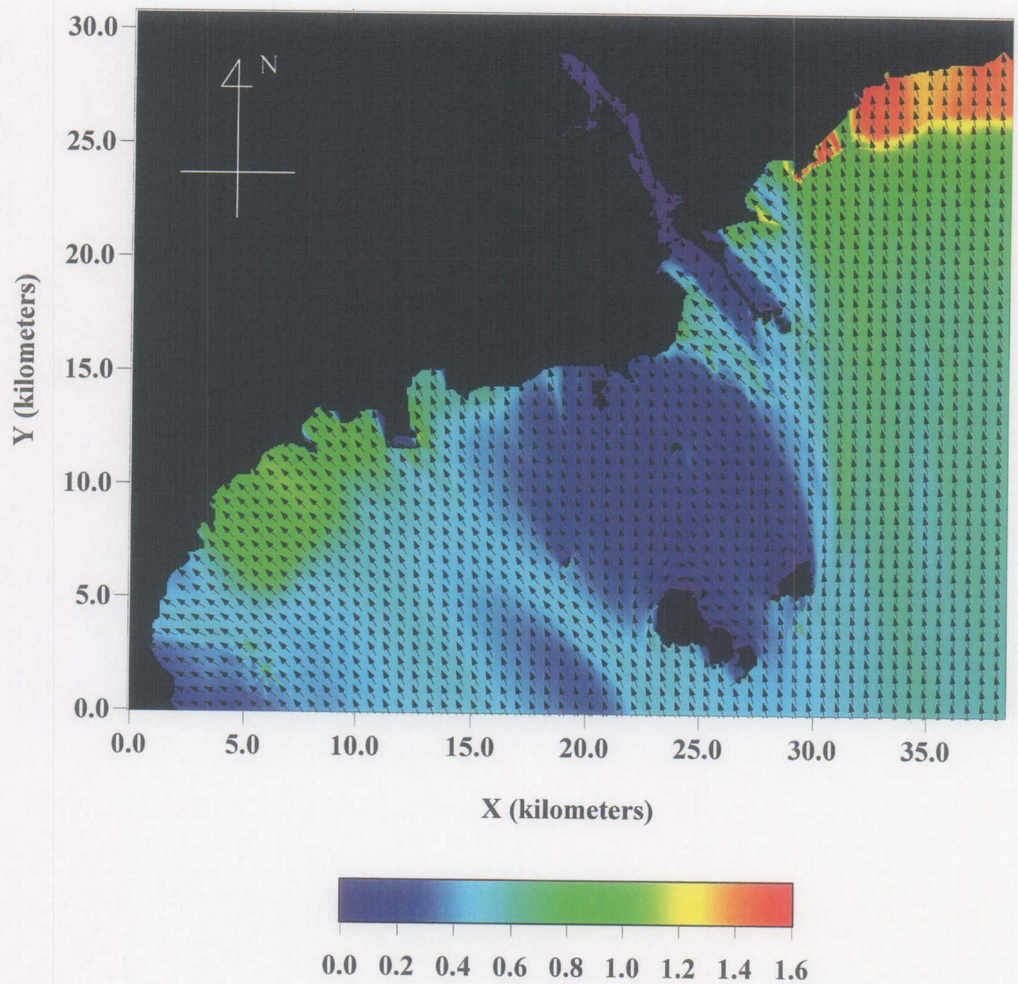


Figure A.2.2.102 Ratio of Wave Height and Mean Wave Directions (Local Model)

(In the case.08_1 ; 20-second-period-waves from 205 degrees)

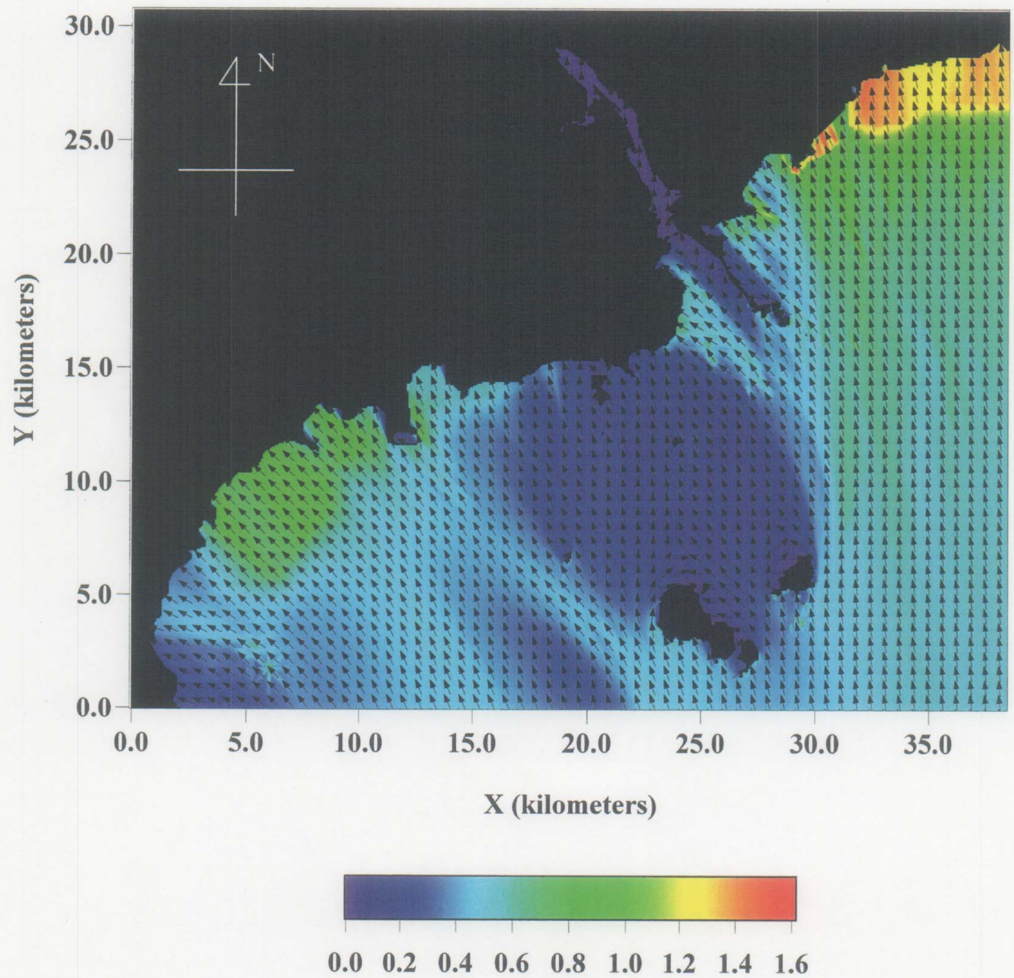


Figure A.2.2.103 Ratio of Wave Height and Mean Wave Directions（Local Model）

（In the case.08_2 ; 20-second-period-waves from 210 degrees）

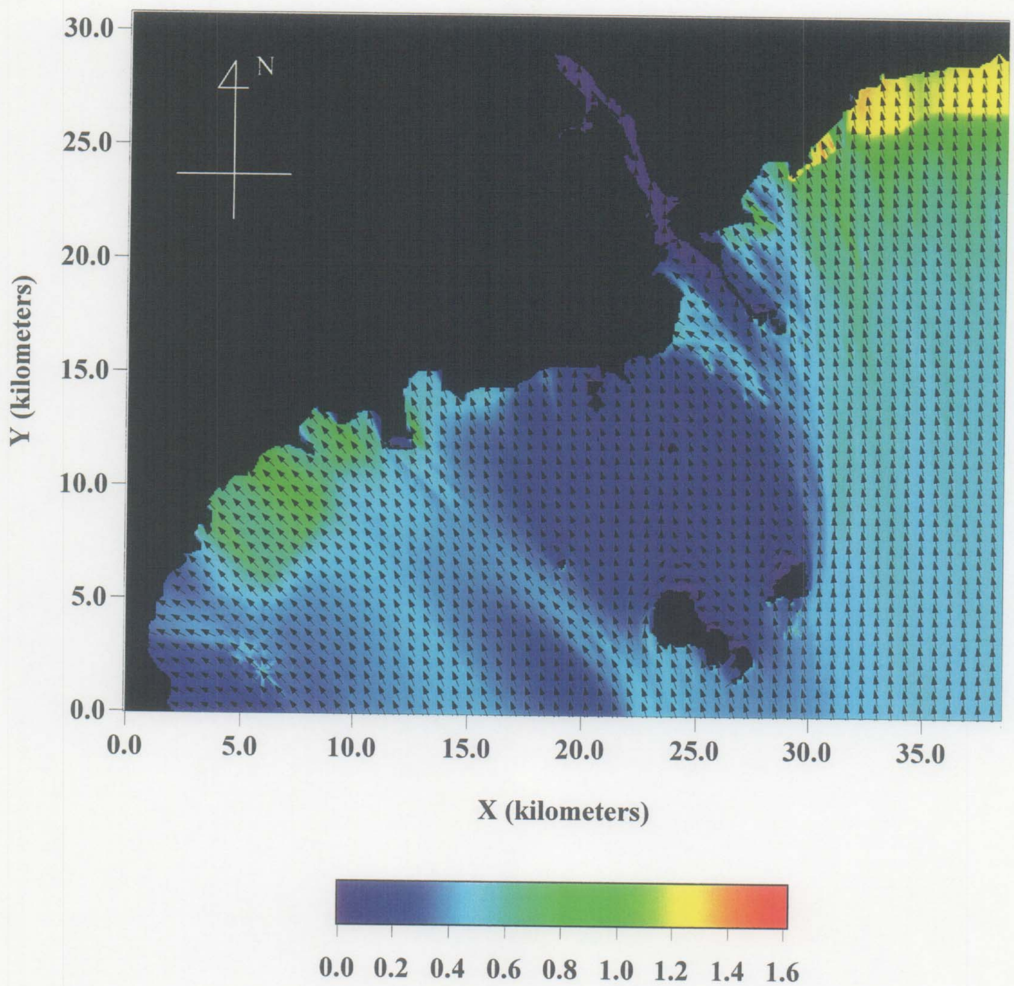


Figure A.2.2.104 Ratio of Wave Height and Mean Wave Directions (Local Model)

(In the case.08_3 ; 20-second-period-waves from 215 degrees)

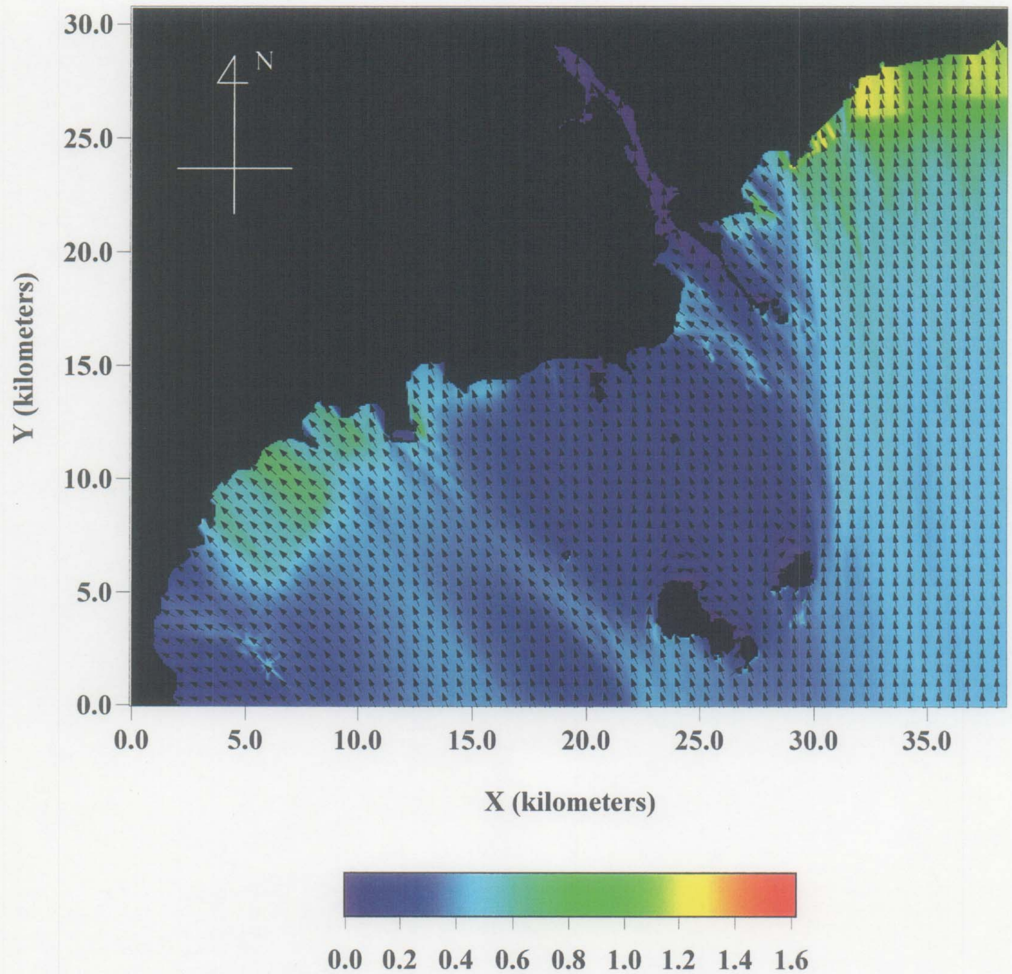


Figure A.2.2.105 Ratio of Wave Height and Mean Wave Directions（Local Model）

（In the case.08_4 ; 20-second-period-waves from 220 degrees）

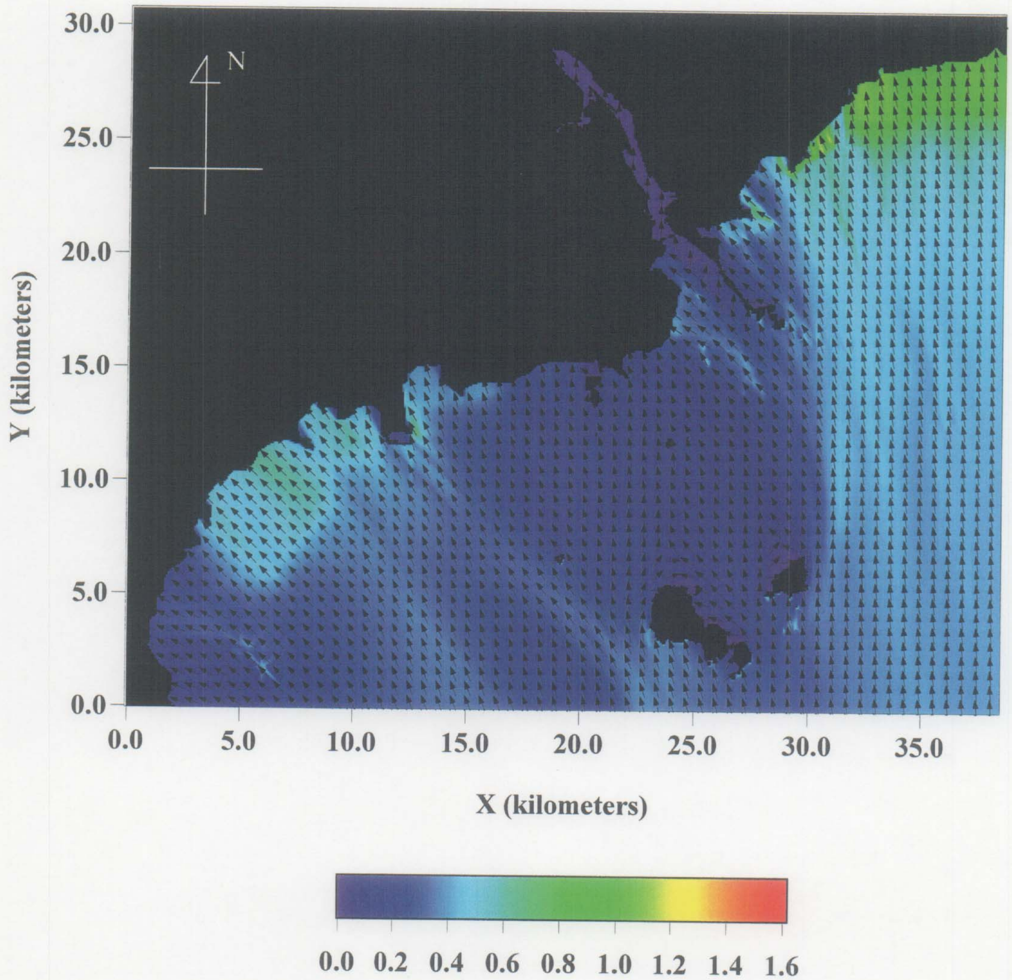


Figure A.2.2.106 Ratio of Wave Height and Mean Wave Directions (Local Model)
(In the case.08_5 ; 20-second-period-waves from 225 degrees)

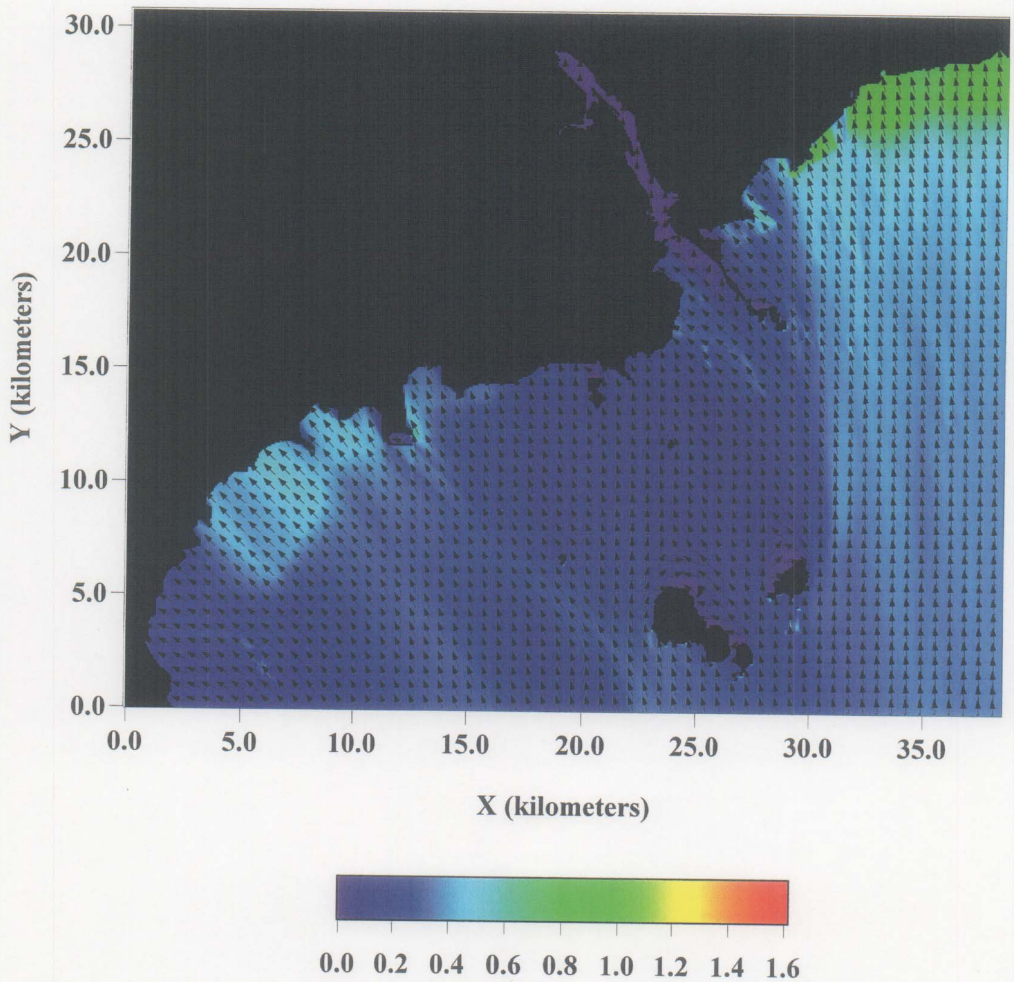


Figure A.2.2.107 Ratio of Wave Height and Mean Wave Directions (Local Model)

(In the case.08_6 ; 20-second-period-waves from 230 degrees)

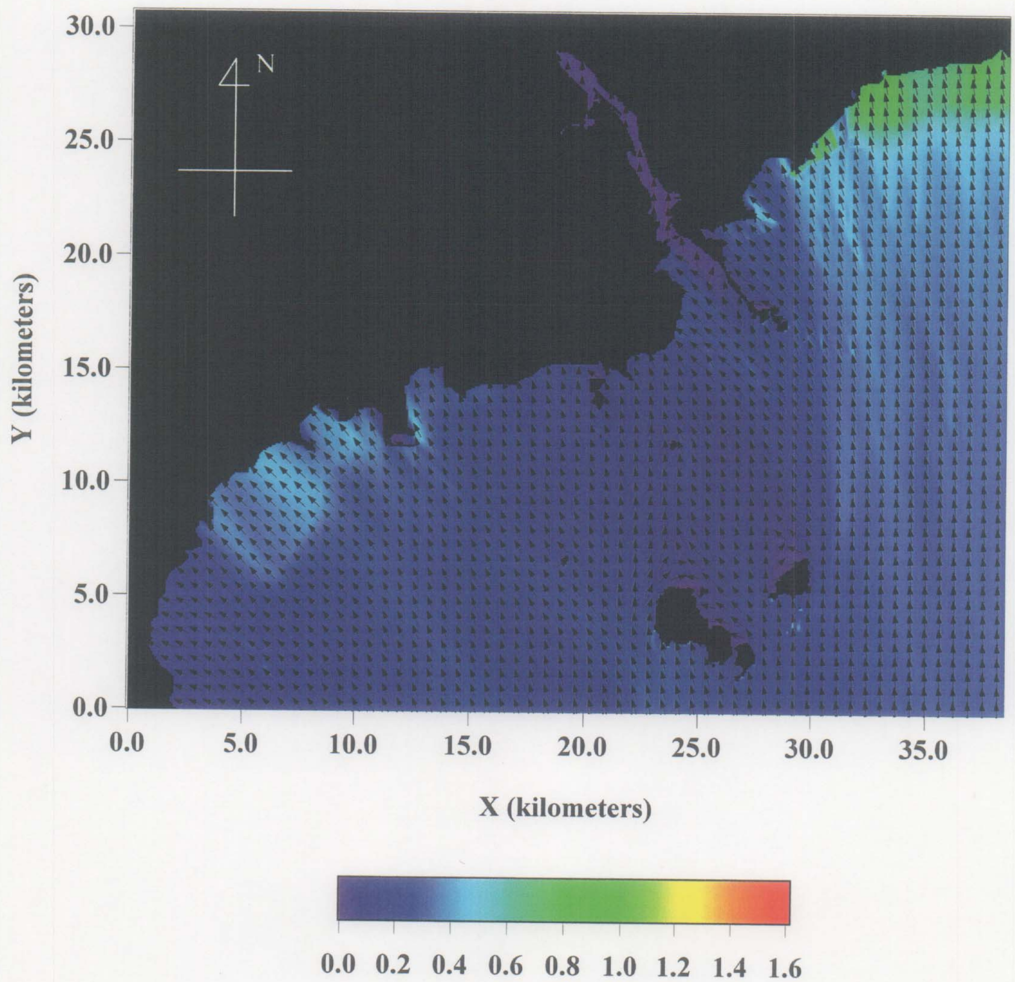


Figure A.2.2.108 Ratio of Wave Height and Mean Wave Directions (Local Model)

(In the case.08_7 ; 20-second-period-waves from 235 degrees)

A.2.3 Results of Analysis of Wave Calmness in the Basin

(Patterns of Ratio of Wave Height)

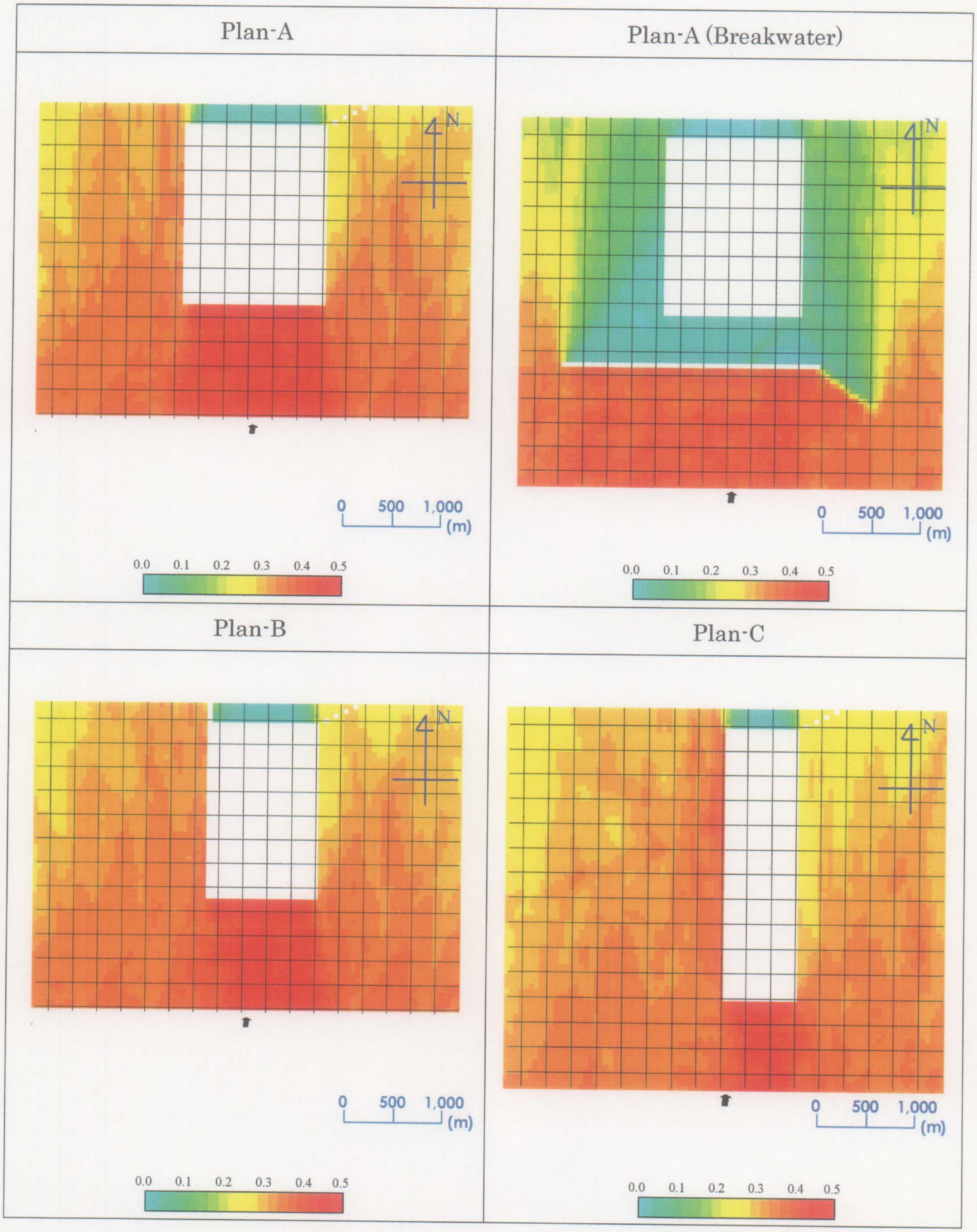


Figure A.2.3.1 Ratio of Wave Height against Offshore Wave

(In the case.01_2 ; 6-second-period-waves from 210 degrees)

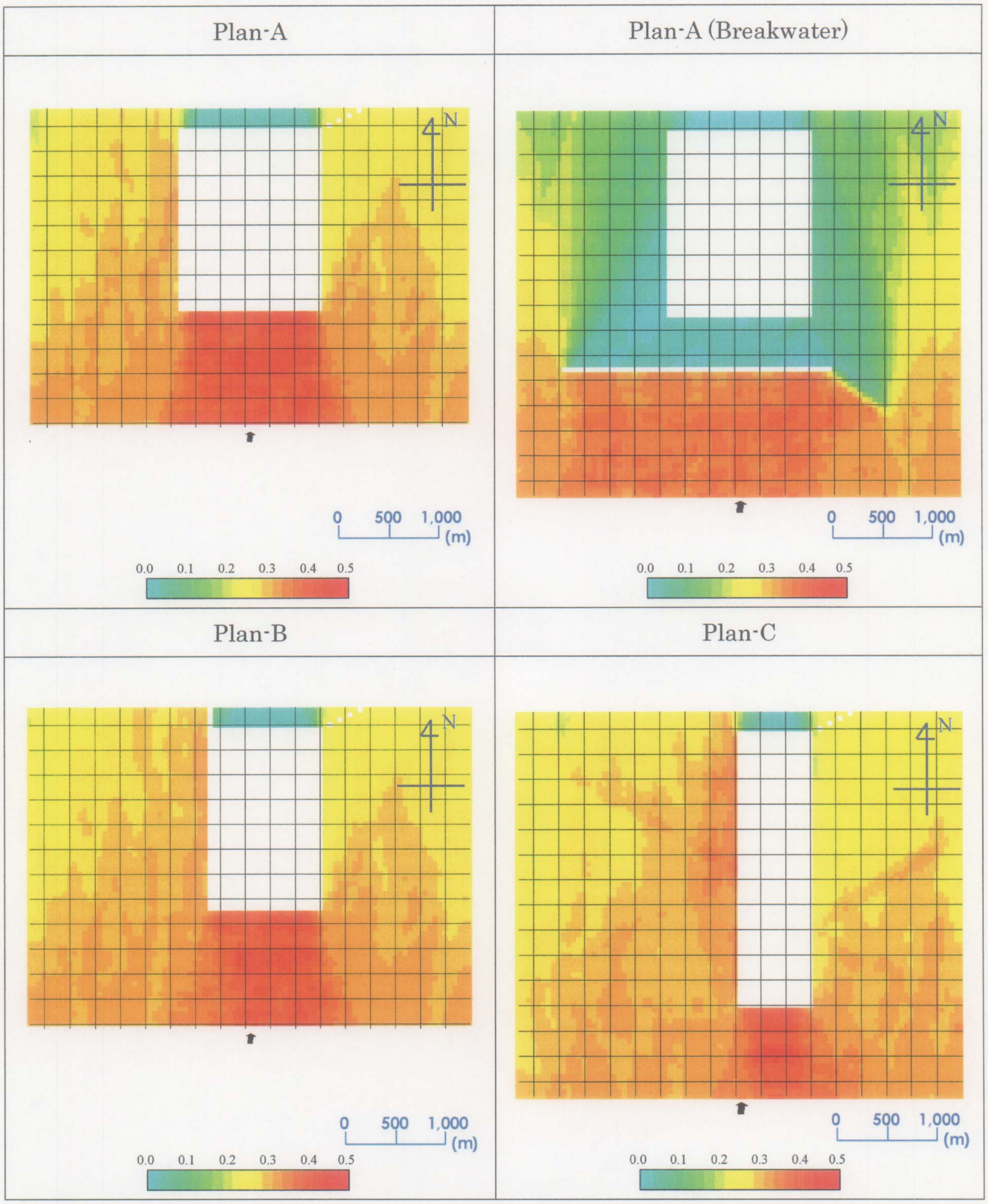


Figure A.2.3.2 Ratio of Wave Height against Offshore Wave

(In the case.01_3 ; 6-second-period-waves from 215 degrees)

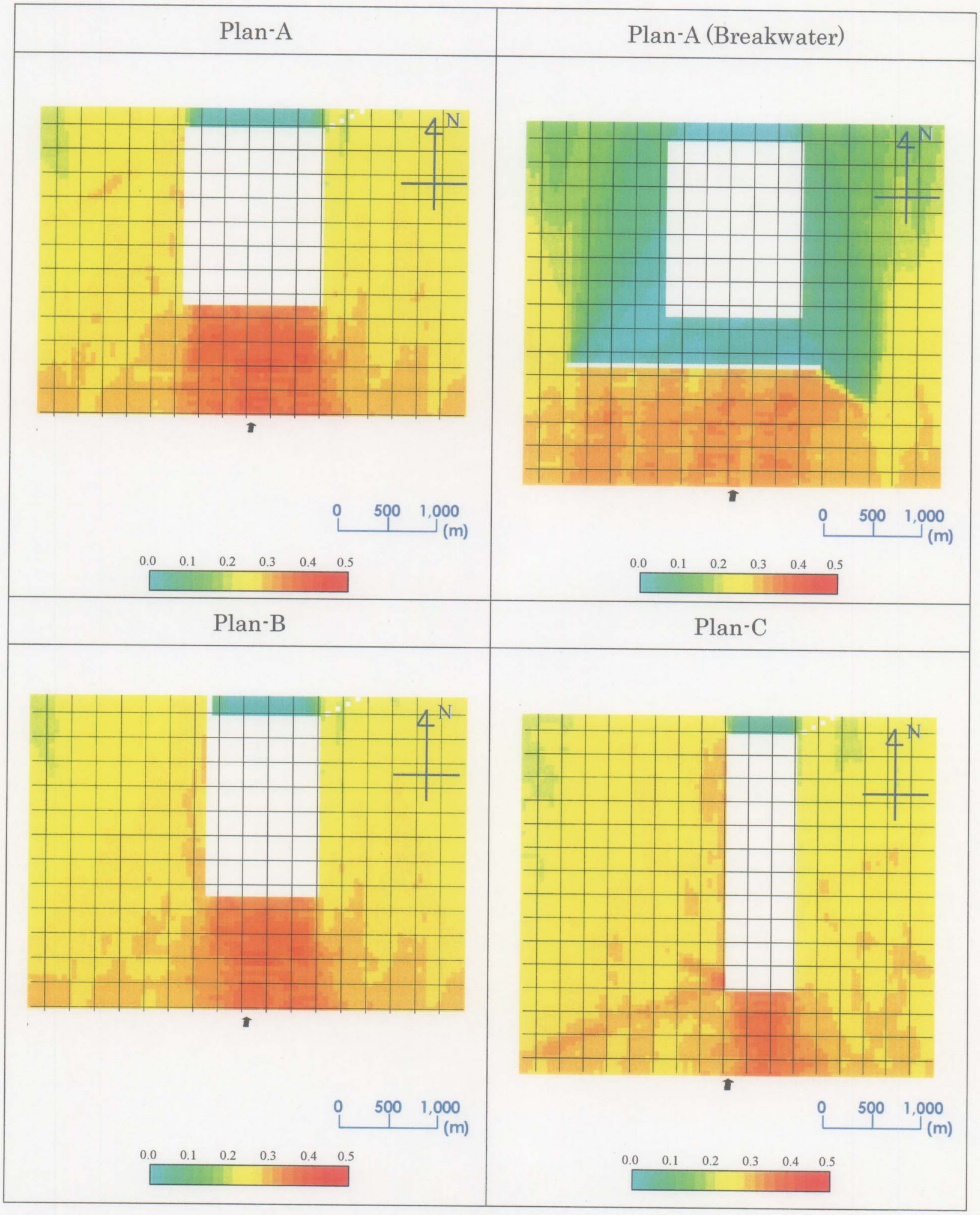


Figure A.2.3.3 Ratio of Wave Height against Offshore Wave

(In the case.01_4 ; 6-second-period-waves from 220 degrees)

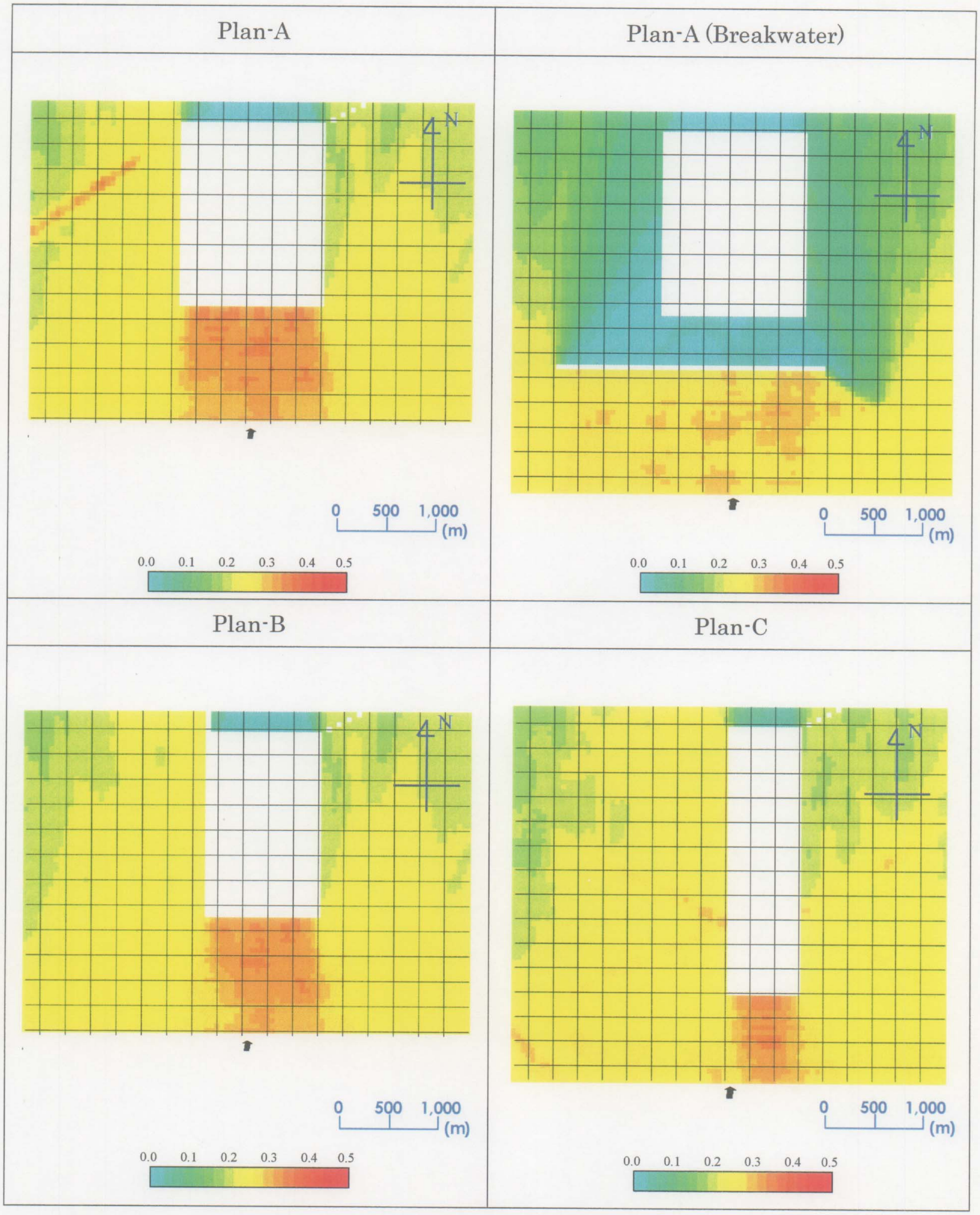


Figure A.2.3.4 Ratio of Wave Height against Offshore Wave

(In the case.01_5 ; 6-second-period-waves from 225 degrees)

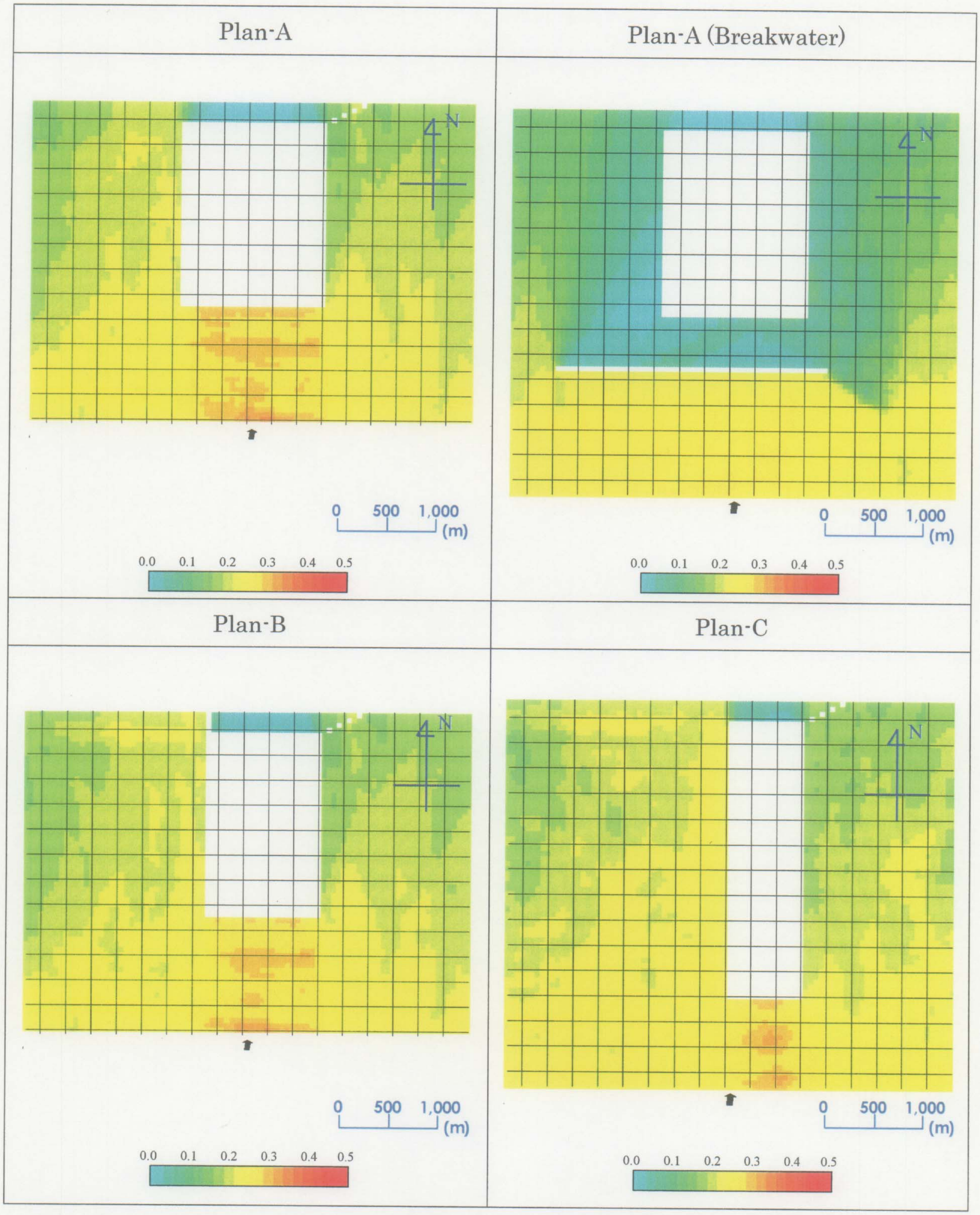


Figure A.2.3.5 Ratio of Wave Height against Offshore Wave

(In the case.01_6 ; 6-second-period-waves from 230 degrees)

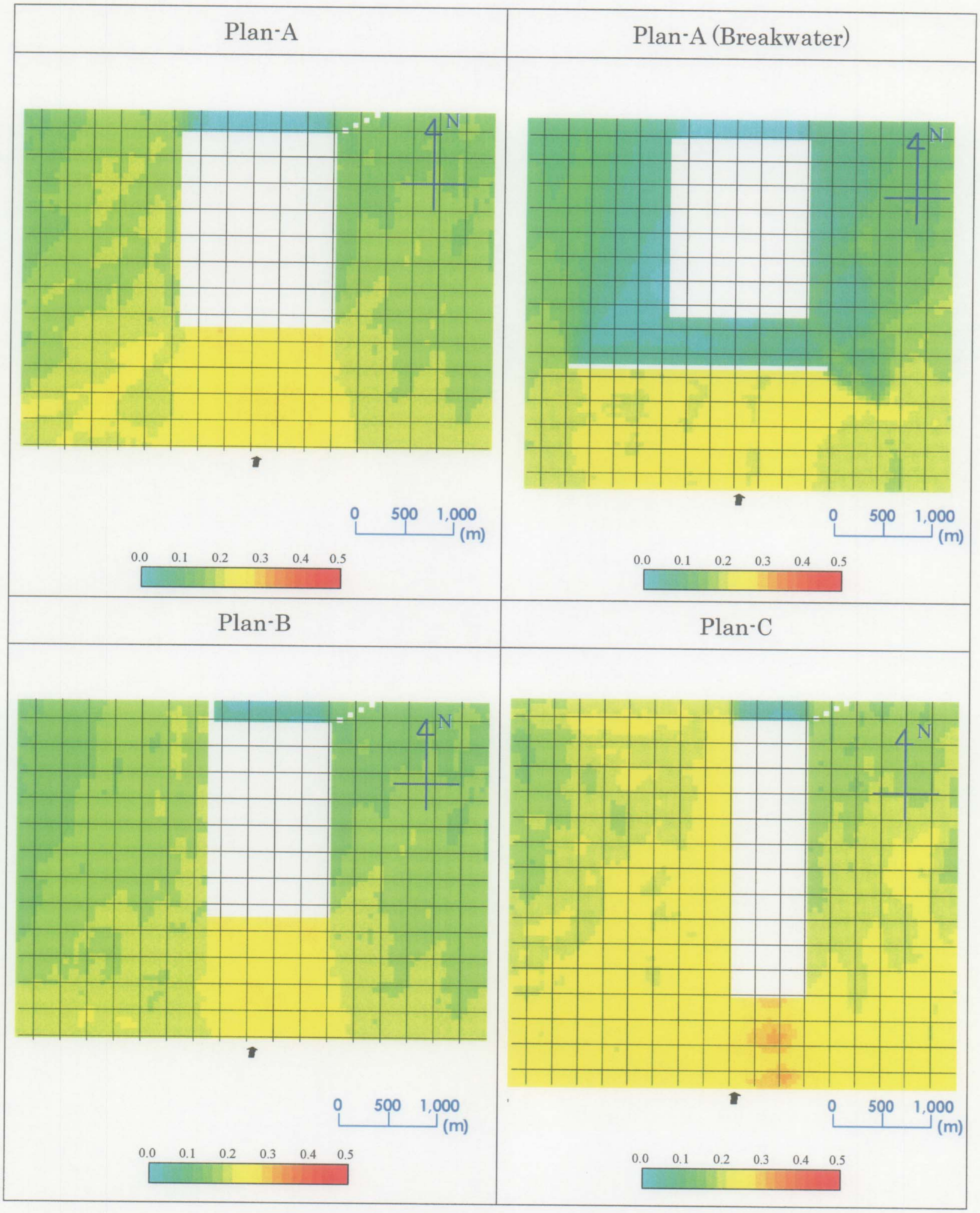


Figure A.2.3.6 Ratio of Wave Height against Offshore Wave

(In the case.01_7 ; 6-second-period-waves from 235 degrees)

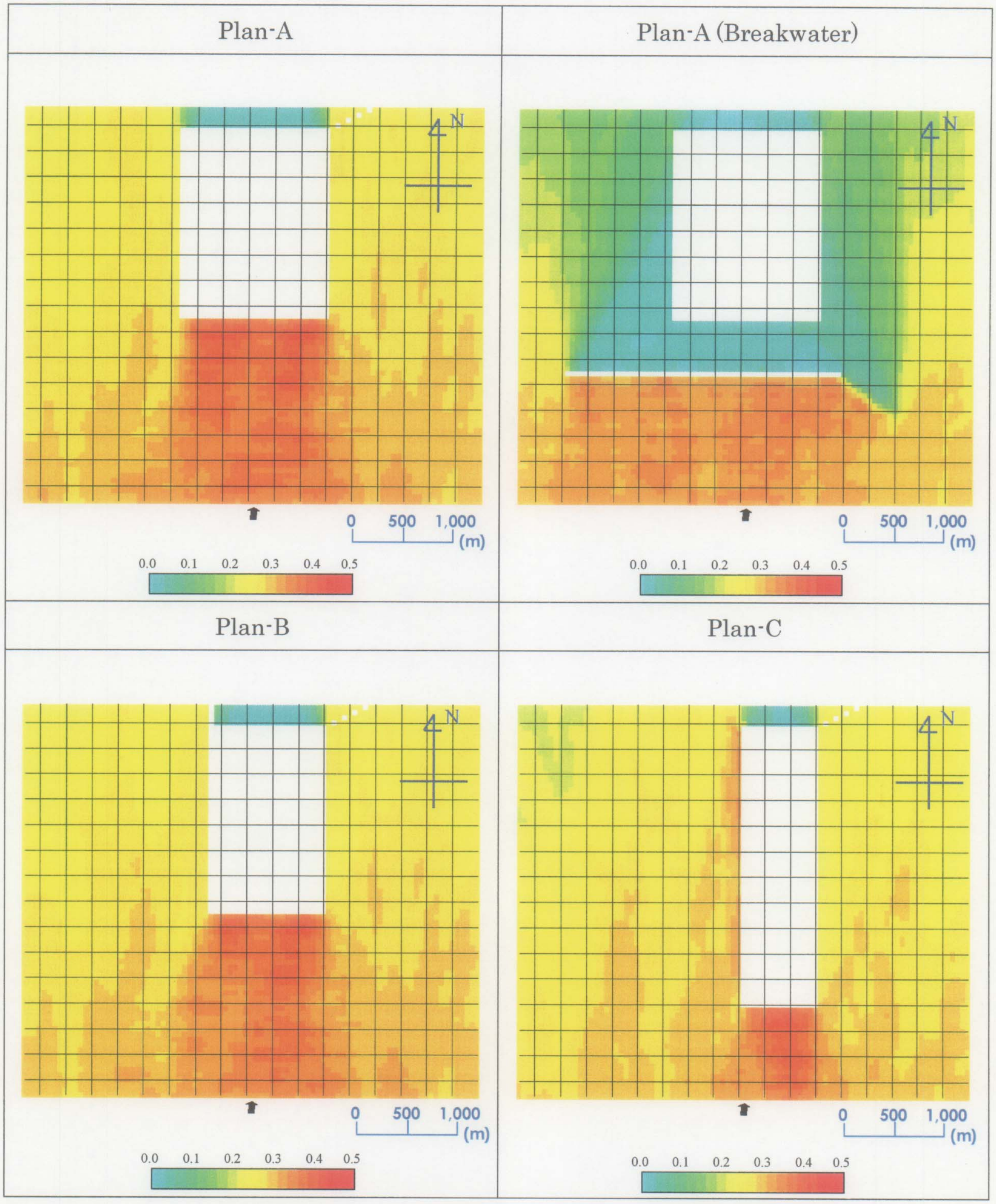


Figure A.2.3.7 Ratio of Wave Height against Offshore Wave

(In the case.02_2 ; 8-second-period-waves from 210 degrees)

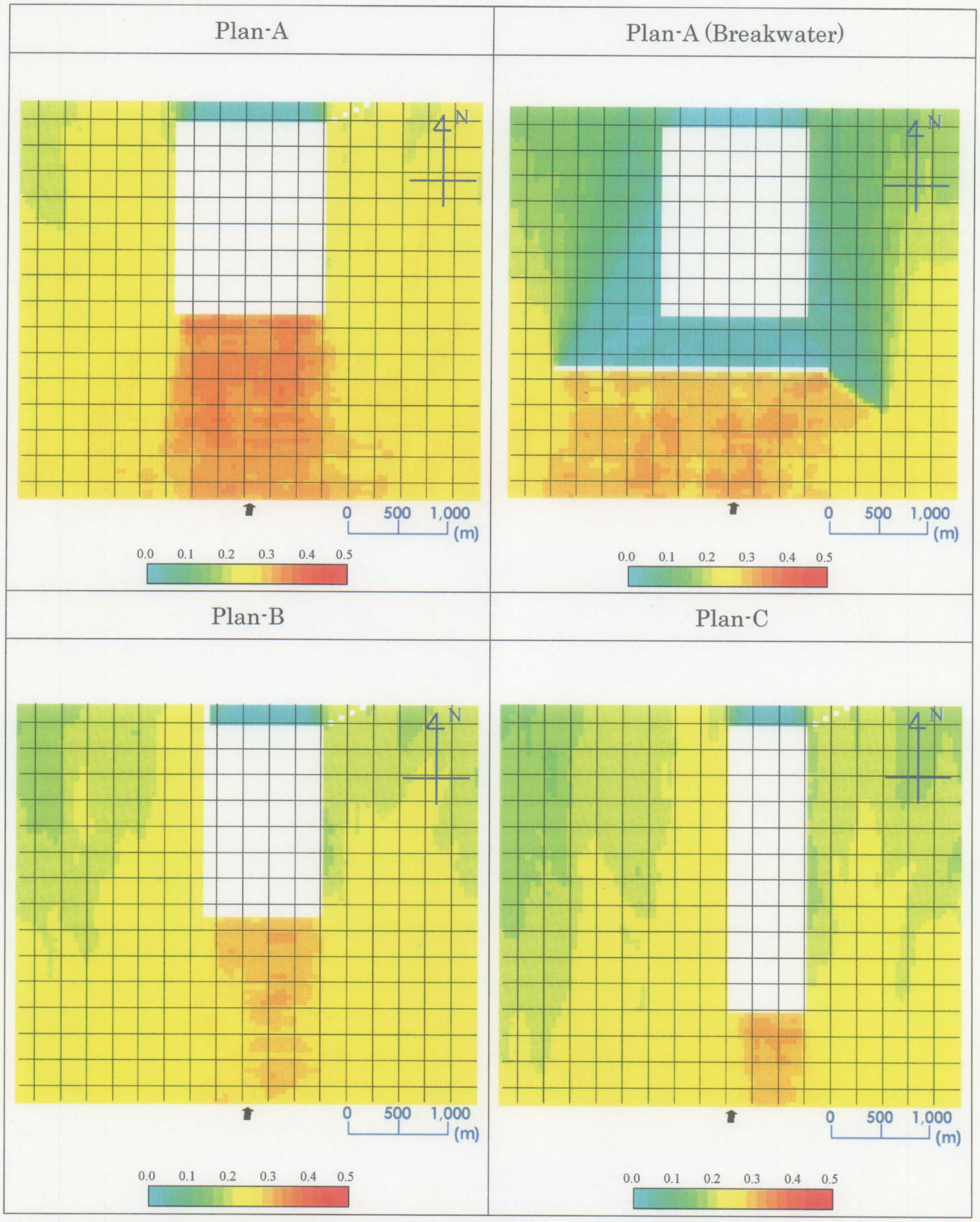
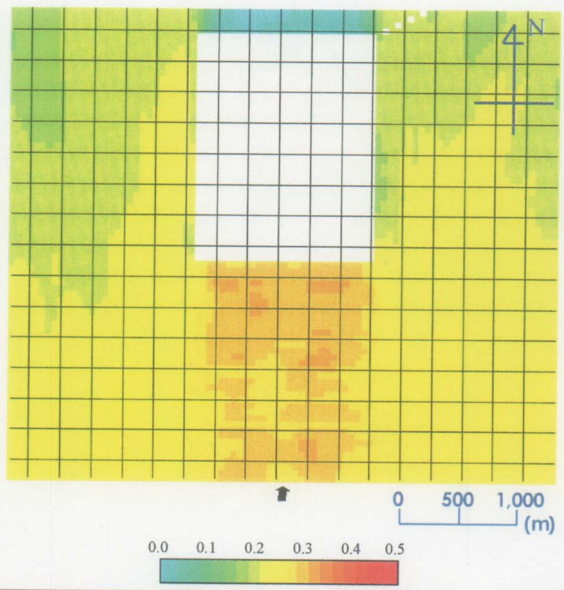


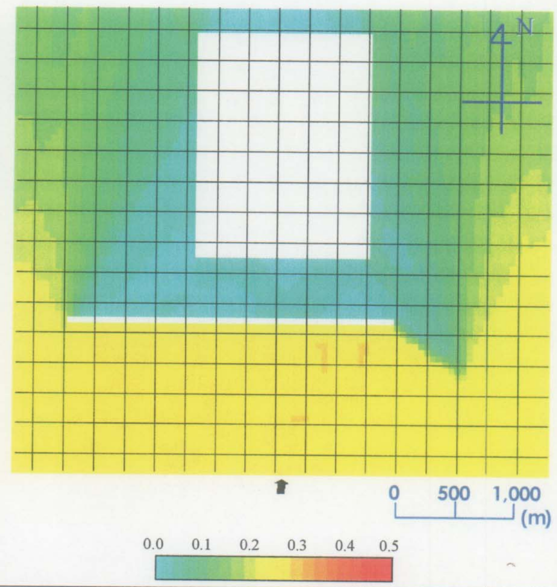
Figure A.2.3.8 Ratio of Wave Height against Offshore Wave

(In the case.02_3 ; 8-second-period-waves from 215 degrees)

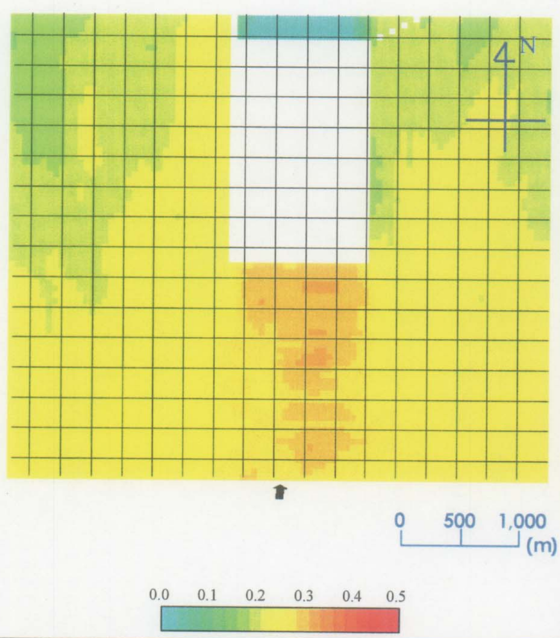
Plan-A



Plan-A (Breakwater)



Plan-B



Plan-C

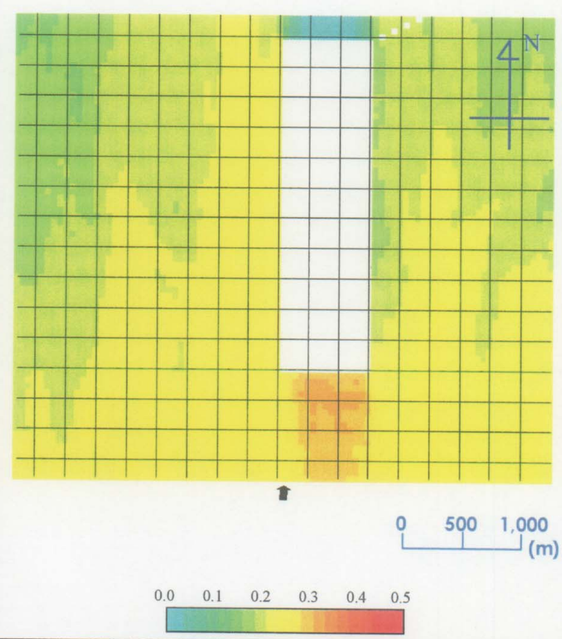


Figure A.2.3.9 Ratio of Wave Height against Offshore Wave

(In the case.02_4 ; 8-second-period-waves from 220 degrees)

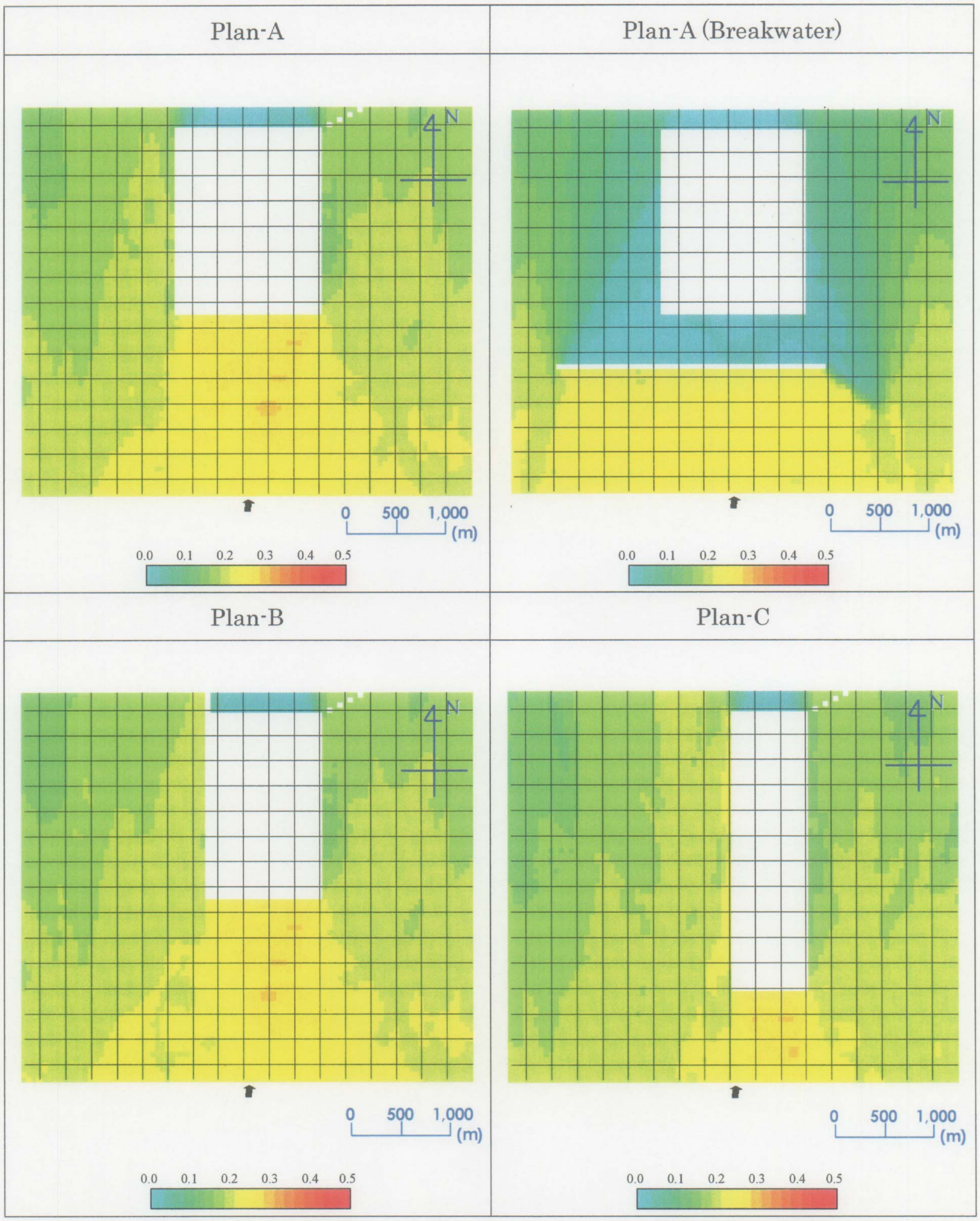


Figure A.2.3.10 Ratio of Wave Height against Offshore Wave

(In the case.02_5 ; 8-second-period-waves from 225 degrees)

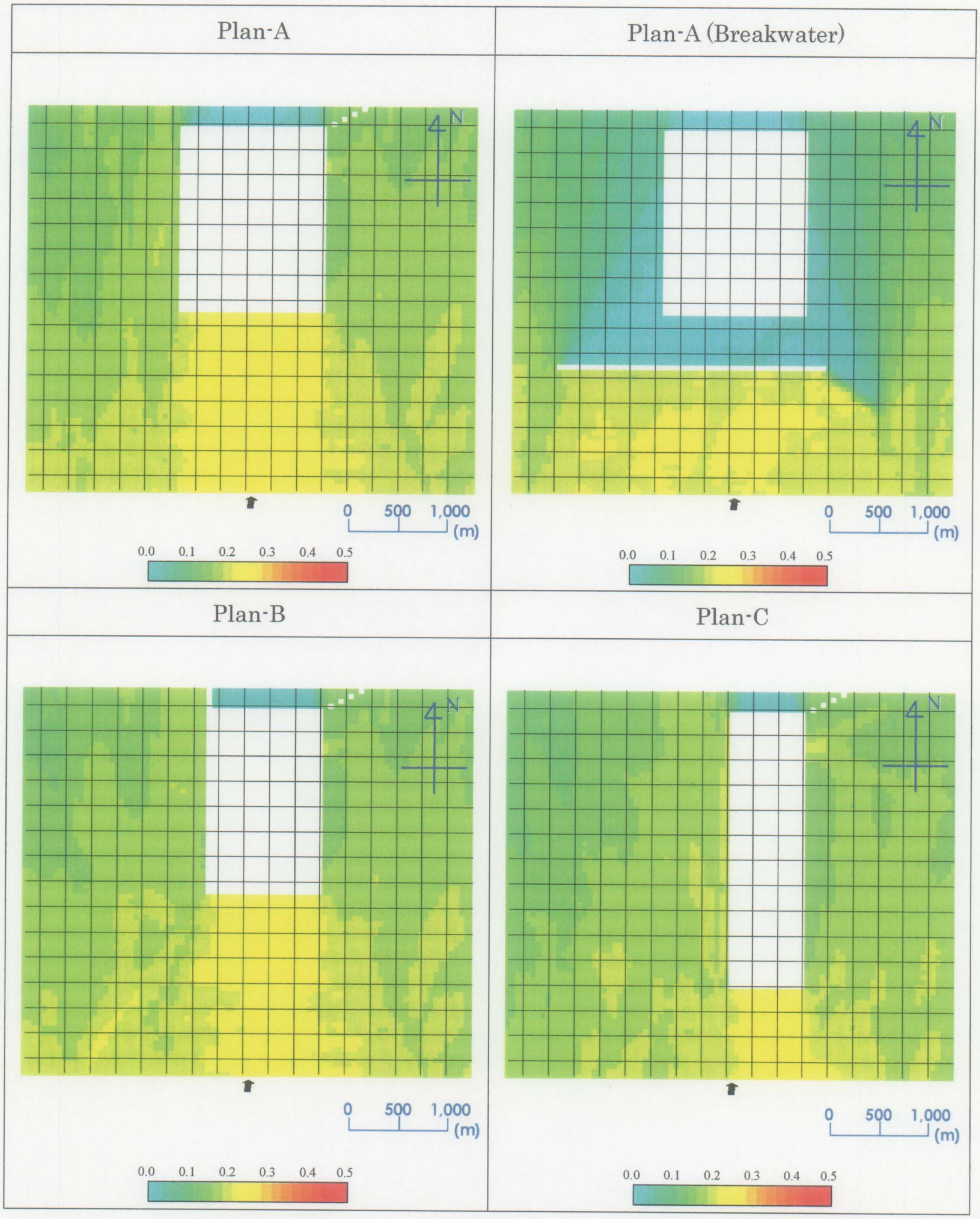


Figure A.2.3.11 Ratio of Wave Height against Offshore Wave

(In the case.02_6 ; 8-second-period-waves from 230 degrees)

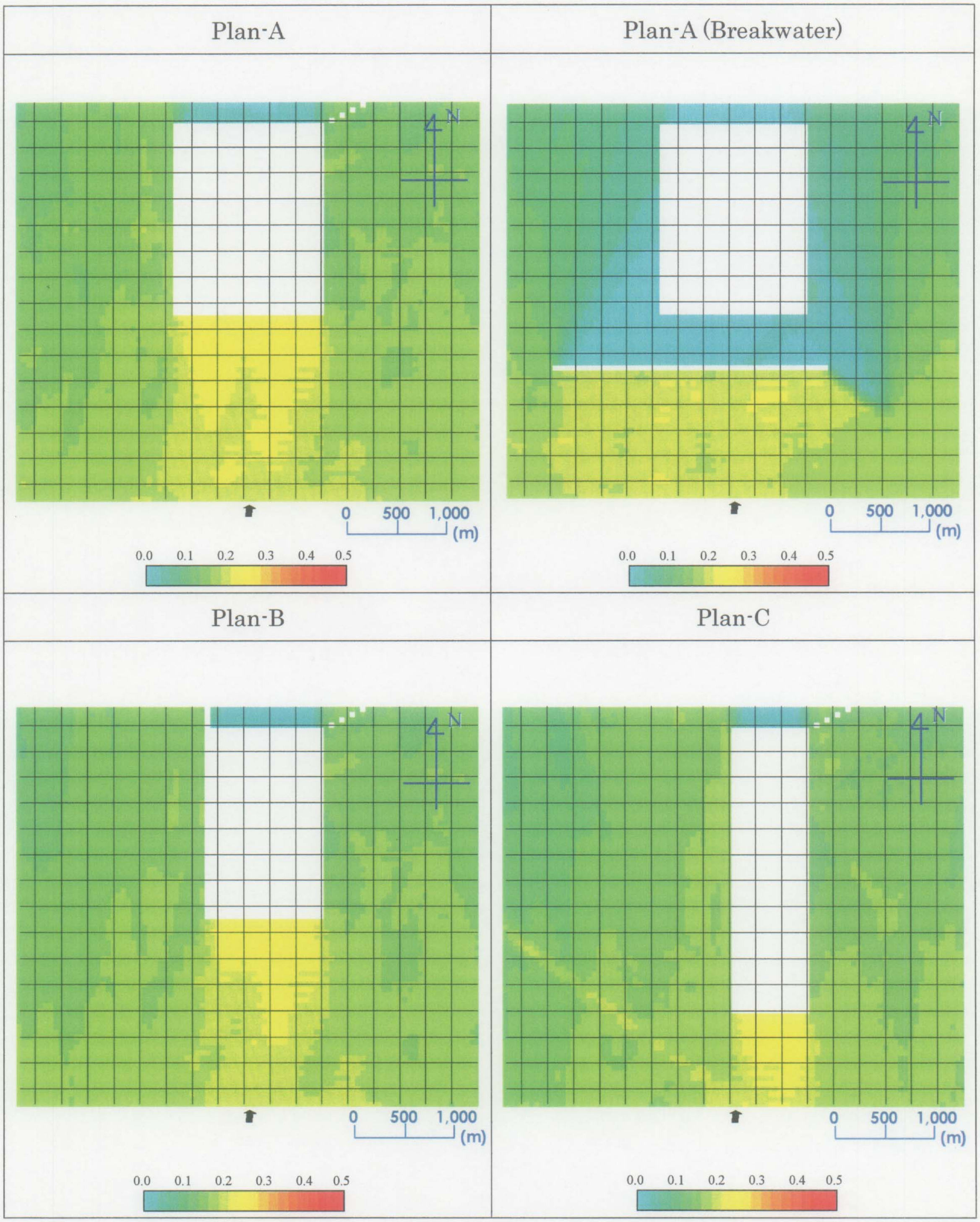


Figure A.2.3.12 Ratio of Wave Height against Offshore Wave

(In the case.02_7 ; 8-second-period-waves from 235 degrees)

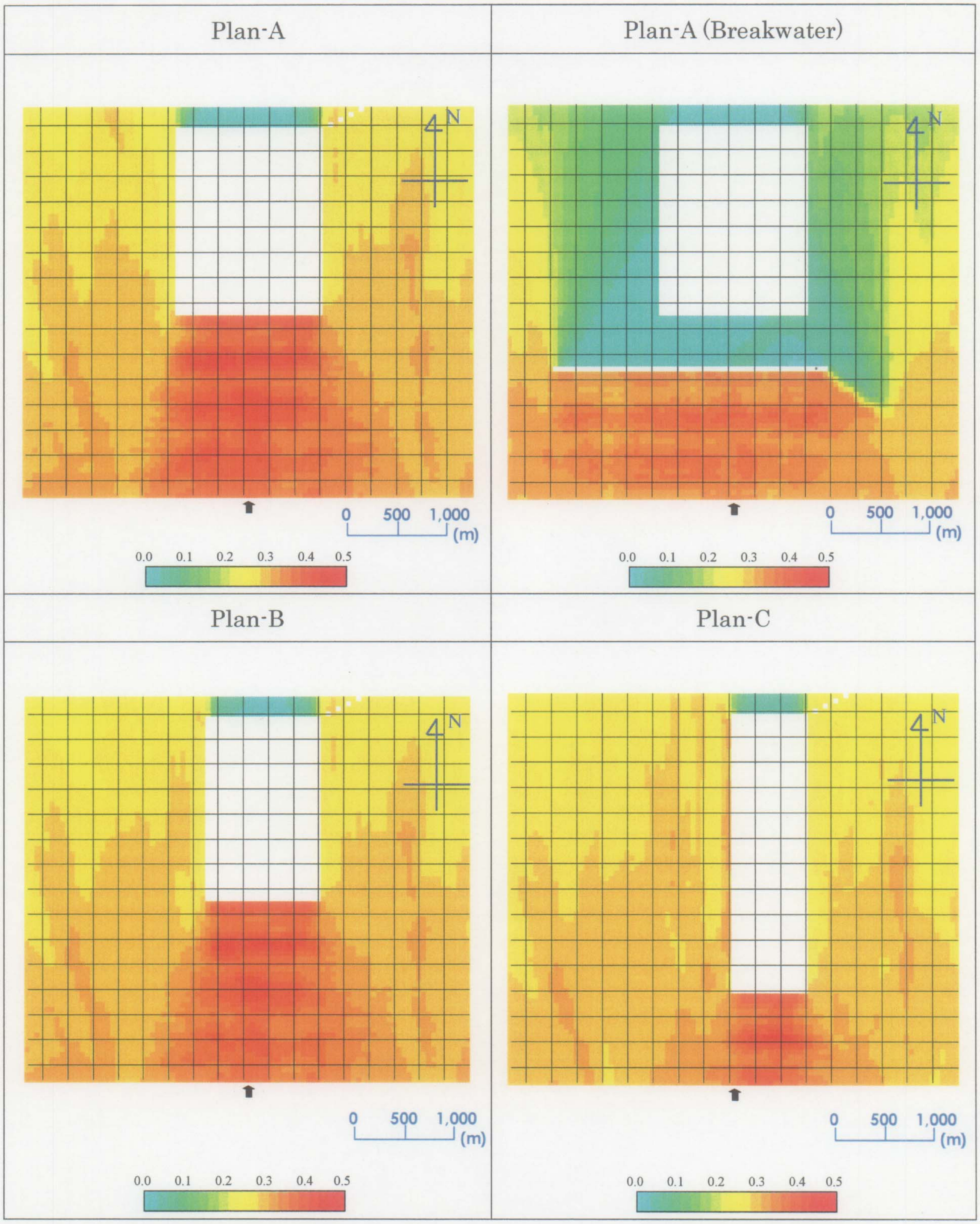


Figure A.2.3.13 Ratio of Wave Height against Offshore Wave

(In the case.03_1 ; 10-second-period-waves from 205 degrees)

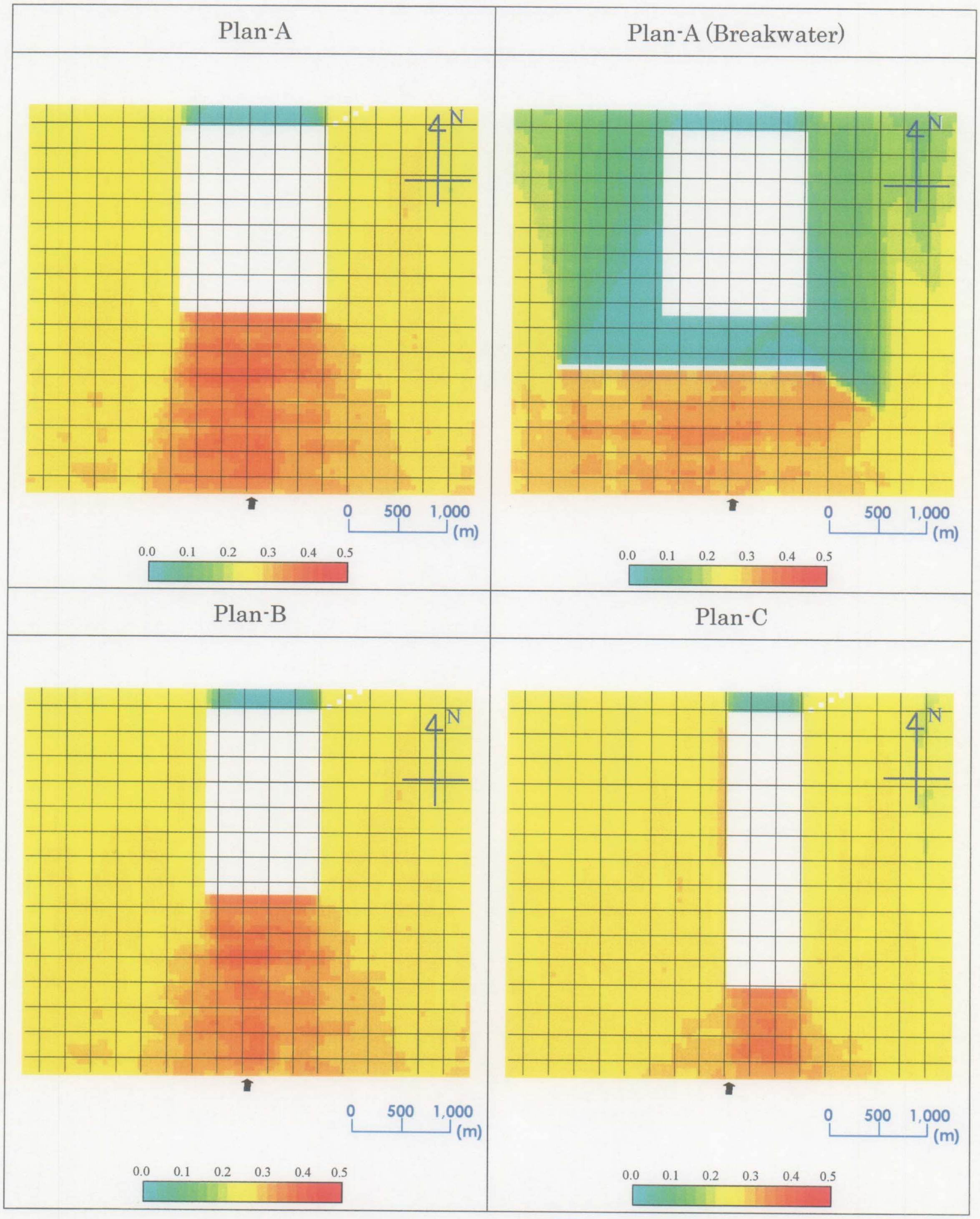


Figure A.2.3.14 Ratio of Wave Height against Offshore Wave

(In the case.03_2 ; 10-second-period-waves from 210 degrees)

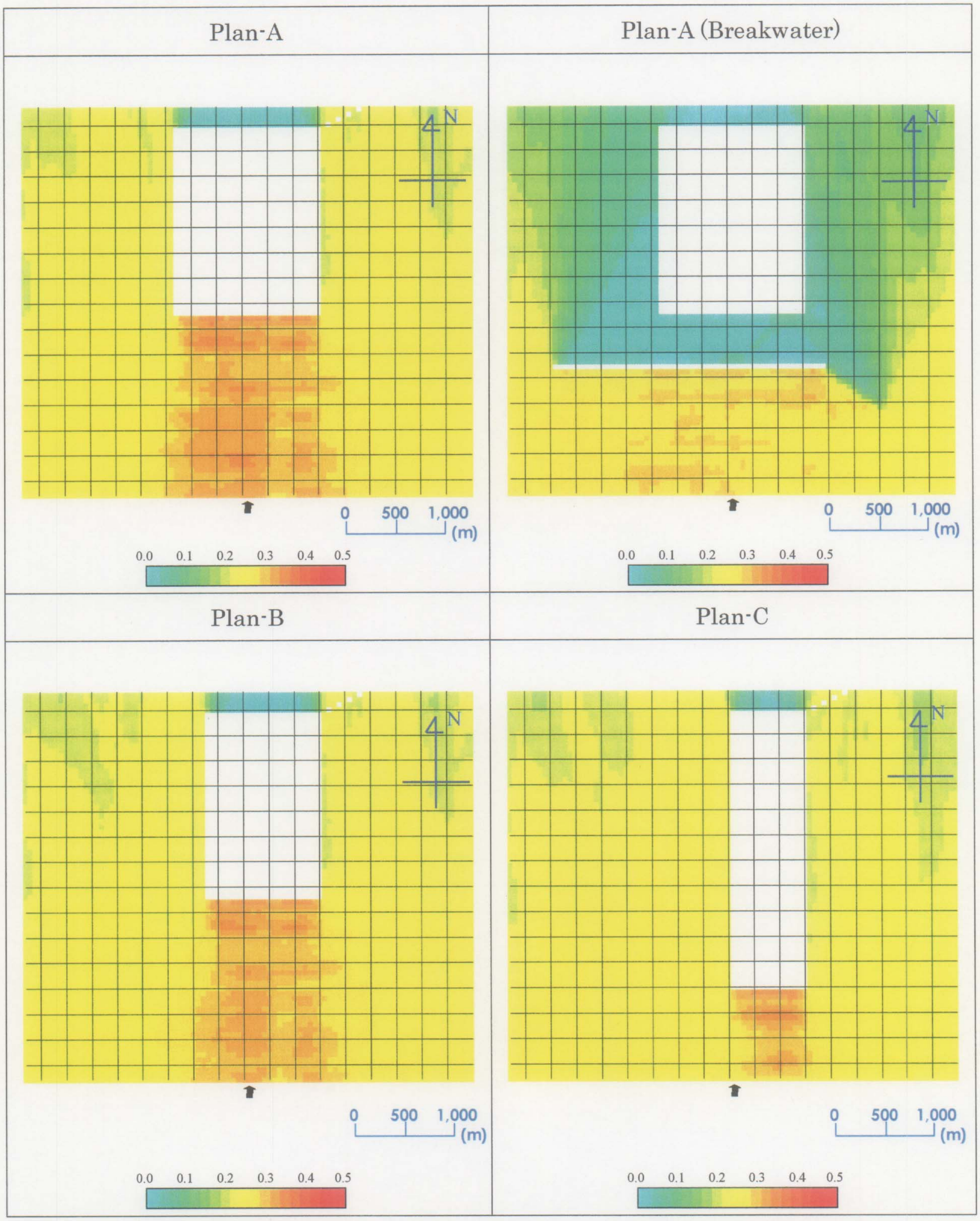


Figure A.2.3.15 Ratio of Wave Height against Offshore Wave

(In the case.03_3 ; 10-second-period-waves from 215 degrees)

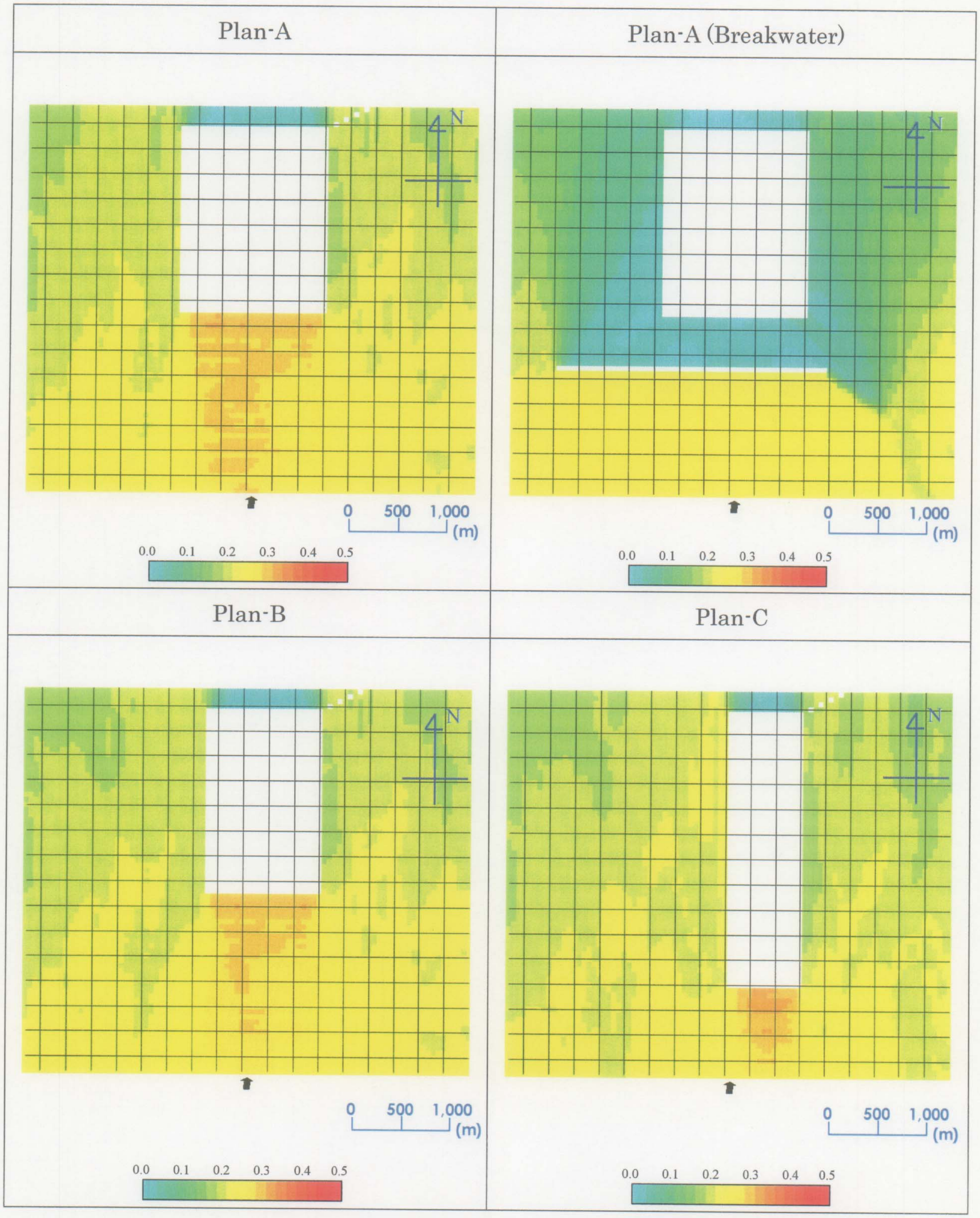


Figure A.2.3.16 Ratio of Wave Height against Offshore Wave
(In the case.03_4 ; 10-second-period-waves from 220 degrees)

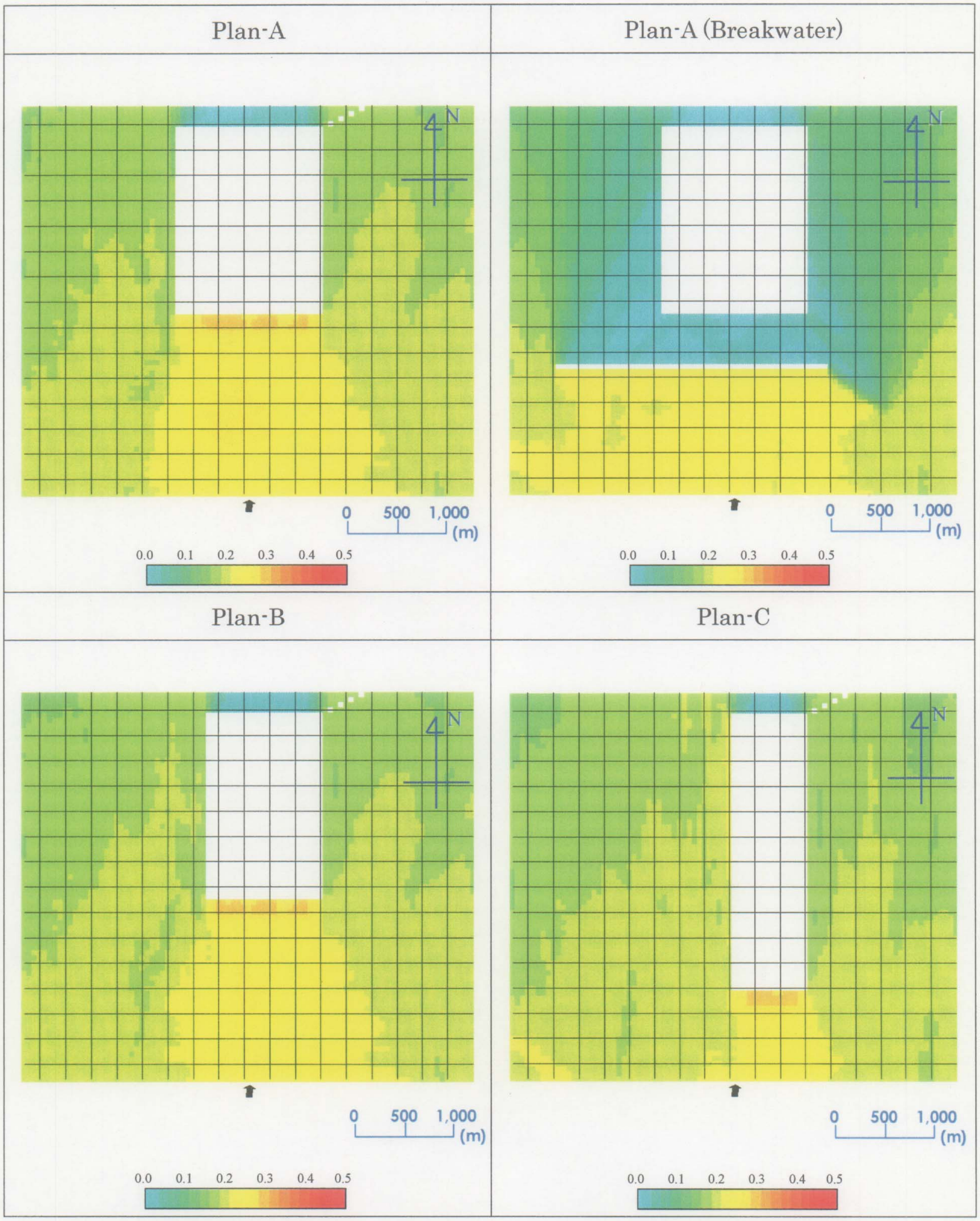


Figure A.2.3.17 Ratio of Wave Height against Offshore Wave
(In the case.03_5 ; 10-second-period-waves from 225 degrees)

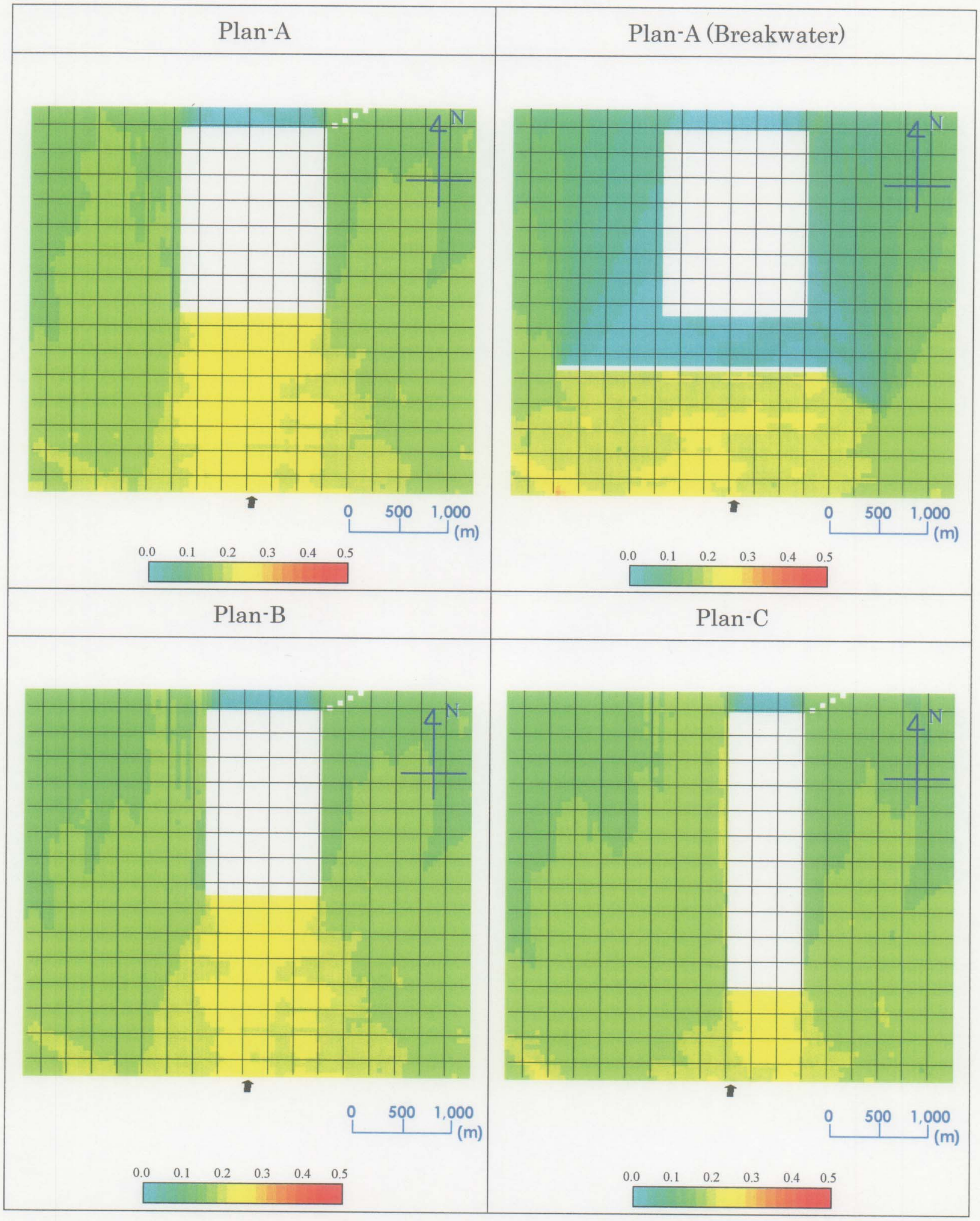


Figure A.2.3.18 Ratio of Wave Height against Offshore Wave
(In the case.03_6 ; 10-second-period-waves from 230 degrees)

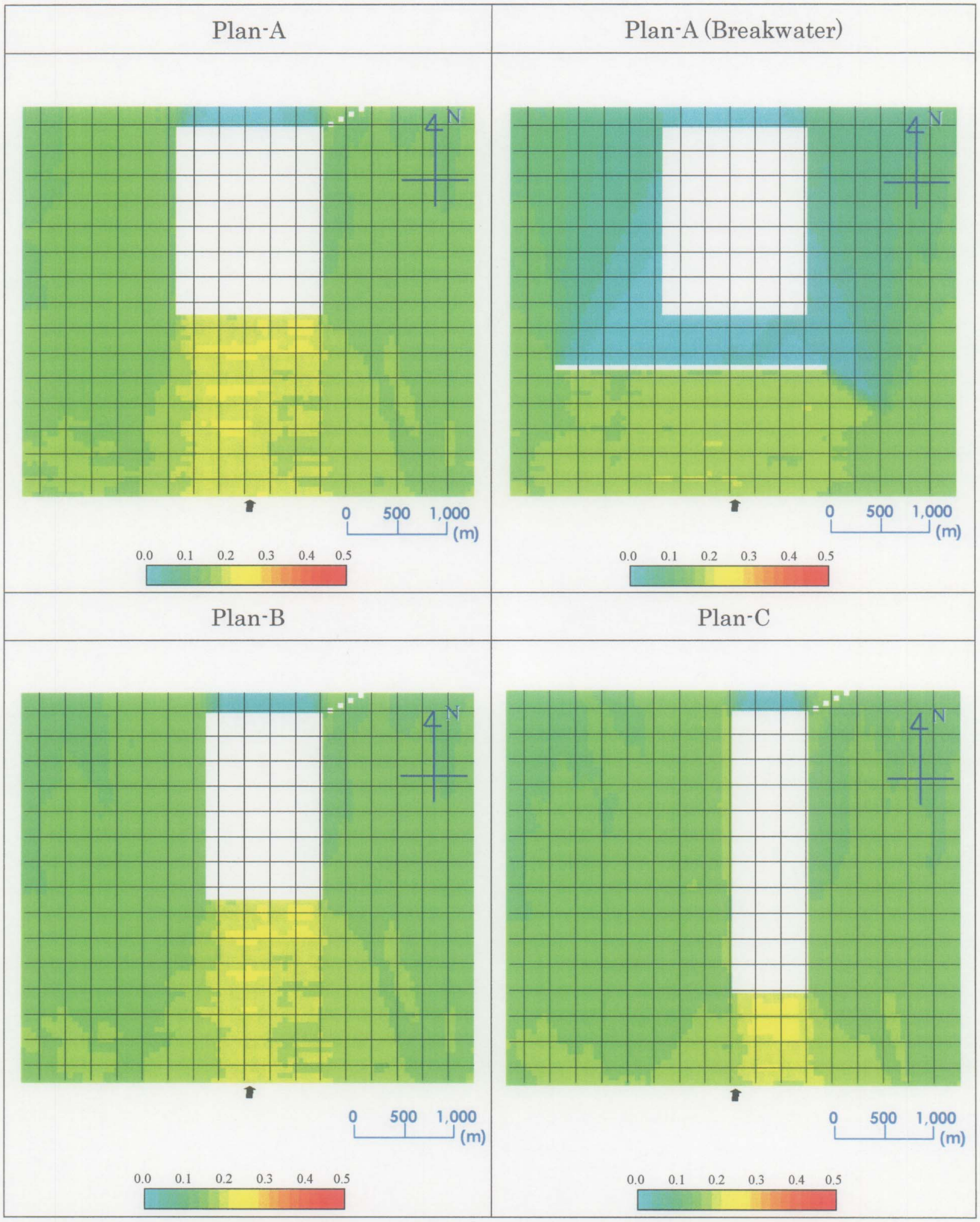


Figure A.2.3.19 Ratio of Wave Height against Offshore Wave

(In the case.03_7 ; 10-second-period-waves from 235 degrees)

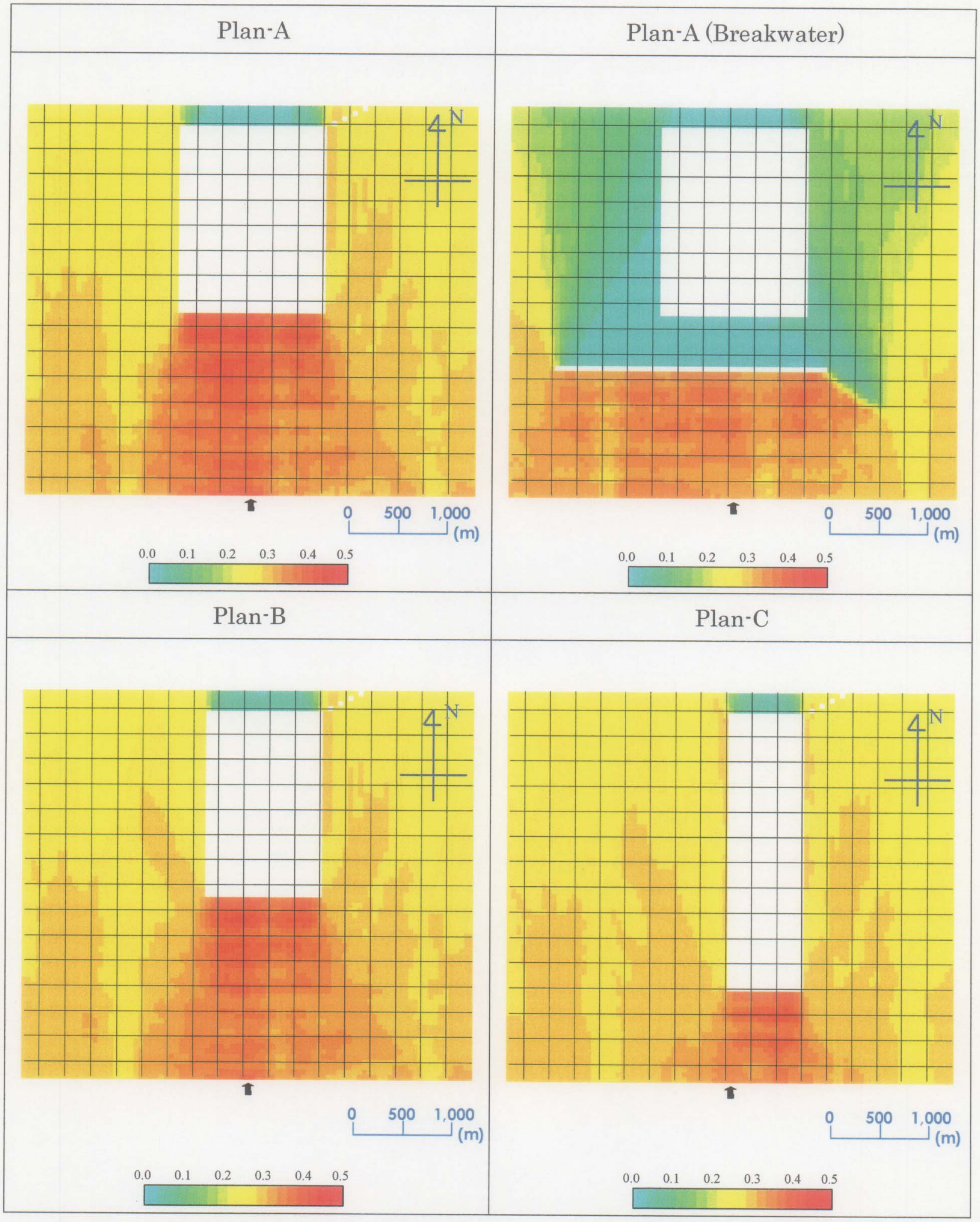


Figure A.2.3.20 Ratio of Wave Height against Offshore Wave

(In the case.04_1 ; 12-second-period-waves from 205 degrees)

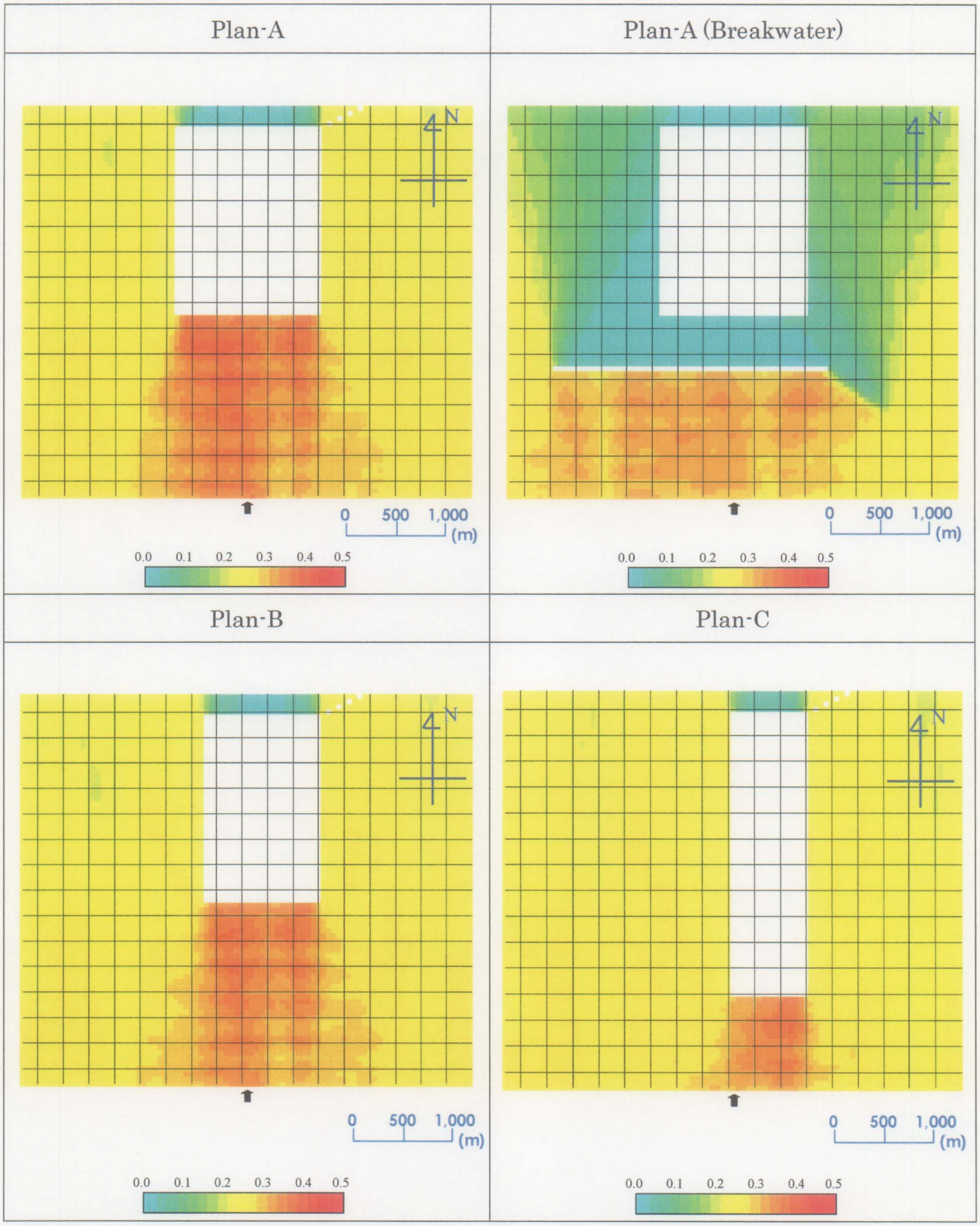


Figure A.2.3.21 Ratio of Wave Height against Offshore Wave
(In the case.04_2 ; 12-second-period-waves from 210 degrees)

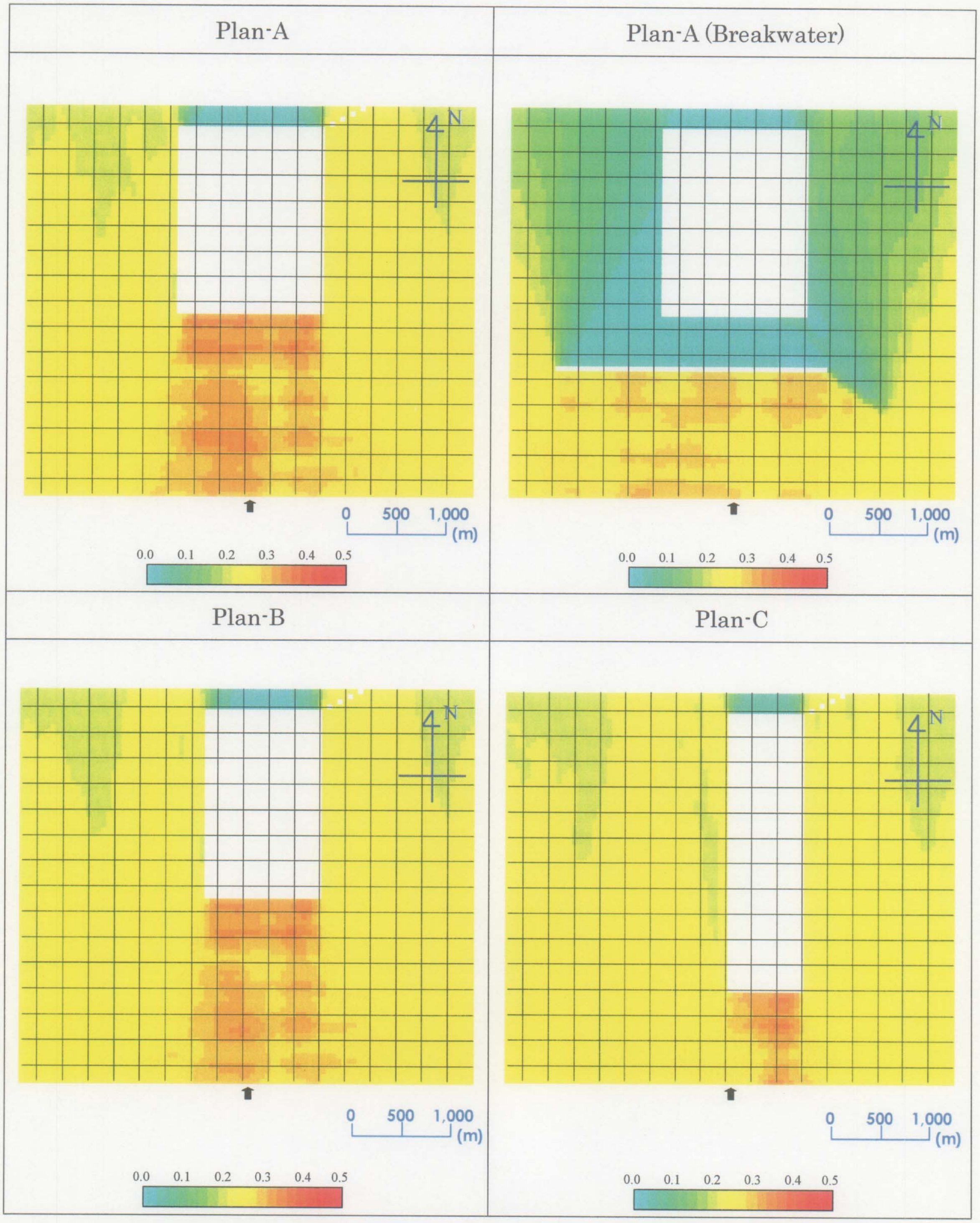


Figure A.2.3.22 Ratio of Wave Height against Offshore Wave
(In the case.04_3 ; 12-second-period-waves from 215 degrees)

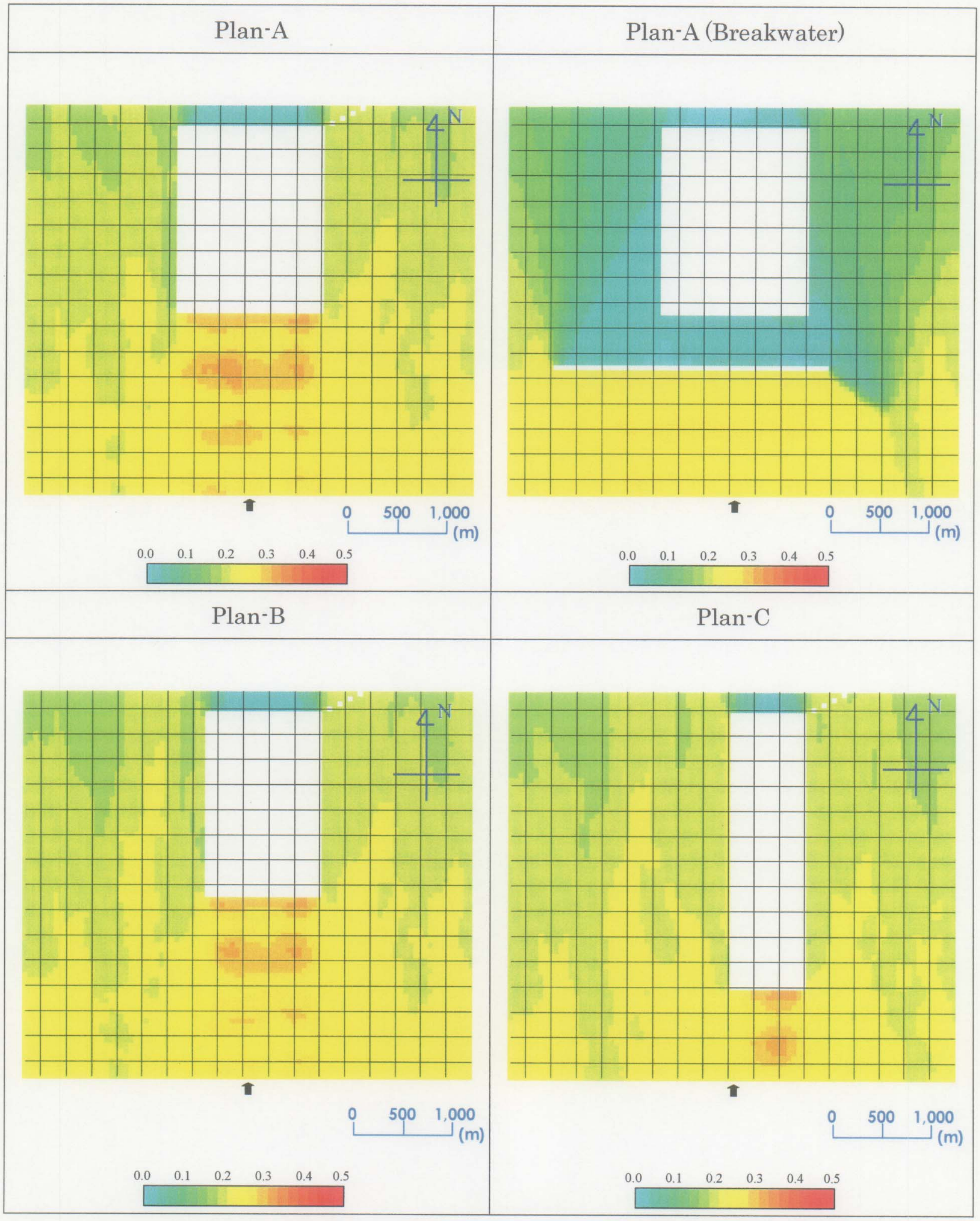


Figure A.2.3.23 Ratio of Wave Height against Offshore Wave
(In the case.04_4 ; 12-second-period-waves from 220 degrees)

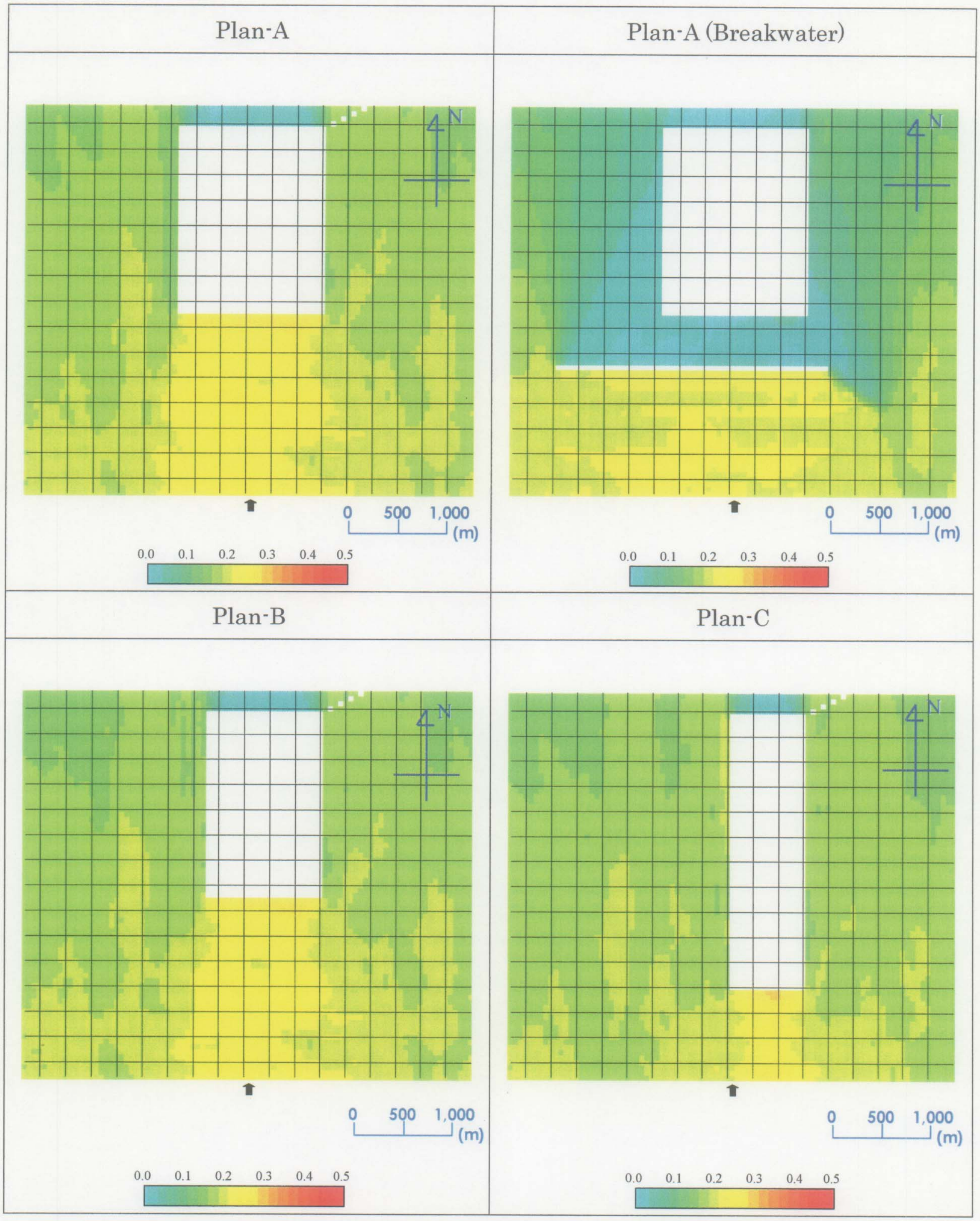


Figure A.2.3.24 Ratio of Wave Height against Offshore Wave
(In the case.04_5 ; 12-second-period-waves from 225 degrees)

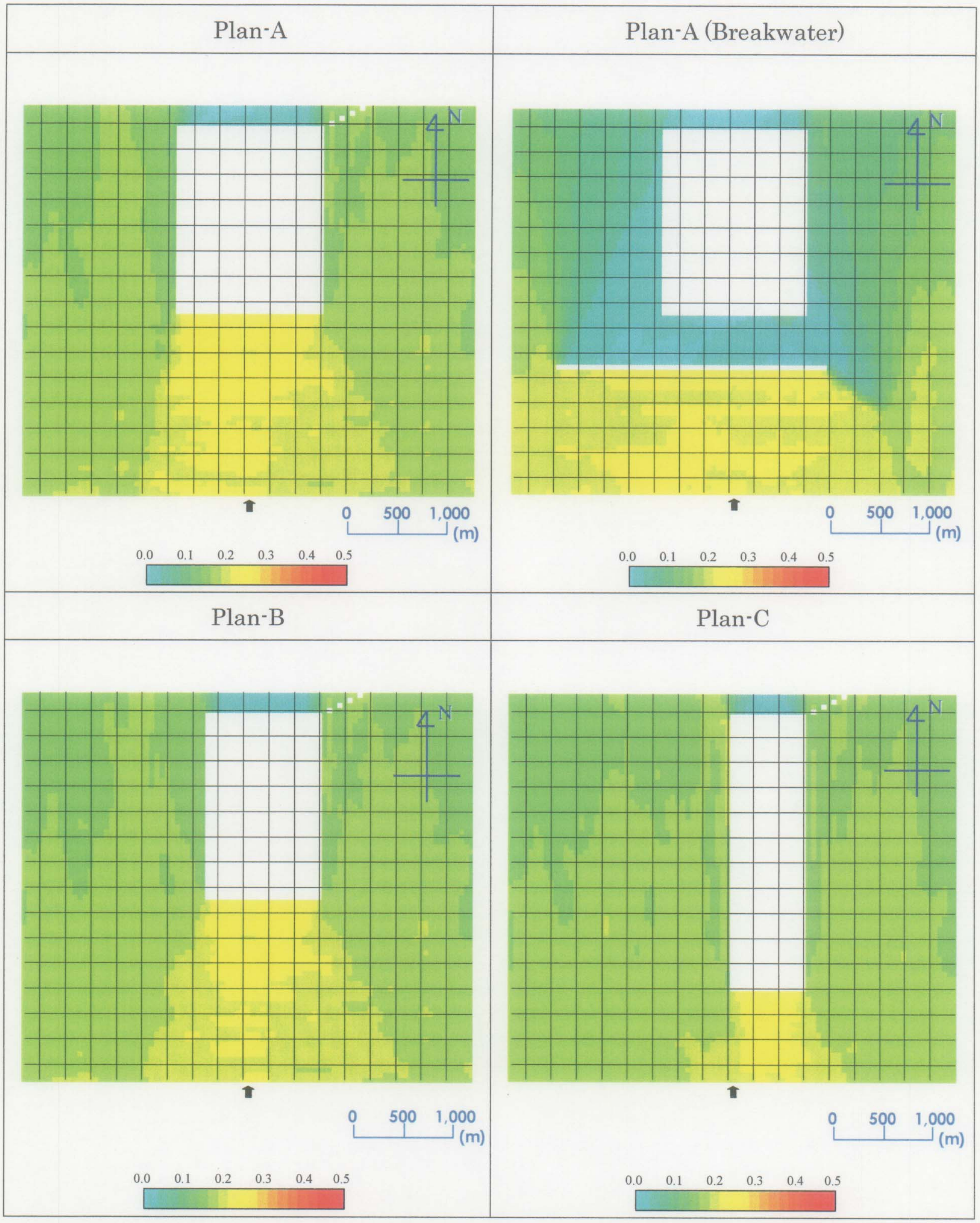


Figure A.2.3.25 Ratio of Wave Height against Offshore Wave
(In the case.04_6 ; 12-second-period-waves from 230 degrees)

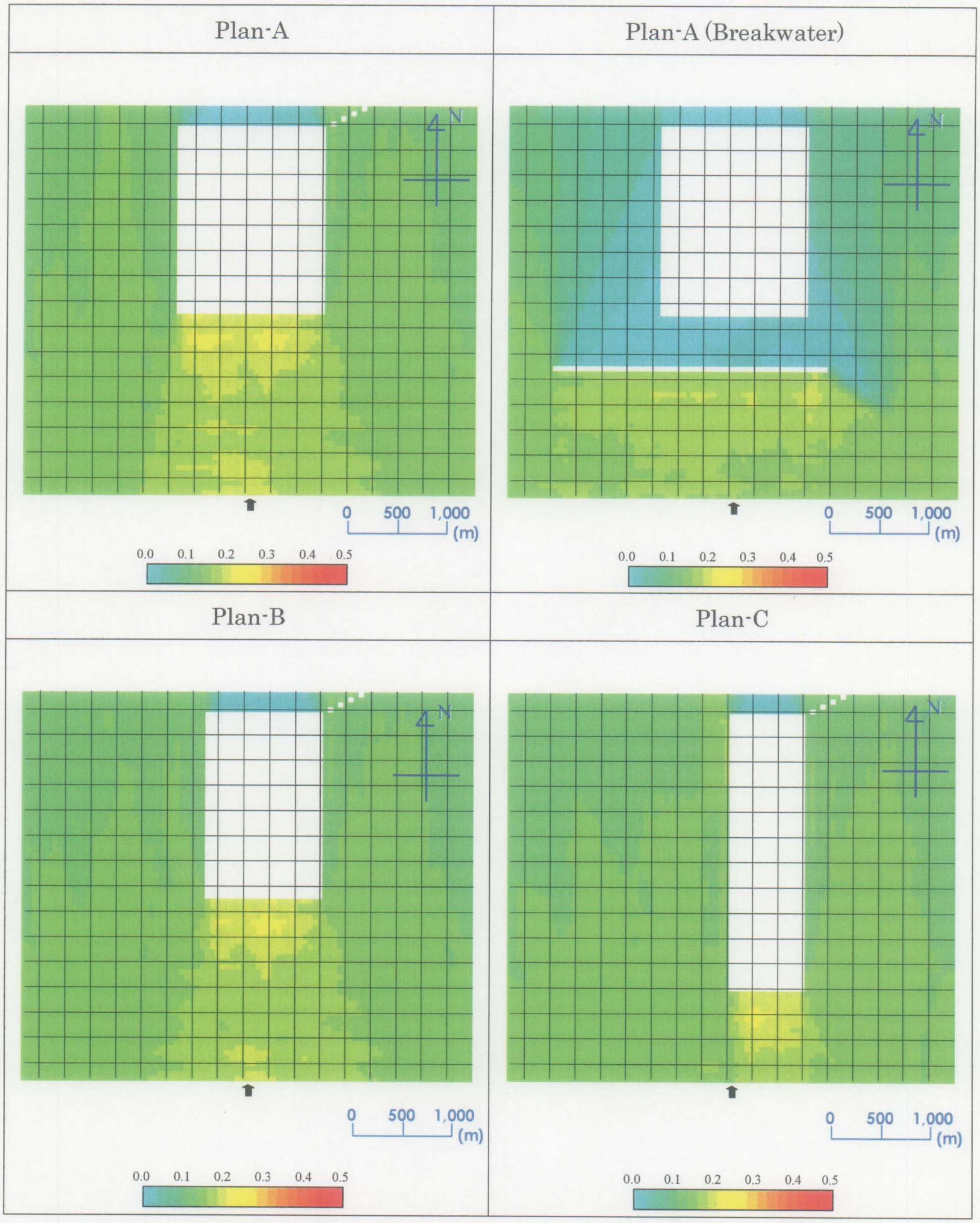


Figure A.2.3.26 Ratio of Wave Height against Offshore Wave
(In the case.04_7 ; 12-second-period-waves from 235 degrees)

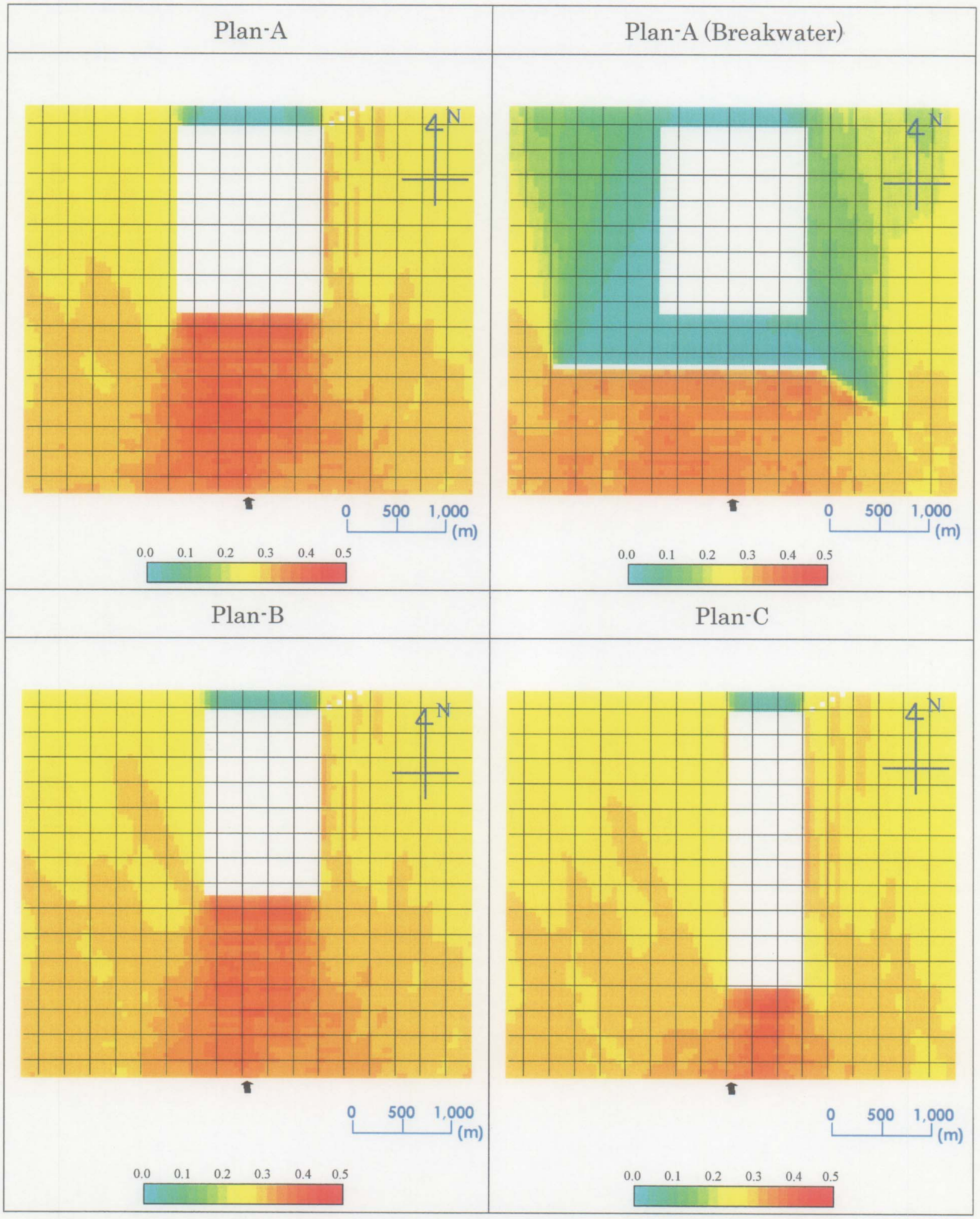


Figure A.2.3.27 Ratio of Wave Height against Offshore Wave
(In the case.05_1 ; 14-second-period-waves from 205 degrees)

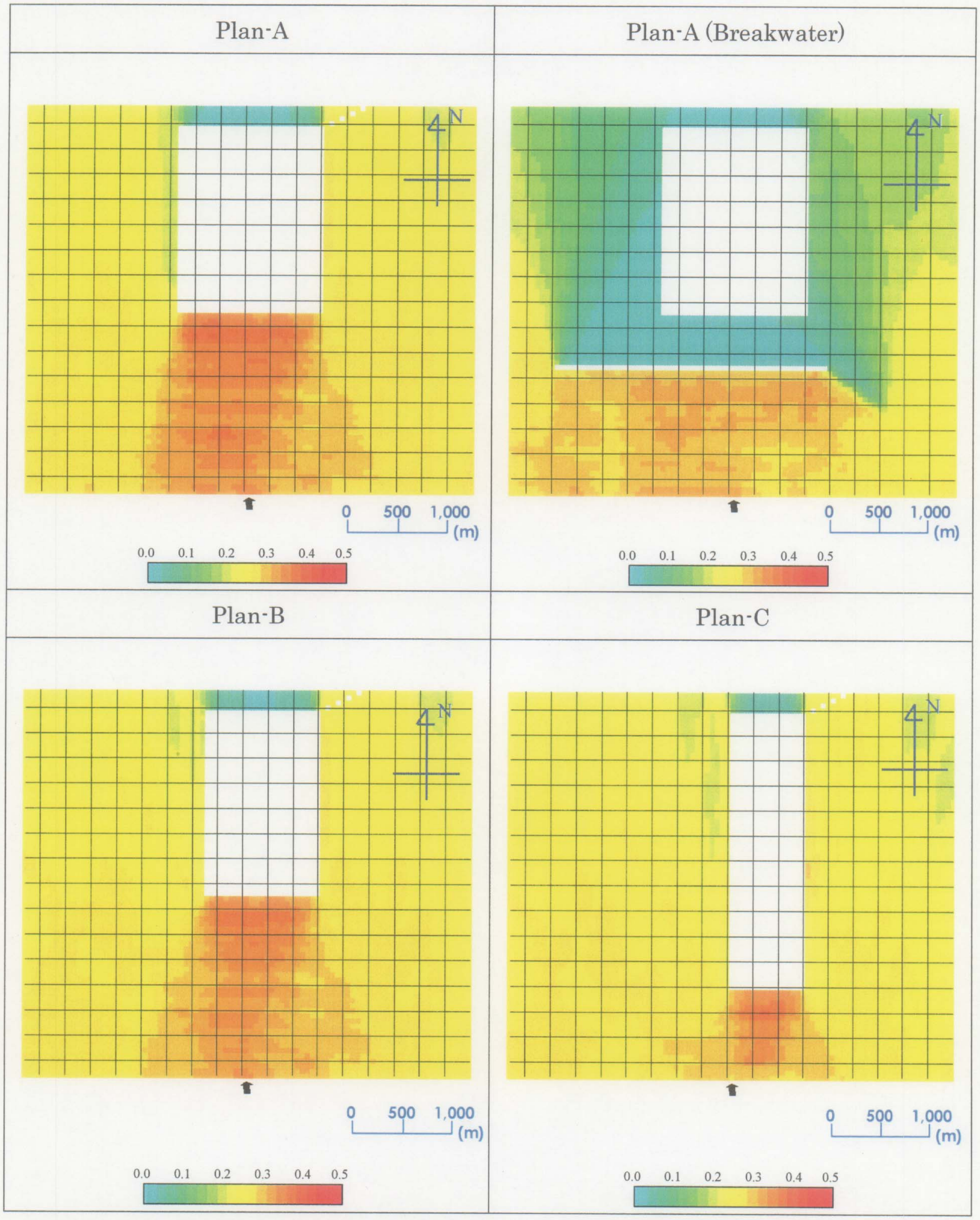


Figure A.2.3.28 Ratio of Wave Height against Offshore Wave

(In the case.05_2 ; 14-second-period-waves from 210 degrees)

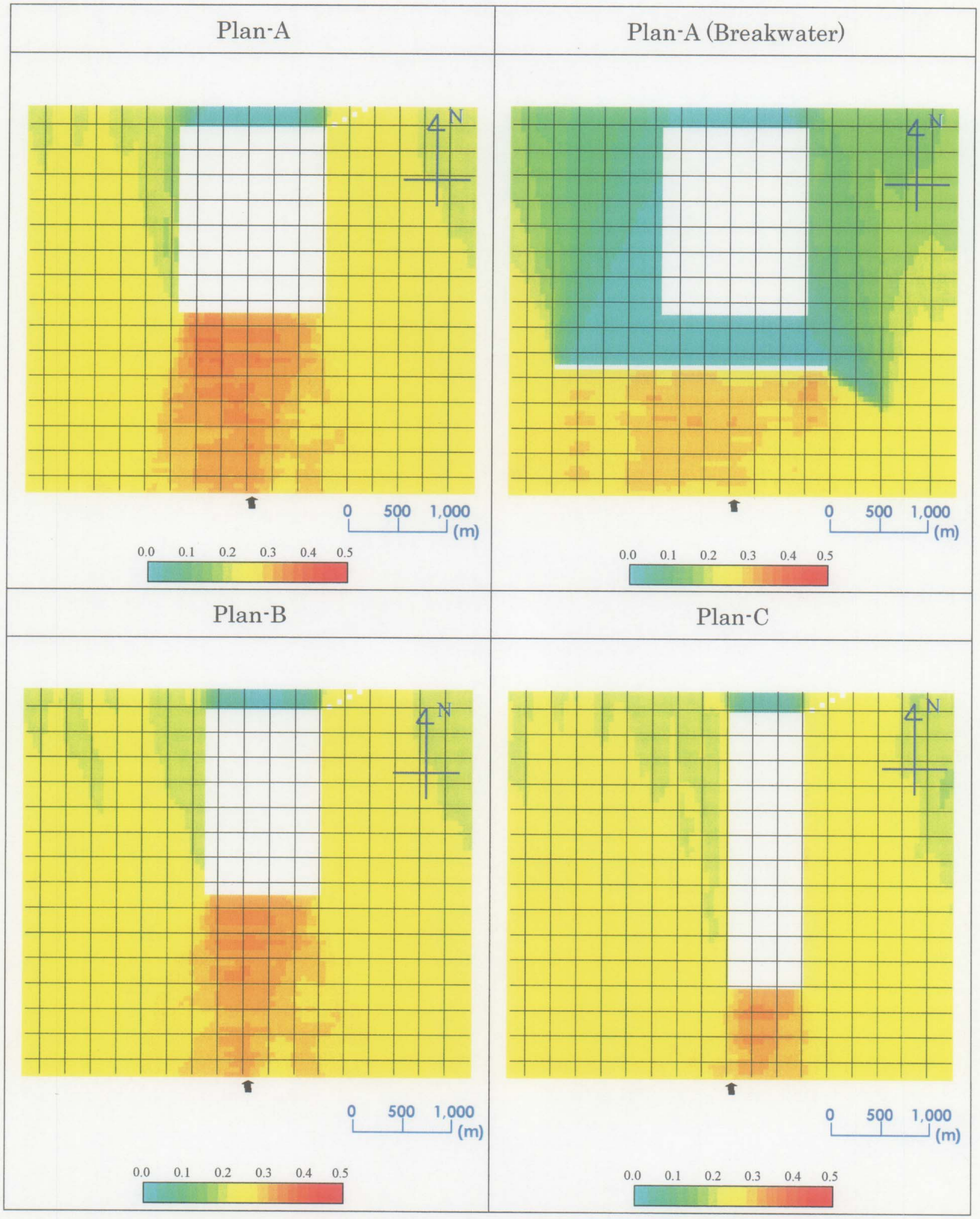


Figure A.2.3.29 Ratio of Wave Height against Offshore Wave
(In the case.05_3 ; 14-second-period-waves from 215 degrees)

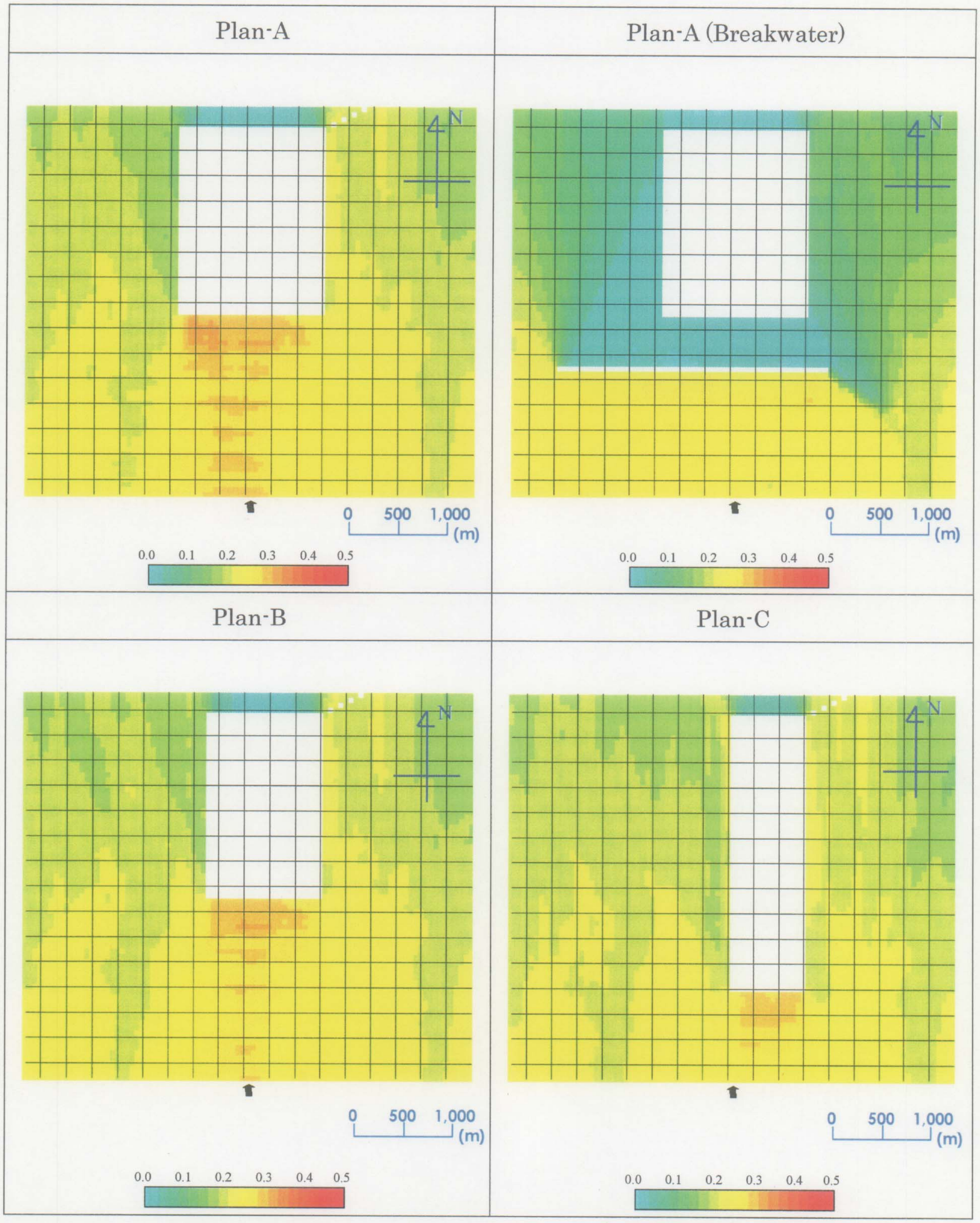


Figure A.2.3.30 Ratio of Wave Height against Offshore Wave
(In the case.05_4 ; 14-second-period-waves from 220 degrees)

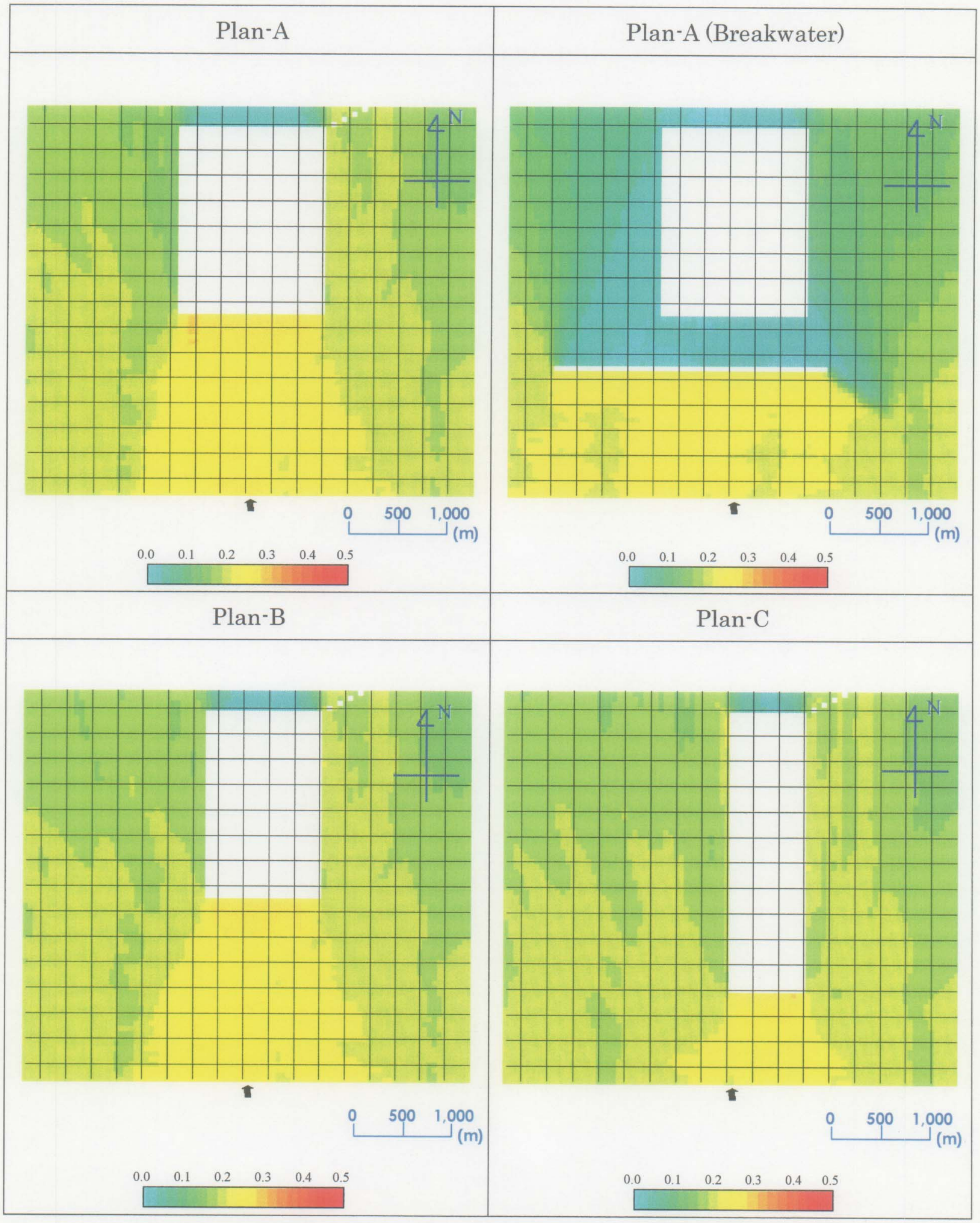


Figure A.2.3.31 Ratio of Wave Height against Offshore Wave
(In the case.05_5 ; 14-second-period-waves from 225 degrees)

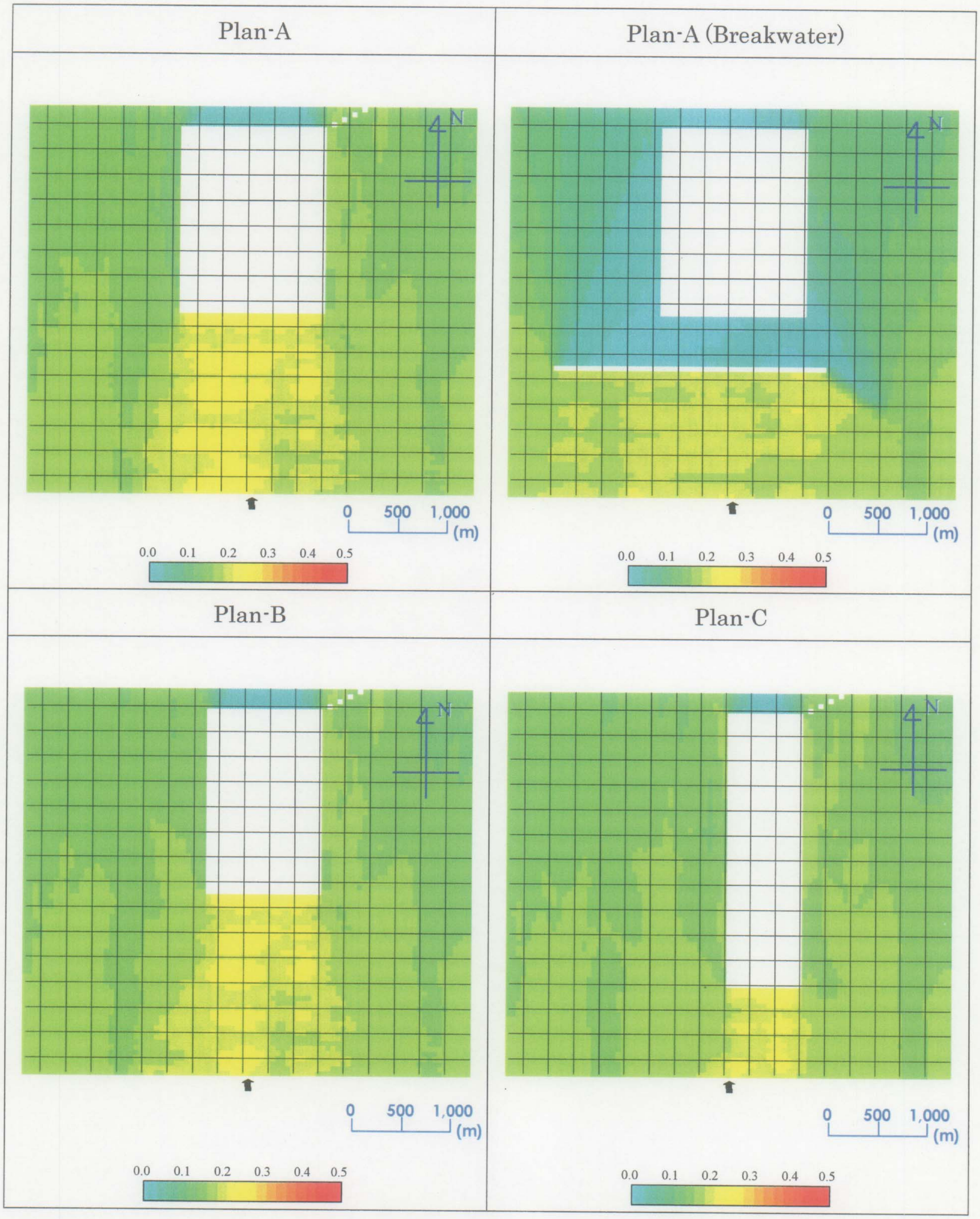


Figure A.2.3.32 Ratio of Wave Height against Offshore Wave
(In the case.05_6 ; 14-second-period-waves from 230 degrees)

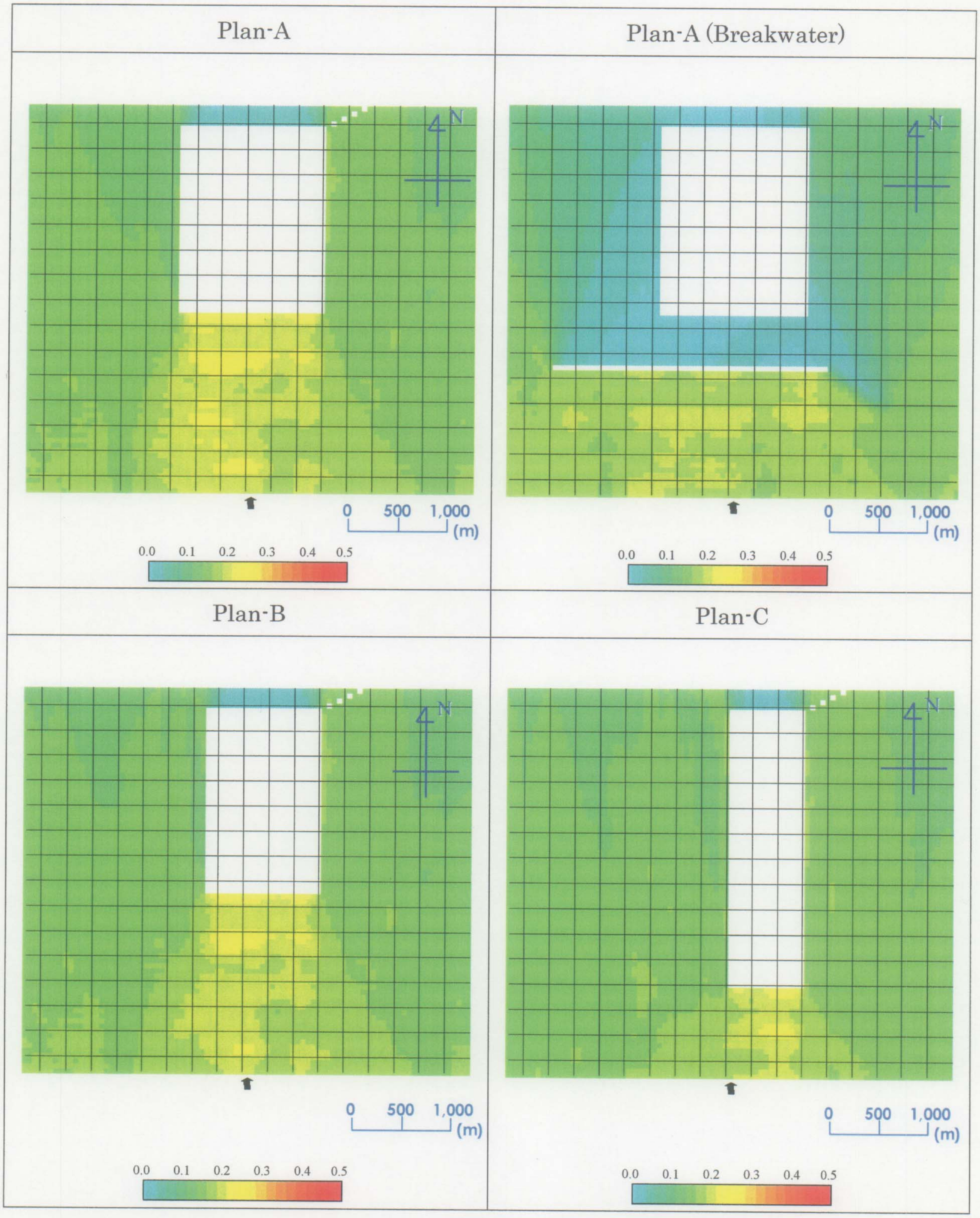


Figure A.2.3.33 Ratio of Wave Height against Offshore Wave
(In the case.05_7 ; 14-second-period-waves from 235 degrees)

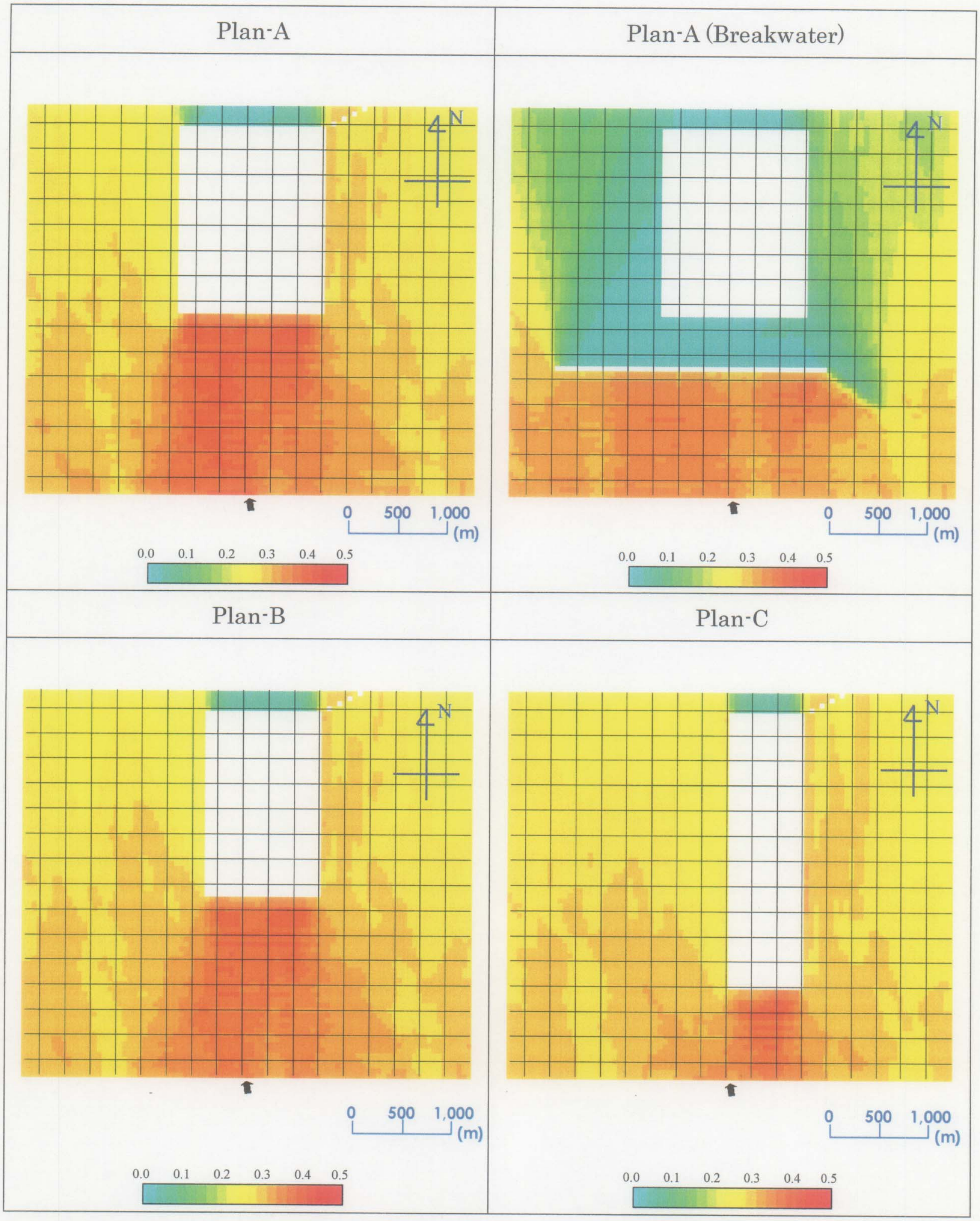


Figure A.2.3.34 Ratio of Wave Height against Offshore Wave
(In the case.06_1 ; 16-second-period-waves from 205 degrees)

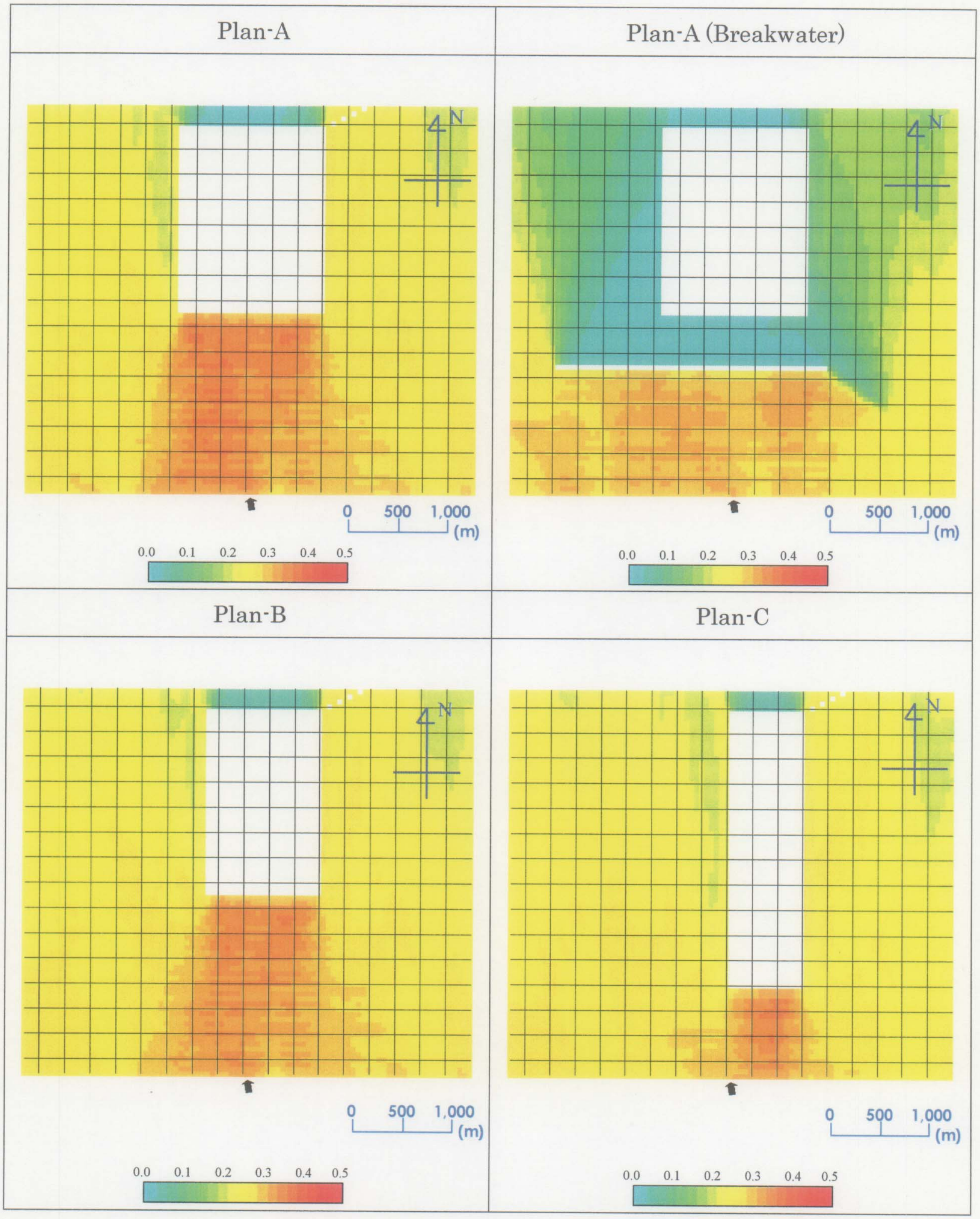


Figure A.2.3.35 Ratio of Wave Height against Offshore Wave
(In the case.06_2 ; 16-second-period-waves from 210 degrees)

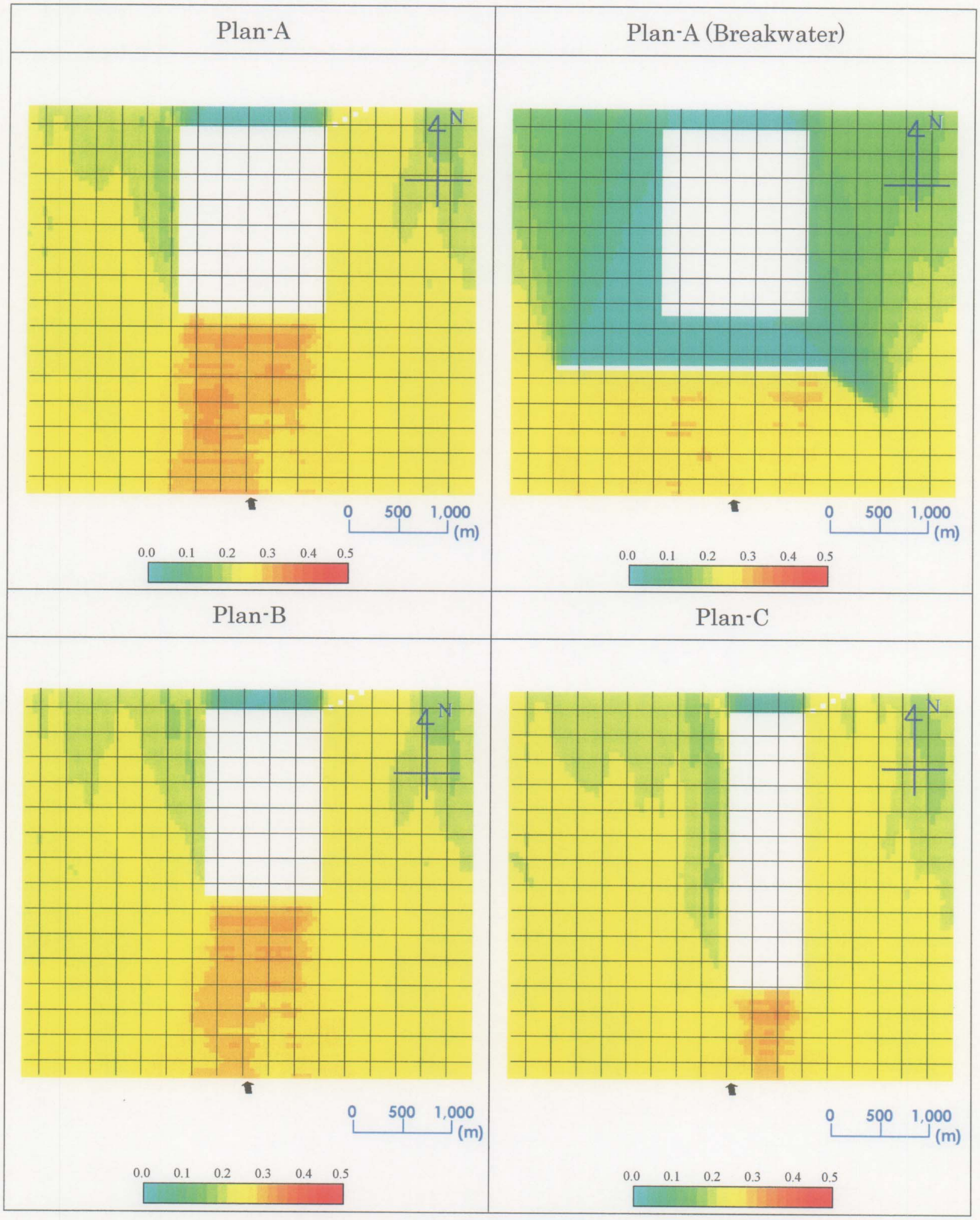


Figure A.2.3.36 Ratio of Wave Height against Offshore Wave
(In the case.06_3 ; 16-second-period-waves from 215 degrees)

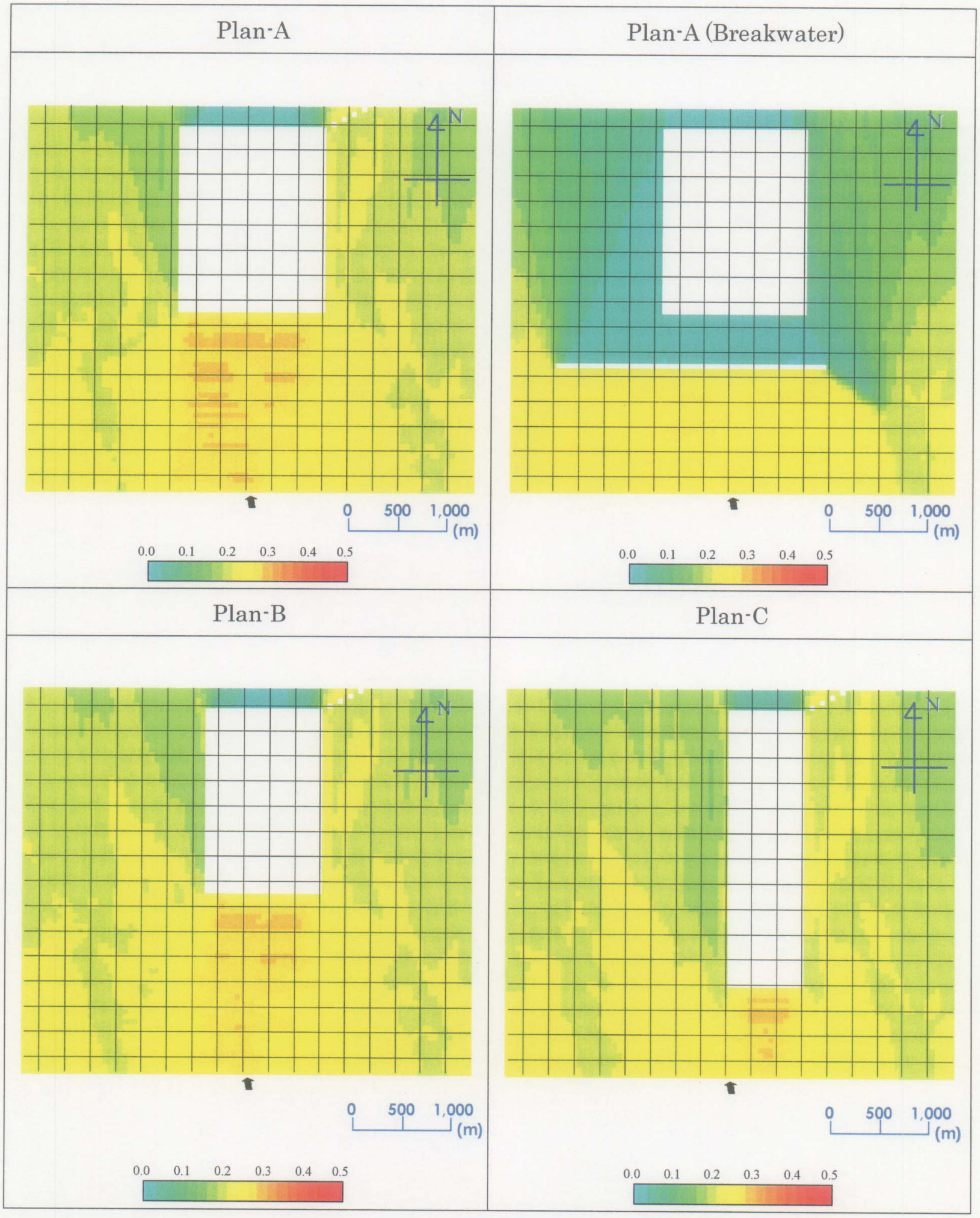


Figure A.2.3.37 Ratio of Wave Height against Offshore Wave
(In the case.06_4 ; 16-second-period-waves from 220 degrees)

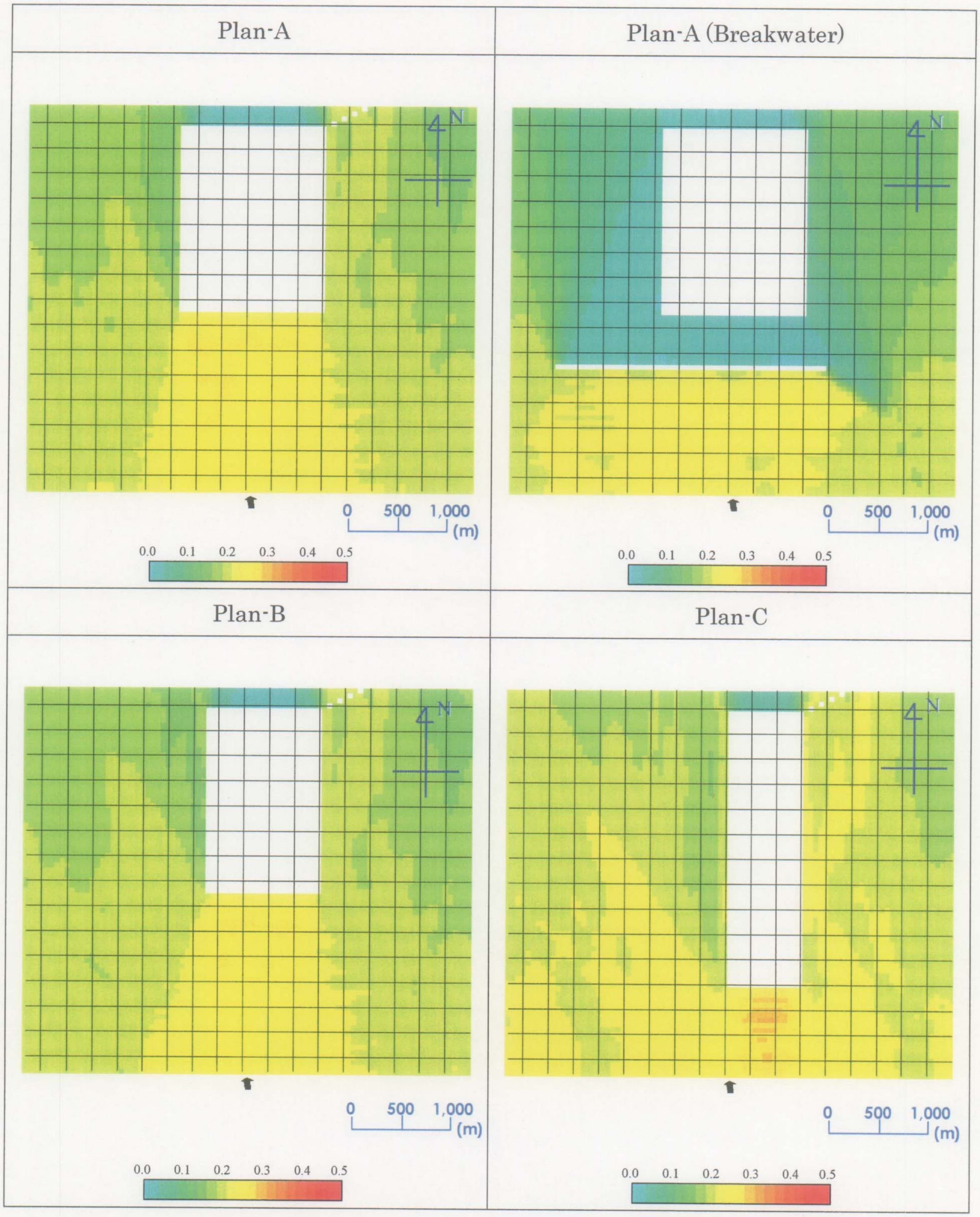


Figure A.2.3.38 Ratio of Wave Height against Offshore Wave
(In the case.06_5 ; 16-second-period-waves from 225 degrees)

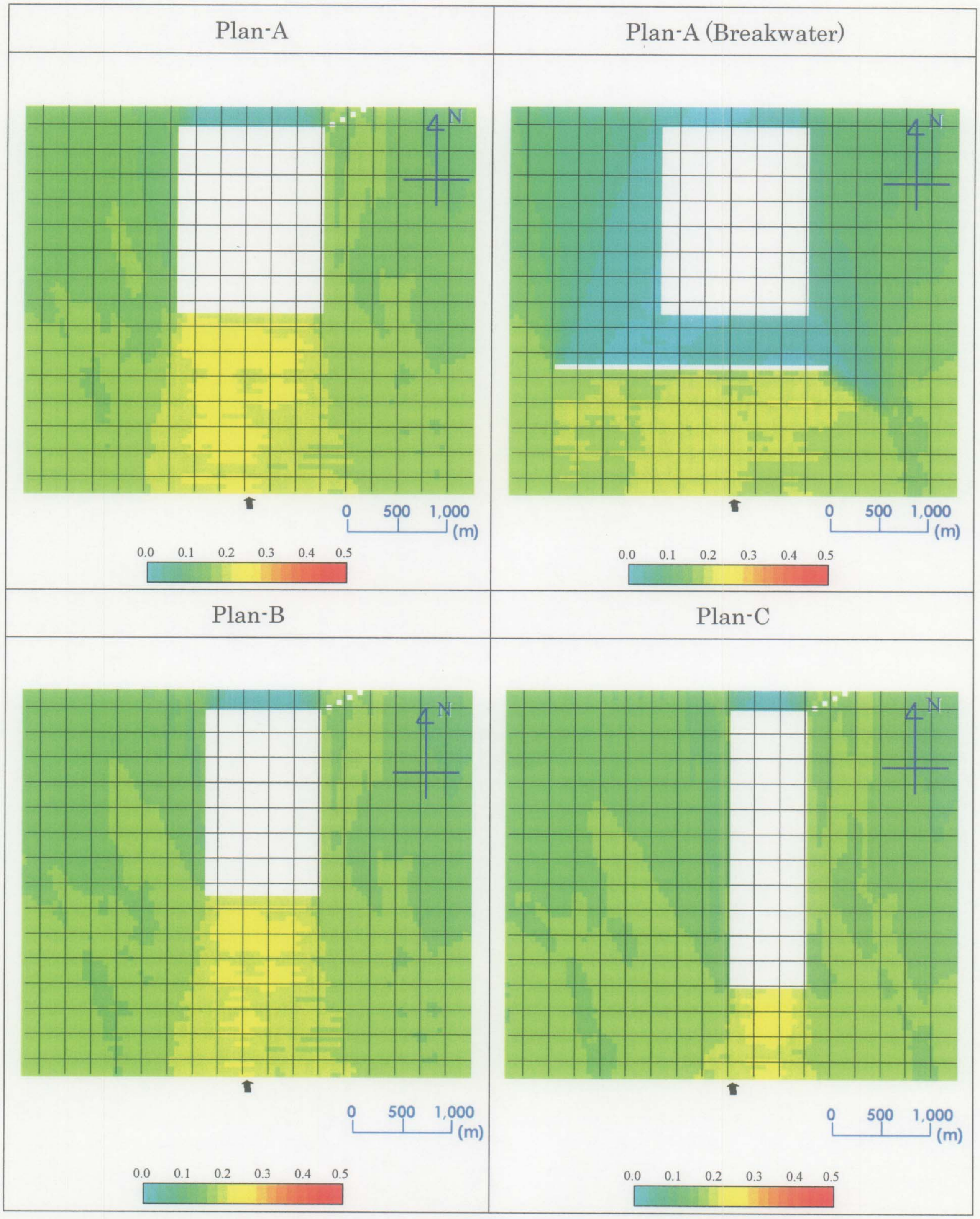


Figure A.2.3.39 Ratio of Wave Height against Offshore Wave
(In the case.06_6 ; 16-second-period-waves from 230 degrees)

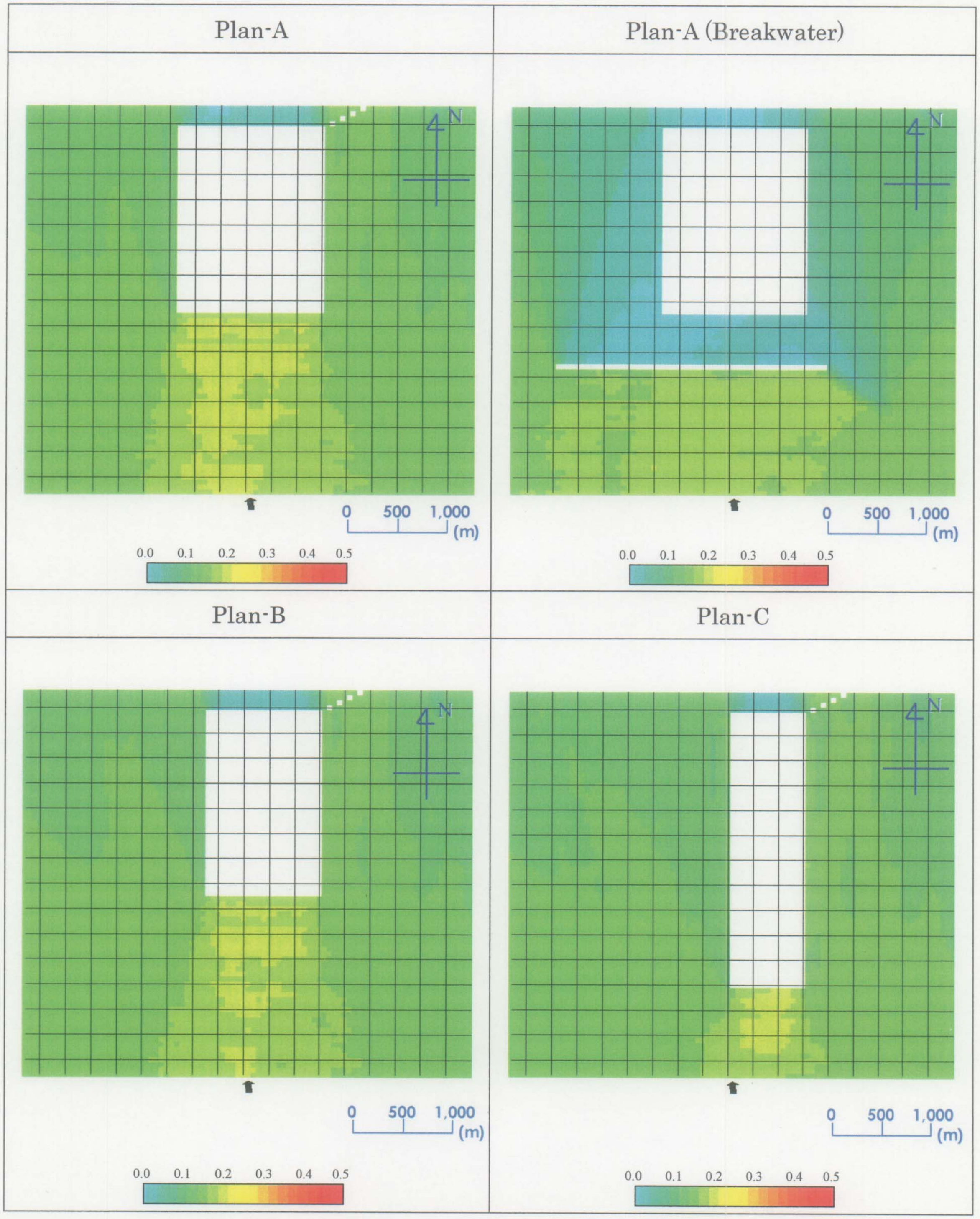


Figure A.2.3.40 Ratio of Wave Height against Offshore Wave
(In the case.06_7 ; 16-second-period-waves from 235 degrees)

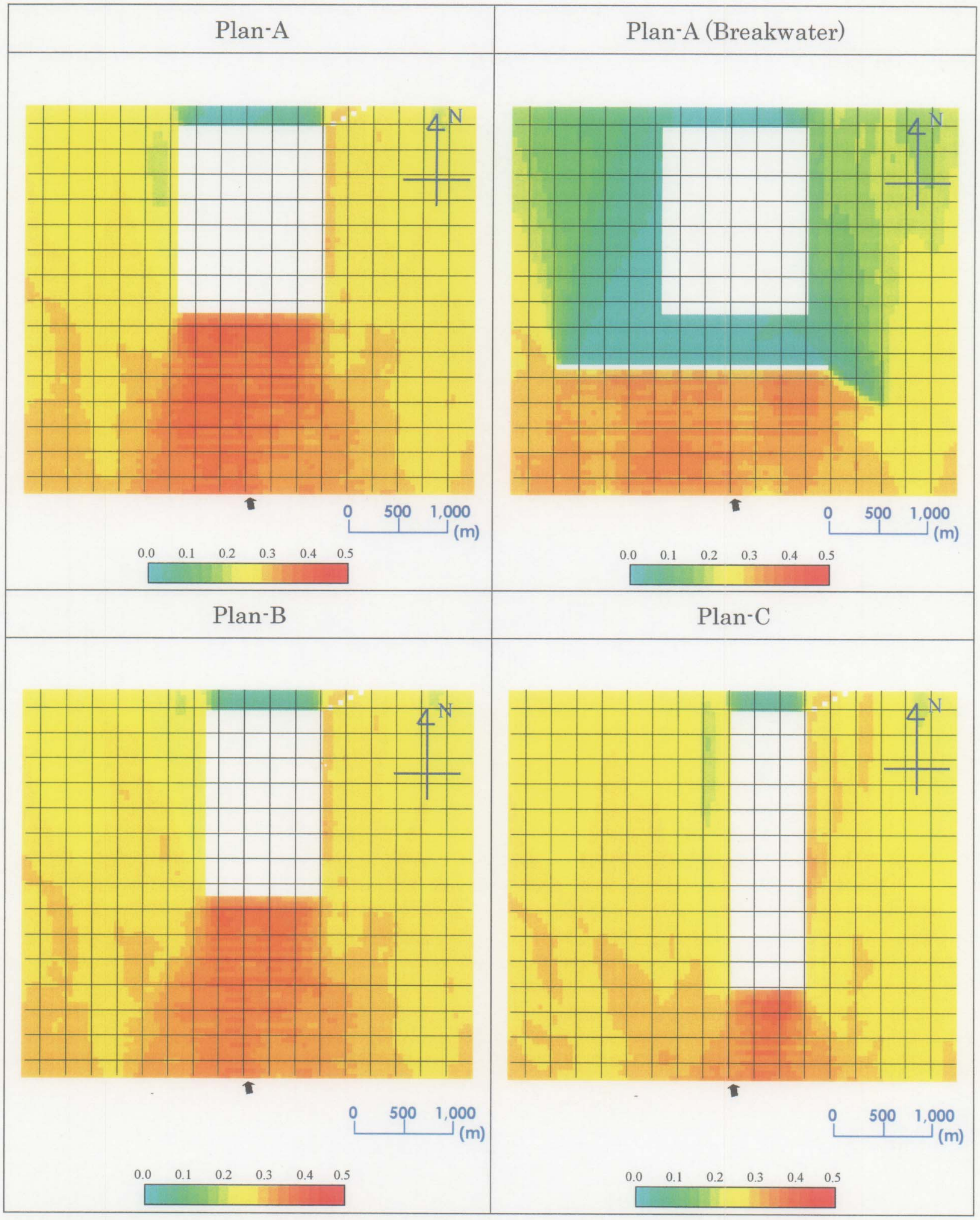


Figure A.2.3.41 Ratio of Wave Height against Offshore Wave
(In the case.07_1 ; 18-second-period-waves from 205 degrees)

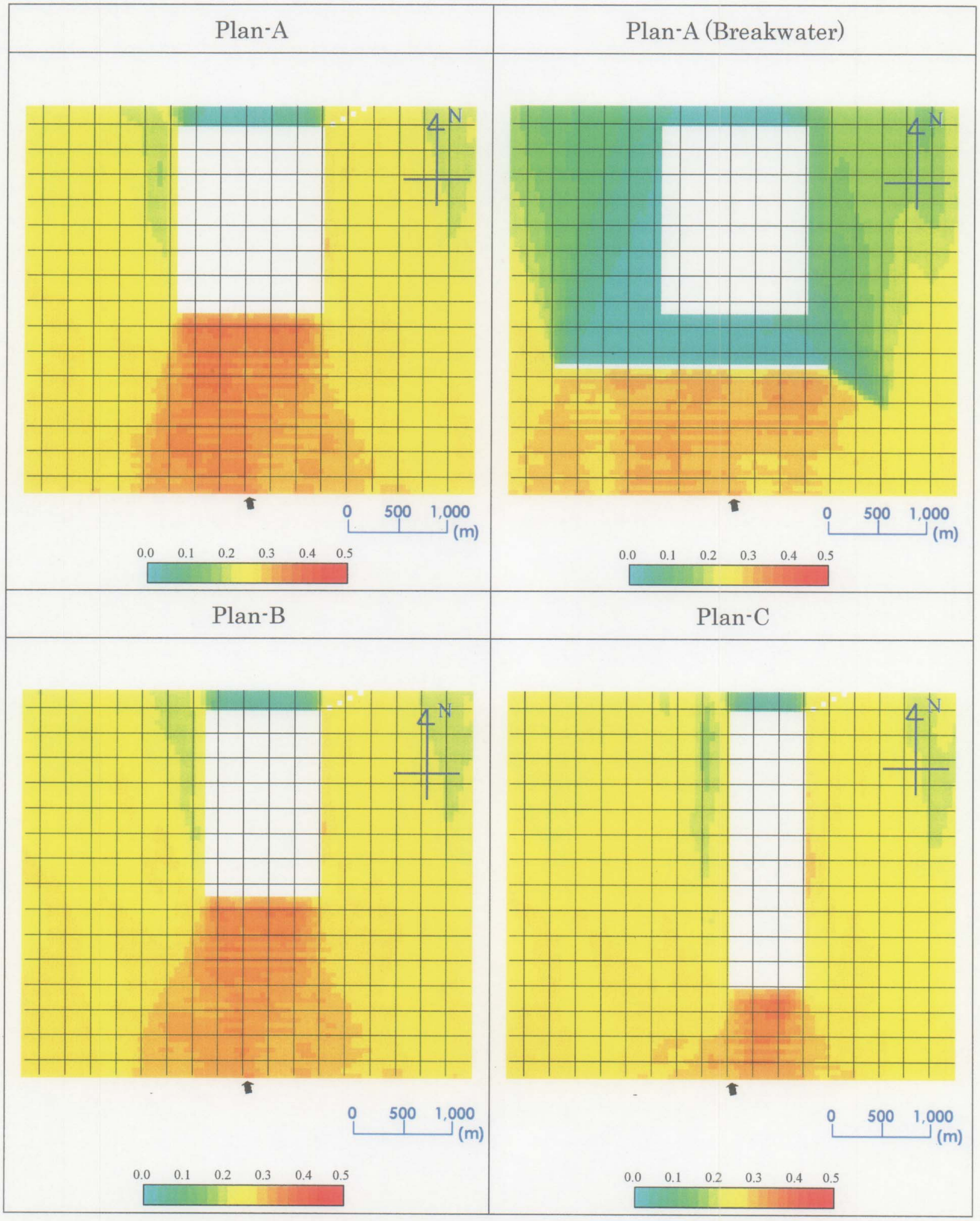


Figure A.2.3.42 Ratio of Wave Height against Offshore Wave
(In the case.07_2 ; 18-second-period-waves from 210 degrees)

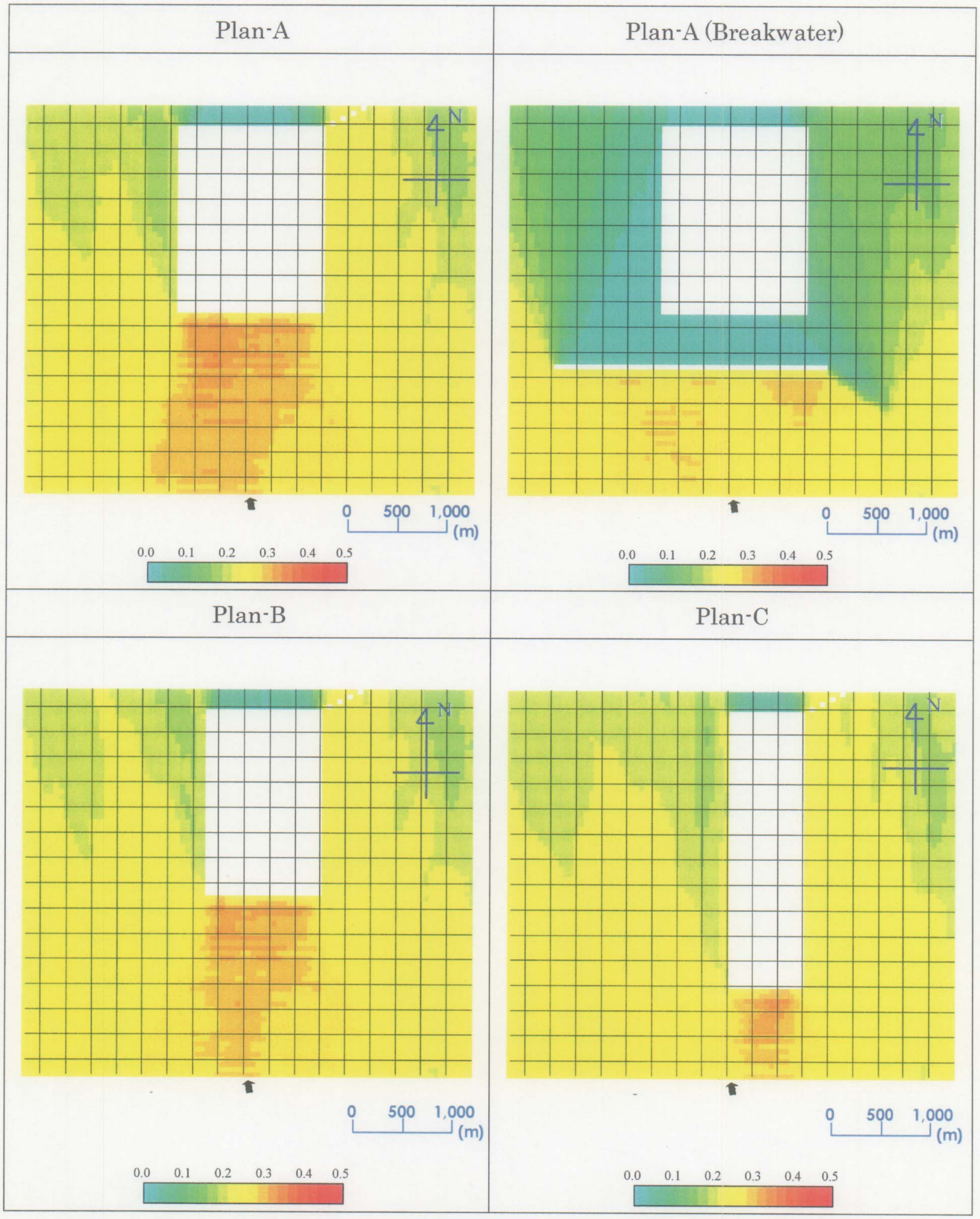


Figure A.2.3.43 Ratio of Wave Height against Offshore Wave
(In the case.07_3 ; 18-second-period-waves from 215 degrees)

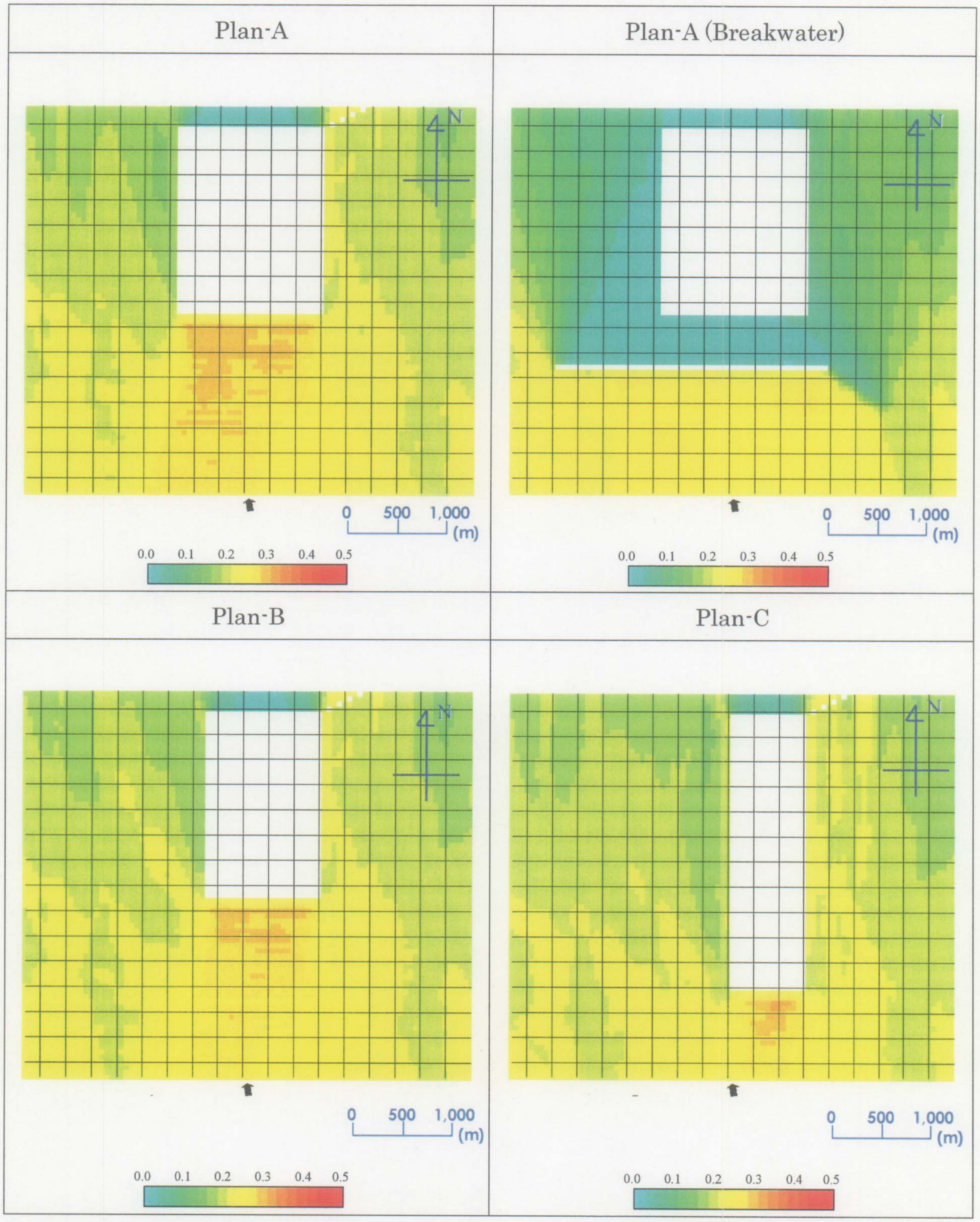


Figure A.2.3.44 Ratio of Wave Height against Offshore Wave

(In the case.07_4 ; 18-second-period-waves from 220 degrees)

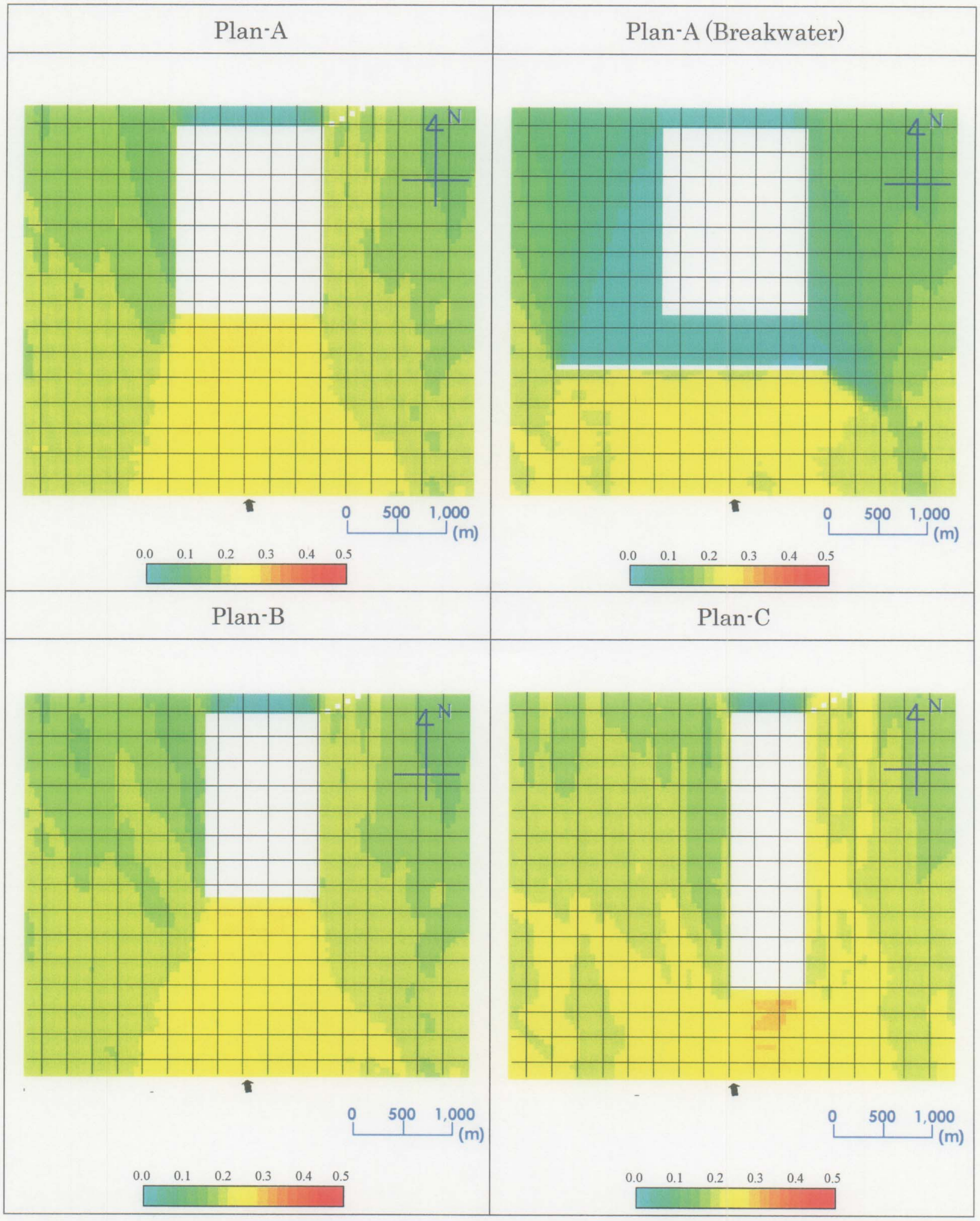


Figure A.2.3.45 Ratio of Wave Height against Offshore Wave
(In the case.07_5 ; 18-second-period-waves from 225 degrees)

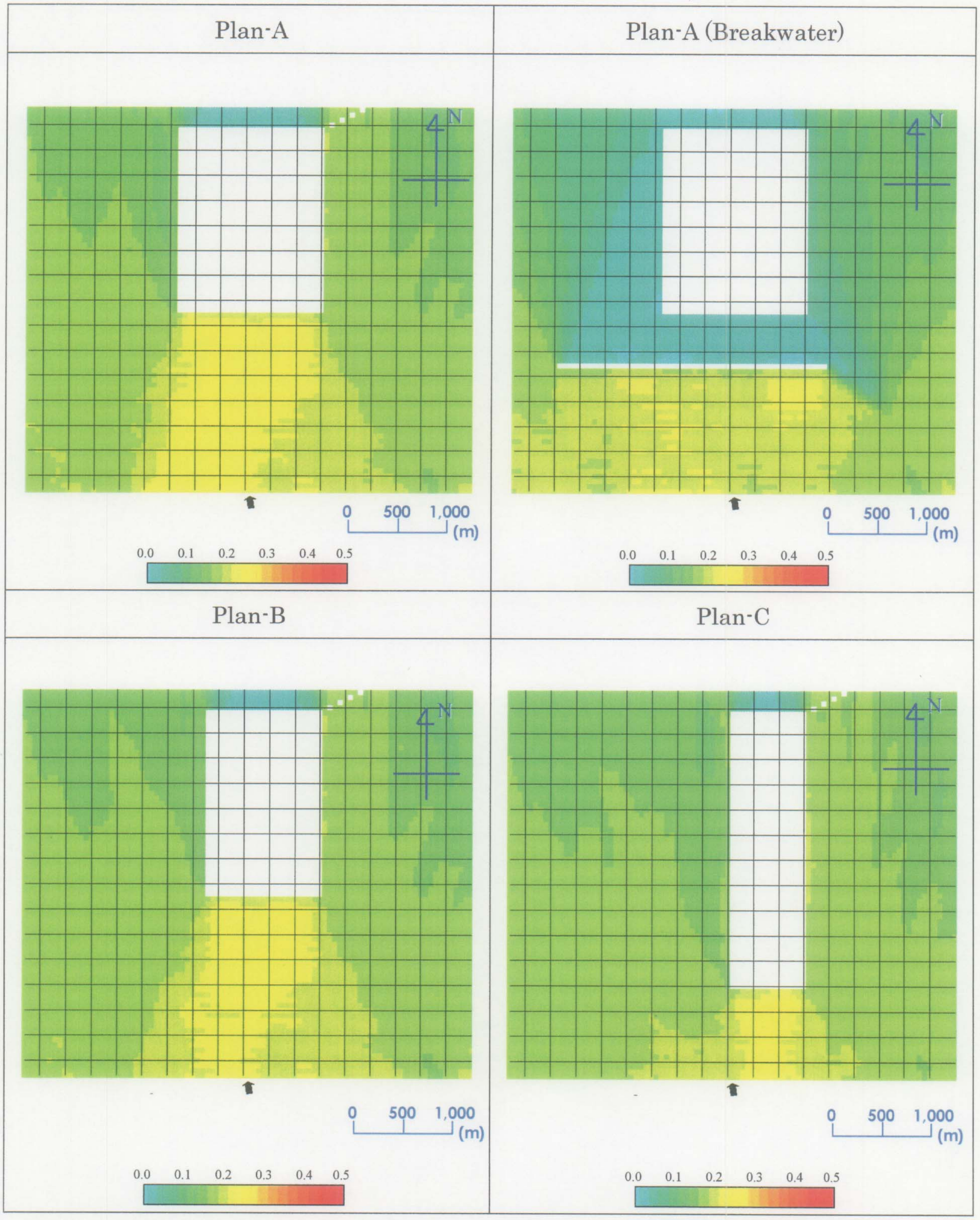


Figure A.2.3.46 Ratio of Wave Height against Offshore Wave
(In the case.07_6 ; 18-second-period-waves from 230 degrees)

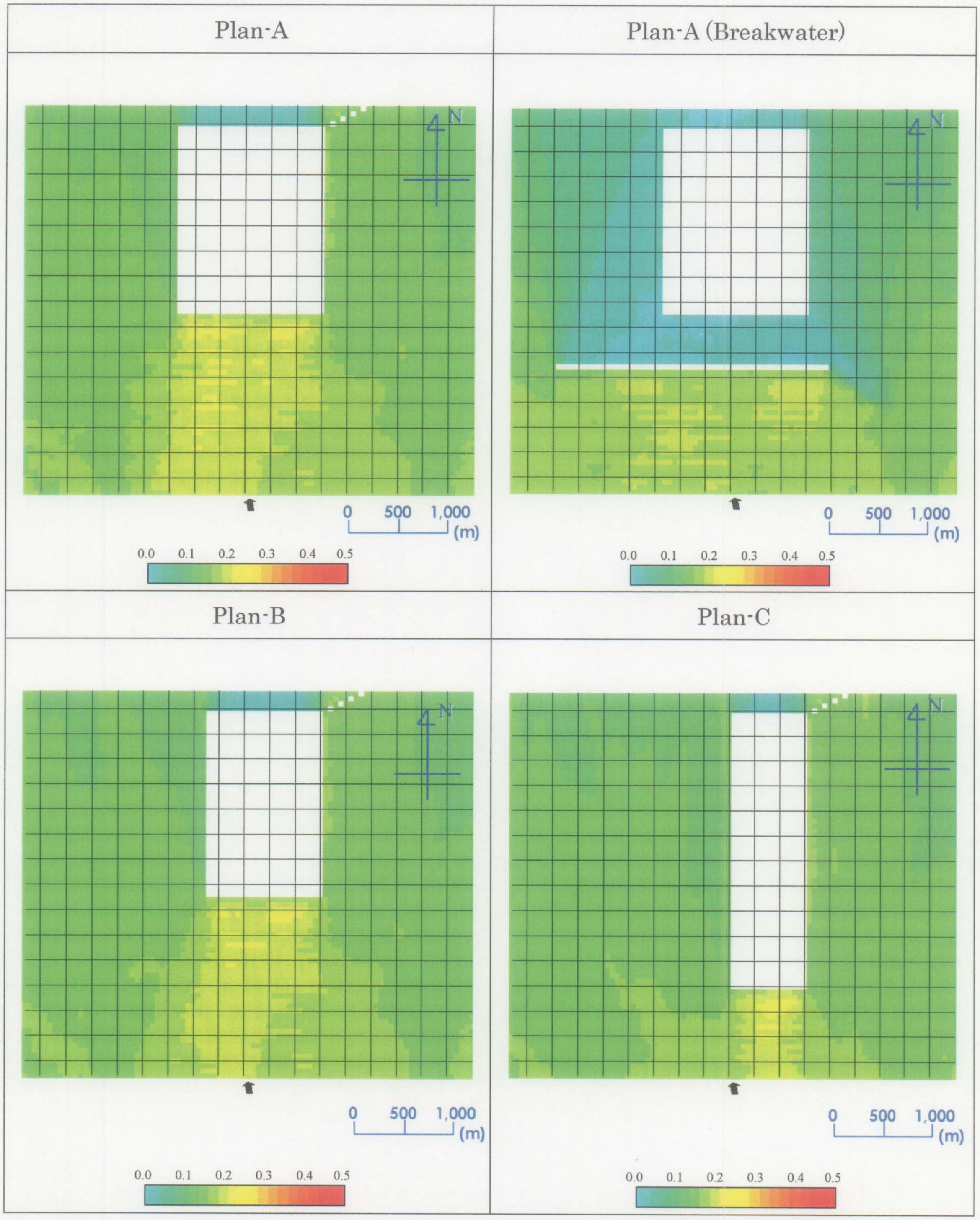


Figure A.2.3.47 Ratio of Wave Height against Offshore Wave
(In the case.07_7 ; 18-second-period-waves from 235 degrees)

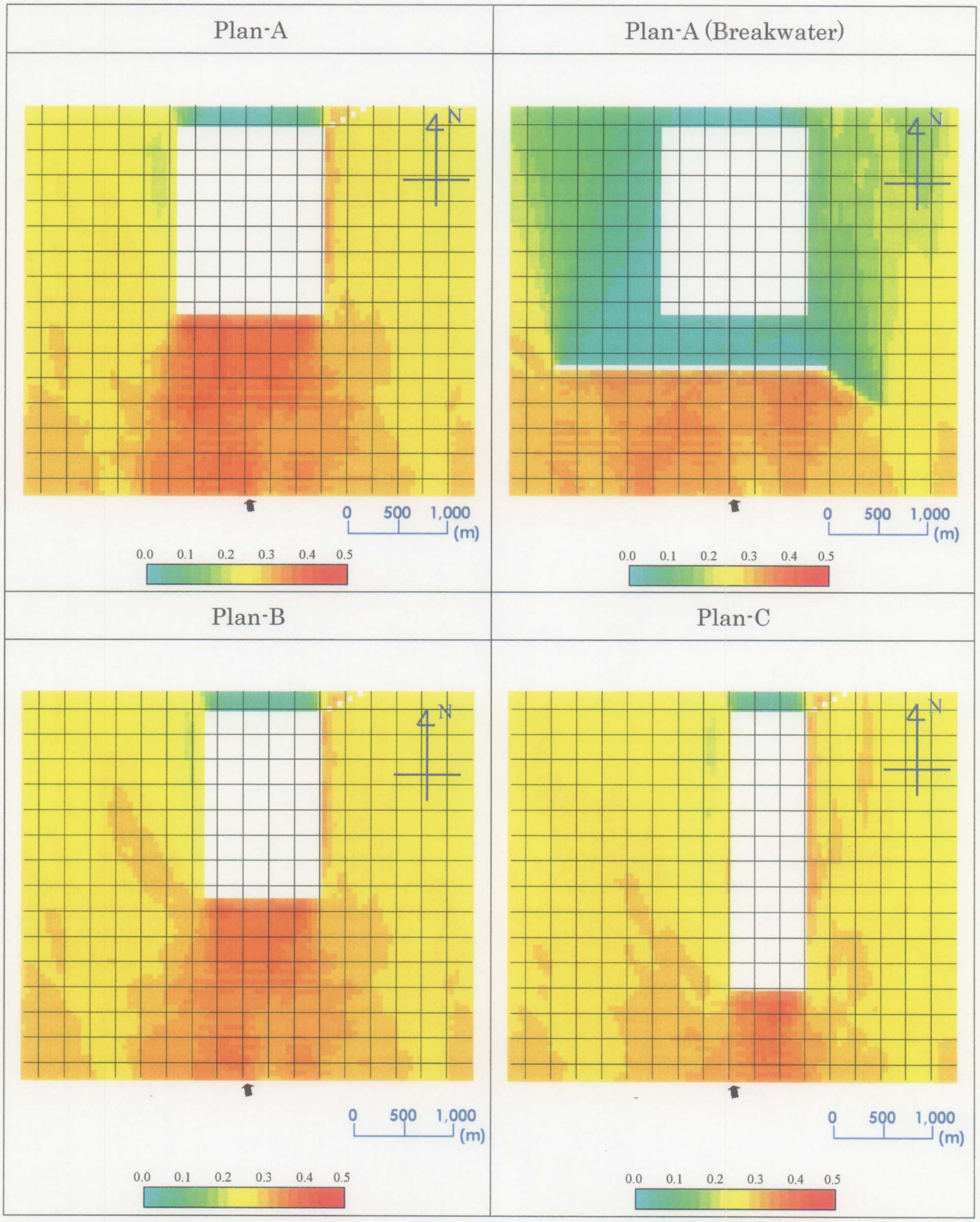


Figure A.2.3.48 Ratio of Wave Height against Offshore Wave
(In the case.08_1 ; 20-second-period-waves from 205 degrees)

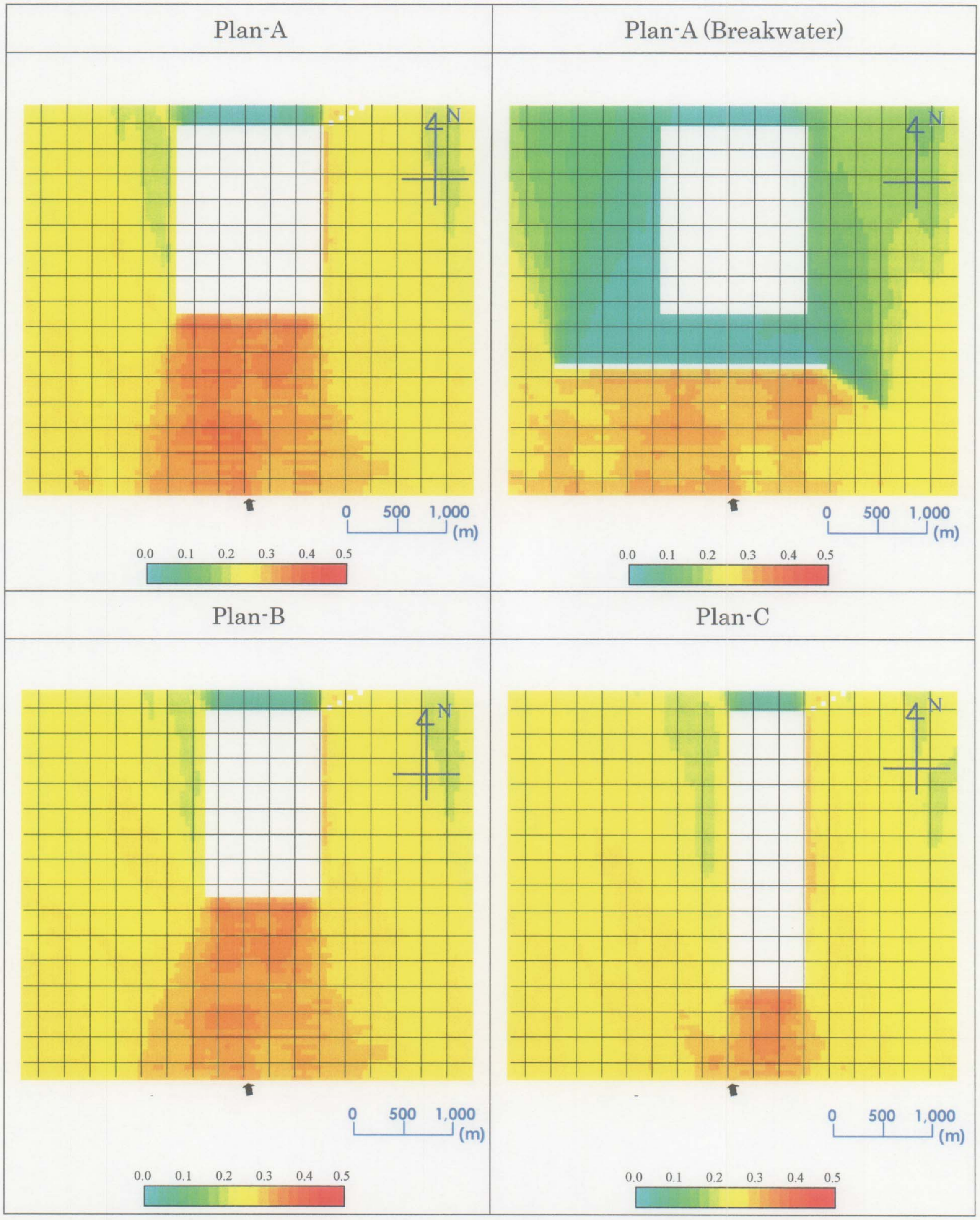


Figure A.2.3.49 Ratio of Wave Height against Offshore Wave
(In the case.08_2 ; 20-second-period-waves from 210 degrees)

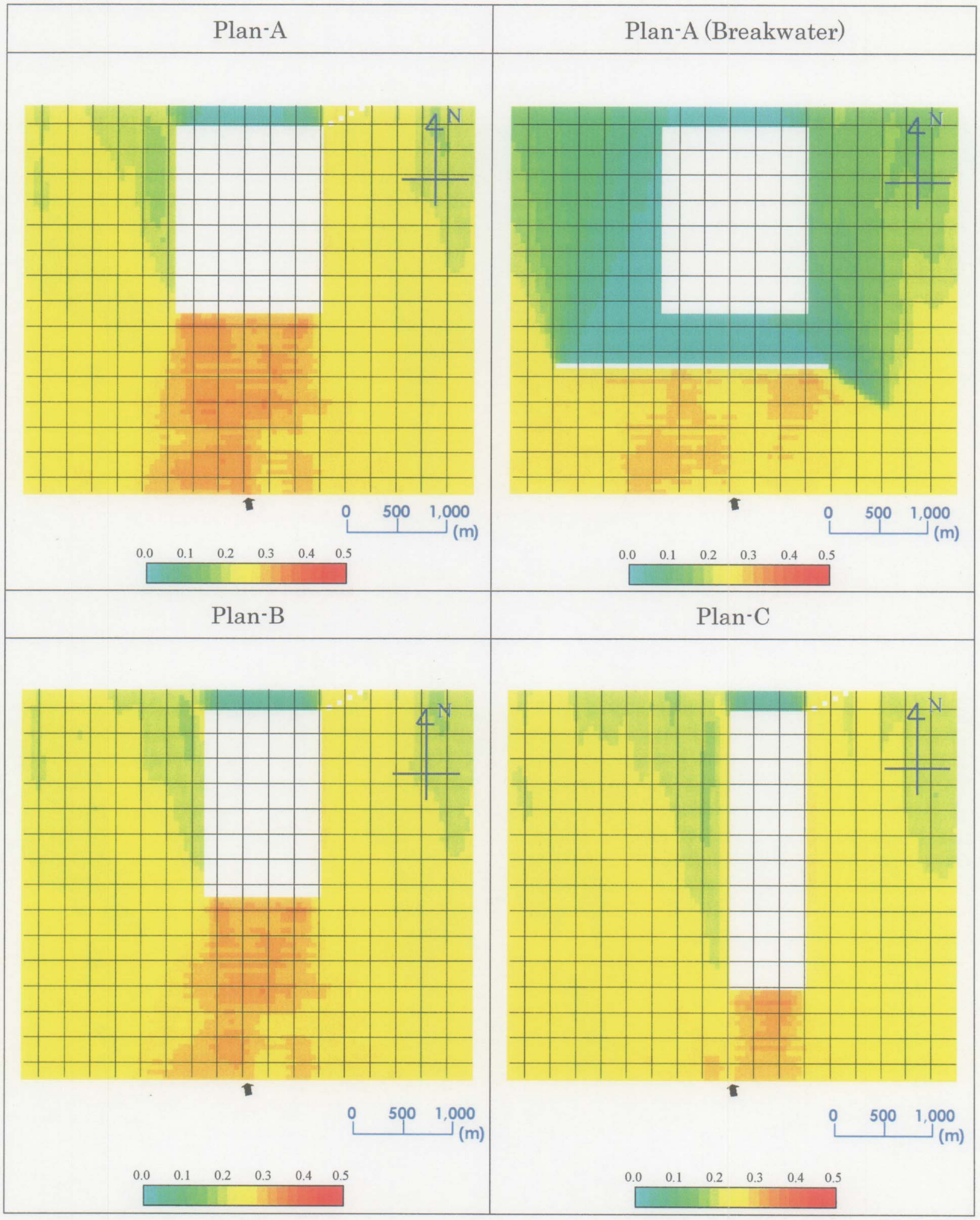


Figure A.2.3.50 Ratio of Wave Height against Offshore Wave

(In the case.08_3 ; 20-second-period-waves from 215 degrees)

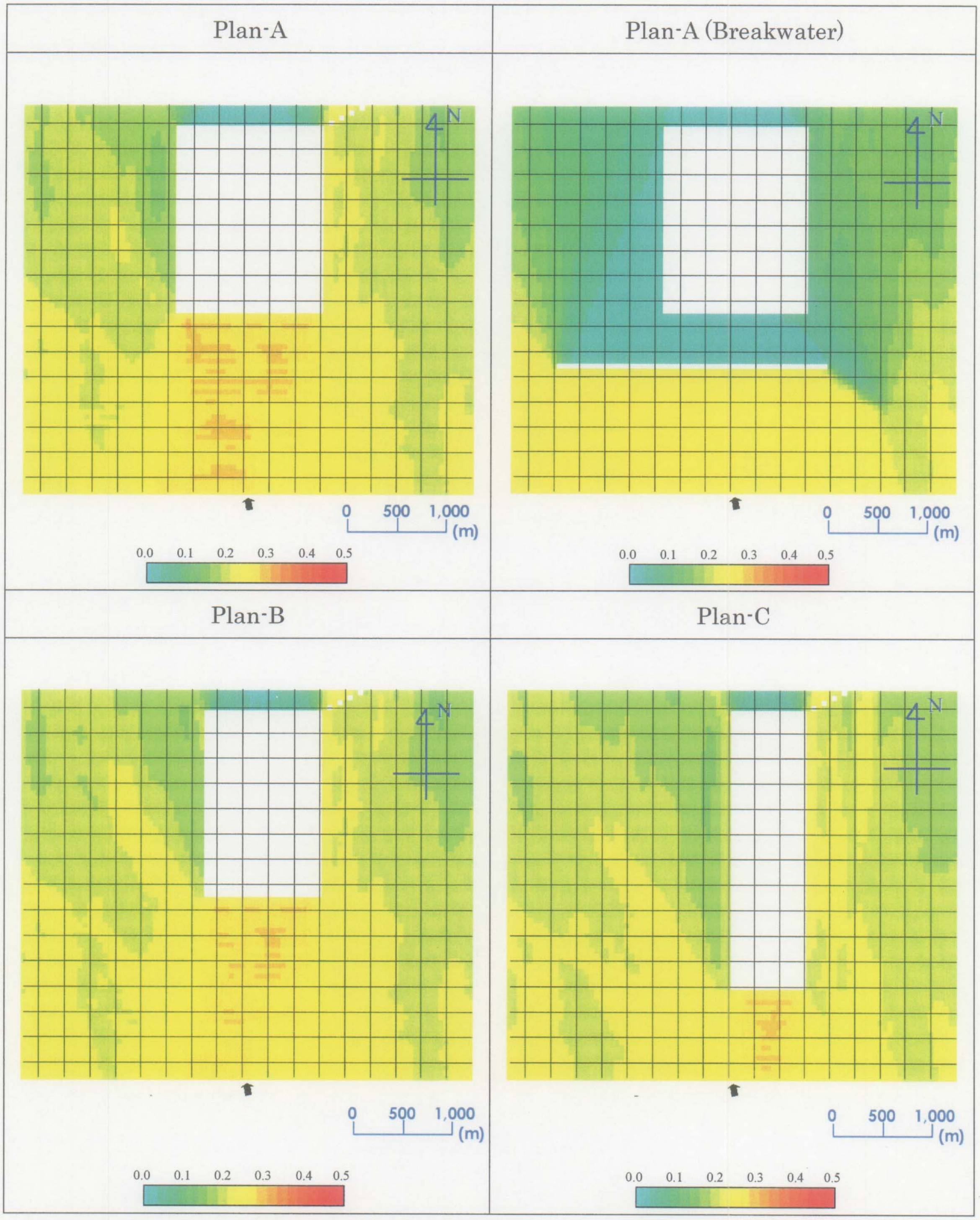


Figure A.2.3.51 Ratio of Wave Height against Offshore Wave
(In the case.08_4 ; 20-second-period-waves from 220 degrees)

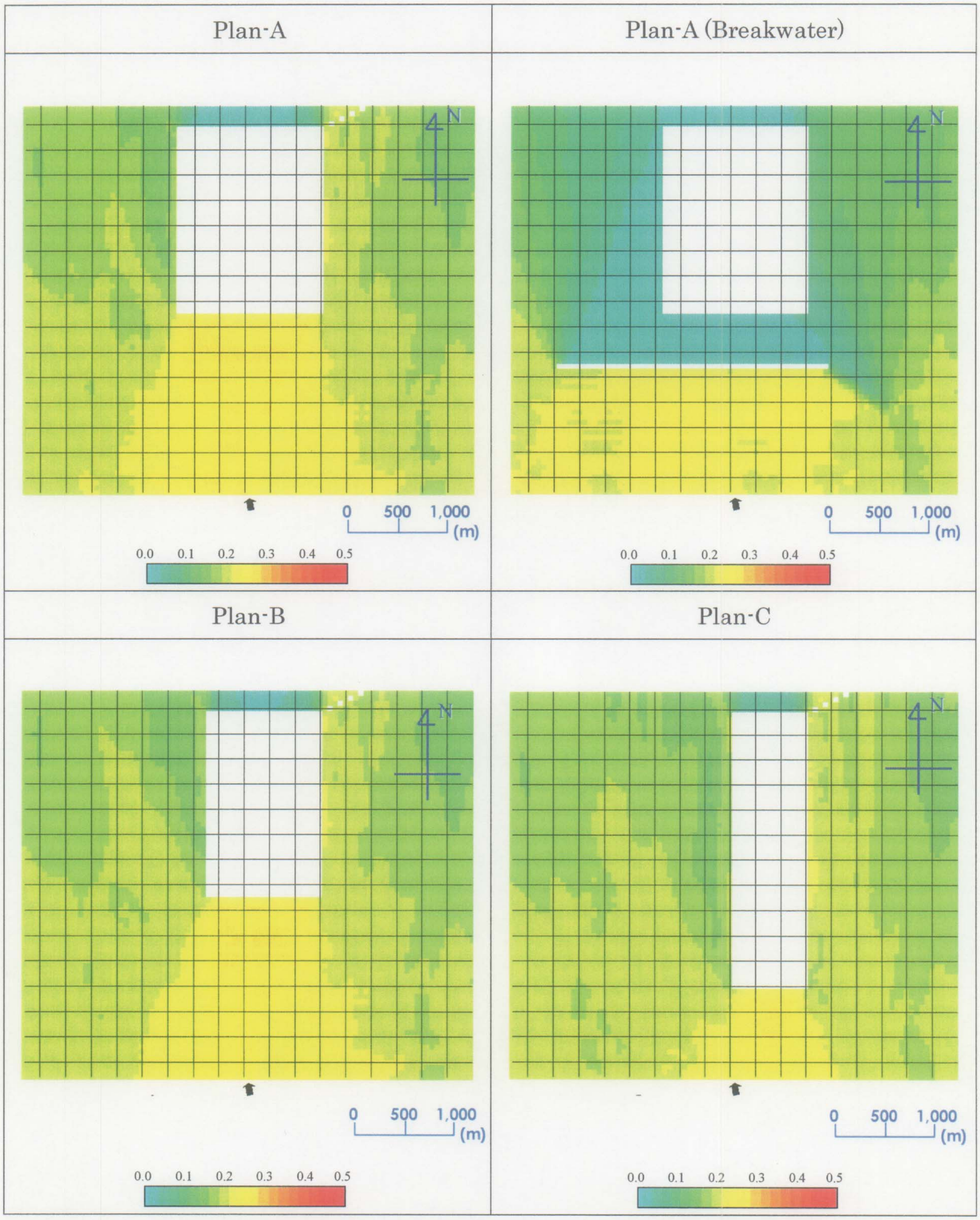


Figure A.2.3.52 Ratio of Wave Height against Offshore Wave
(In the case.08_5 ; 20-second-period-waves from 225 degrees)

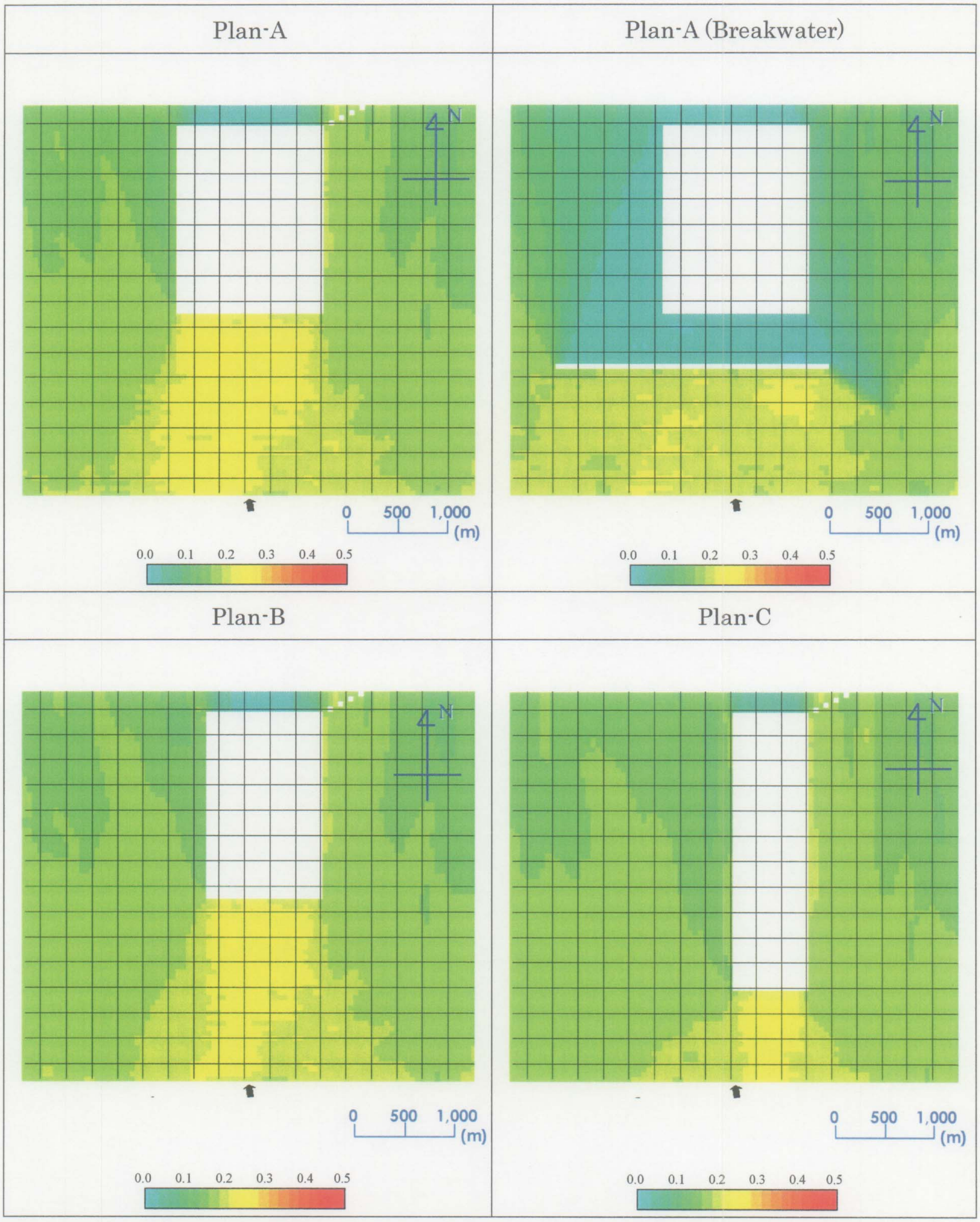


Figure A.2.3.53 Ratio of Wave Height against Offshore Wave

(In the case.08_6 ; 20-second-period-waves from 230 degrees)

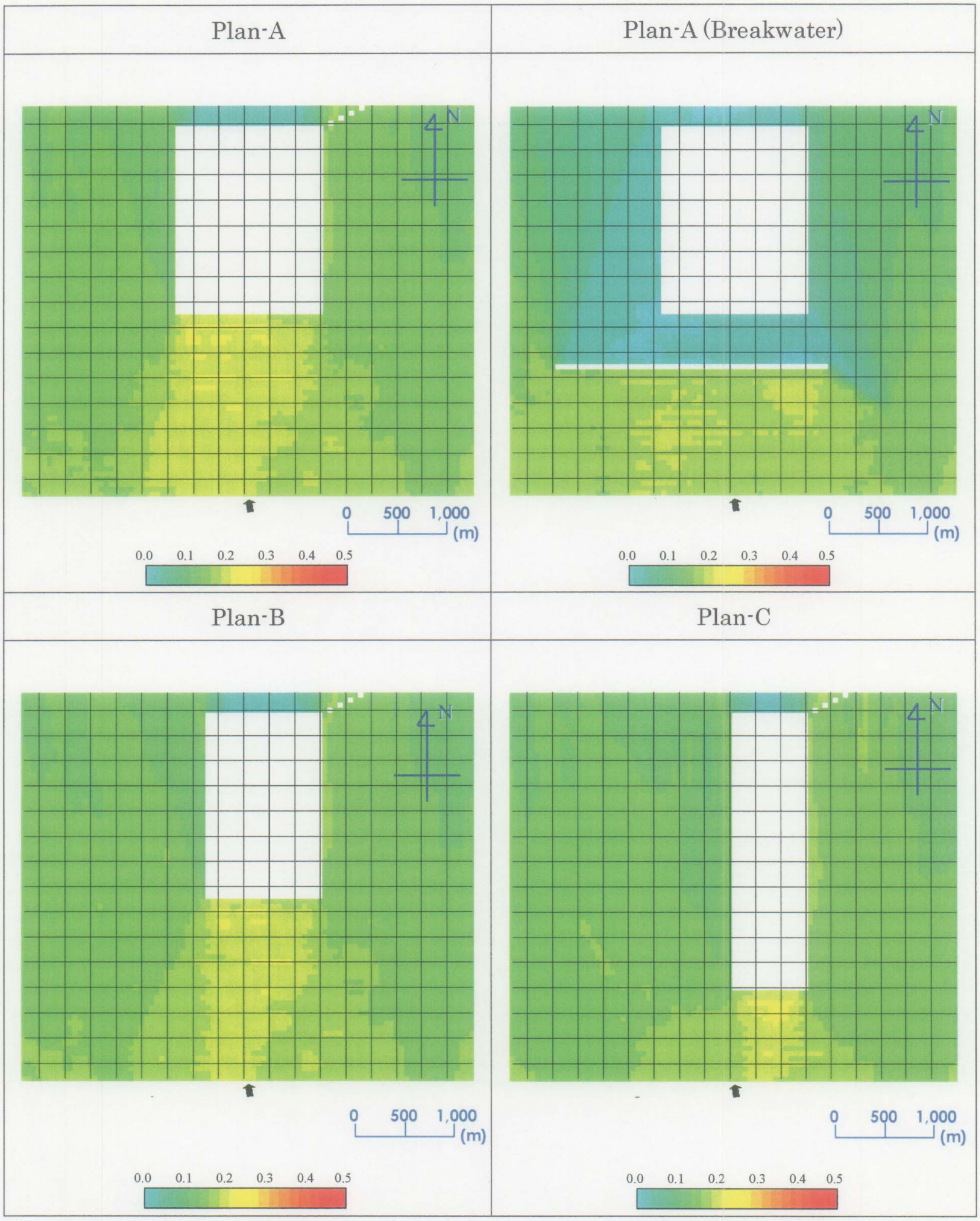


Figure A.2.3.54 Ratio of Wave Height against Offshore Wave

(In the case.08_7 ; 20-second-period-waves from 235 degrees)

A.2.4 Results of Analysis of Wave Calmness in the Basin (The Numerical Values of Ratio of Wave Height)

Table A.2.4.1(a) Results of Analysis of Calmness at the Case of Plan-A

- Ratio of Wave Height against Offshore Wave Height

【BERTH_E1】

Peak Wave Period, Tp (sec)	Wave Direction(degrees)						
	205	210	215	220	225	230	235
6		0.29	0.27	0.26	0.23	0.18	0.18
8		0.29	0.24	0.21	0.17	0.24	0.14
10	0.33	0.29	0.26	0.23	0.20	0.18	0.15
12	0.36	0.31	0.28	0.24	0.21	0.18	0.17
14	0.36	0.32	0.30	0.27	0.25	0.21	0.19
16	0.38	0.34	0.30	0.27	0.24	0.20	0.18
18	0.37	0.34	0.30	0.28	0.25	0.23	0.20
20	0.38	0.35	0.32	0.28	0.25	0.23	0.20

【BERTH_E2】

Peak Wave Period, Tp (sec)	Wave Direction(degrees)						
	205	210	215	220	225	230	235
6		0.32	0.30	0.27	0.23	0.19	0.15
8		0.29	0.25	0.21	0.17	0.16	0.18
10	0.34	0.29	0.26	0.23	0.19	0.18	0.14
12	0.33	0.30	0.28	0.24	0.22	0.18	0.17
14	0.39	0.35	0.33	0.28	0.26	0.21	0.20
16	0.39	0.35	0.30	0.28	0.25	0.21	0.19
18	0.40	0.38	0.34	0.31	0.28	0.25	0.22
20	0.41	0.38	0.35	0.31	0.28	0.25	0.22

【BERTH_E3】

Peak Wave Period, Tp (sec)	Wave Direction(degrees)						
	205	210	215	220	225	230	235
6		0.33	0.30	0.26	0.22	0.17	0.15
8		0.26	0.23	0.21	0.17	0.15	0.14
10	0.33	0.30	0.27	0.23	0.20	0.18	0.15
12	0.34	0.31	0.29	0.25	0.22	0.18	0.18
14	0.39	0.35	0.32	0.28	0.25	0.21	0.19
16	0.38	0.35	0.31	0.29	0.27	0.23	0.20
18	0.39	0.36	0.31	0.29	0.25	0.23	0.20
20	0.40	0.37	0.34	0.30	0.27	0.24	0.21

Table A.2.4.1(b) Results of Analysis of Calmness at the Case of Plan-A
- Ratio of Wave Height against Offshore Wave Height

【BERTH_E4】

	Wave Direction(degrees)						
Peak Wave Period, Tp (sec)	205	210	215	220	225	230	235
6		0.30	0.27	0.26	0.22	0.23	0.18
8		0.30	0.25	0.23	0.20	0.18	0.17
10	0.31	0.28	0.26	0.22	0.18	0.17	0.15
12	0.33	0.30	0.28	0.24	0.21	0.18	0.16
14	0.38	0.33	0.30	0.26	0.23	0.19	0.17
16	0.38	0.35	0.31	0.29	0.26	0.22	0.20
18	0.37	0.34	0.30	0.27	0.24	0.22	0.19
20	0.39	0.36	0.34	0.29	0.26	0.23	0.21

【BERTH_S1】

	Wave Direction(degrees)						
Peak Wave Period, Tp (sec)	205	210	215	220	225	230	235
6		0.57	0.47	0.41	0.34	0.32	0.28
8		0.43	0.35	0.32	0.30	0.29	0.24
10	0.45	0.43	0.37	0.31	0.28	0.27	0.19
12	0.45	0.40	0.37	0.34	0.31	0.27	0.24
14	0.39	0.36	0.36	0.33	0.31	0.26	0.24
16	0.51	0.45	0.38	0.35	0.32	0.27	0.23
18	0.43	0.42	0.38	0.36	0.34	0.30	0.27
20	0.45	0.42	0.39	0.33	0.30	0.26	0.23

【BERTH_S2】

	Wave Direction(degrees)						
Peak Wave Period, Tp (sec)	205	210	215	220	225	230	235
6		0.55	0.46	0.41	0.34	0.31	0.28
8		0.41	0.35	0.32	0.29	0.27	0.24
10	0.44	0.43	0.38	0.32	0.28	0.25	0.20
12	0.45	0.40	0.37	0.33	0.31	0.26	0.23
14	0.38	0.36	0.34	0.32	0.30	0.27	0.25
16	0.47	0.42	0.38	0.35	0.31	0.26	0.23
18	0.40	0.38	0.36	0.33	0.30	0.28	0.25
20	0.37	0.34	0.31	0.27	0.25	0.22	0.20

Table A.2.4.2(a) Results of Analysis of Calmness at the Case of Plan-A with a Breakwater - Ratio of Wave Height against Offshore Wave Height

【BERTH_E1】

	Wave Direction(degrees)						
Peak Wave Period, Tp (sec)	205	210	215	220	225	230	235
6		0.13	0.10	0.12	0.10	0.08	0.07
8		0.14	0.12	0.11	0.09	0.07	0.05
10	0.17	0.15	0.14	0.12	0.10	0.10	0.08
12	0.17	0.15	0.14	0.12	0.11	0.09	0.09
14	0.19	0.18	0.16	0.14	0.13	0.11	0.10
16	0.21	0.19	0.16	0.15	0.14	0.12	0.10
18	0.22	0.20	0.18	0.16	0.15	0.13	0.11
20	0.23	0.21	0.19	0.17	0.15	0.13	0.12

【BERTH_E2】

	Wave Direction(degrees)						
Peak Wave Period, Tp (sec)	205	210	215	220	225	230	235
6		0.13	0.09	0.09	0.10	0.08	0.08
8		0.12	0.09	0.07	0.05	0.04	0.04
10	0.16	0.14	0.13	0.11	0.09	0.08	0.06
12	0.17	0.15	0.13	0.12	0.11	0.09	0.09
14	0.19	0.17	0.16	0.13	0.12	0.10	0.09
16	0.20	0.18	0.16	0.15	0.13	0.11	0.10
18	0.20	0.18	0.16	0.15	0.14	0.12	0.11
20	0.21	0.19	0.18	0.15	0.14	0.12	0.11

【BERTH_E3】

	Wave Direction(degrees)						
Peak Wave Period, Tp (sec)	205	210	215	220	225	230	235
6		0.06	0.07	0.05	0.08	0.11	0.07
8		0.06	0.04	0.03	0.03	0.03	0.03
10	0.10	0.08	0.06	0.05	0.04	0.04	0.03
12	0.13	0.11	0.10	0.09	0.07	0.06	0.05
14	0.16	0.14	0.13	0.12	0.10	0.09	0.08
16	0.18	0.16	0.14	0.12	0.11	0.09	0.08
18	0.19	0.18	0.16	0.14	0.13	0.11	0.10
20	0.20	0.19	0.18	0.15	0.14	0.12	0.11

Table A.2.4.2(b) Results of Analysis of Calmness at the Case of Plan-A with a Breakwater - Ratio of Wave Height against Offshore Wave Height

【BERTH_E4】

Peak Wave Period, Tp (sec)	Wave Direction(degrees)						
	205	210	215	220	225	230	235
6		0.06	0.10	0.12	0.08	0.11	0.14
8		0.06	0.05	0.04	0.05	0.05	0.06
10	0.05	0.04	0.04	0.05	0.05	0.07	0.07
12	0.08	0.07	0.05	0.04	0.04	0.03	0.03
14	0.12	0.11	0.10	0.08	0.07	0.05	0.04
16	0.13	0.12	0.10	0.09	0.08	0.07	0.06
18	0.15	0.14	0.12	0.11	0.09	0.08	0.07
20	0.16	0.15	0.13	0.11	0.10	0.09	0.08

【BERTH_S1】

Peak Wave Period, Tp (sec)	Wave Direction(degrees)						
	205	210	215	220	225	230	235
6		0.04	0.04	0.02	0.02	0.02	0.08
8		0.02	0.01	0.02	0.02	0.02	0.01
10	0.03	0.02	0.02	0.02	0.02	0.02	0.02
12	0.03	0.03	0.02	0.02	0.02	0.02	0.02
14	0.03	0.03	0.03	0.02	0.02	0.02	0.02
16	0.04	0.03	0.03	0.02	0.02	0.02	0.02
18	0.03	0.03	0.03	0.03	0.03	0.02	0.02
20	0.04	0.03	0.03	0.03	0.03	0.02	0.02

【BERTH_S2】

Peak Wave Period, Tp (sec)	Wave Direction(degrees)						
	205	210	215	220	225	230	235
6		0.02	0.02	0.01	0.02	0.07	0.03
8		0.02	0.01	0.02	0.01	0.01	0.01
10	0.03	0.02	0.02	0.02	0.02	0.01	0.01
12	0.03	0.03	0.02	0.02	0.02	0.02	0.02
14	0.03	0.03	0.03	0.02	0.02	0.02	0.02
16	0.05	0.04	0.03	0.03	0.03	0.02	0.02
18	0.04	0.04	0.03	0.03	0.02	0.02	0.02
20	0.05	0.05	0.04	0.03	0.03	0.03	0.02

Table A.2.4.3(a) Results of Analysis of Calmness at the Case of Plan-B

- Ratio of Wave Height against Offshore Wave Height

【BERTH_E1】

Peak Wave Period, Tp (sec)	Wave Direction(degrees)						
	205	210	215	220	225	230	235
6		0.29	0.27	0.26	0.23	0.18	0.18
8		0.29	0.24	0.21	0.17	0.24	0.14
10	0.33	0.29	0.26	0.23	0.20	0.18	0.15
12	0.36	0.31	0.28	0.24	0.21	0.18	0.17
14	0.36	0.32	0.30	0.27	0.25	0.21	0.19
16	0.38	0.34	0.30	0.27	0.24	0.20	0.18
18	0.37	0.34	0.30	0.28	0.25	0.23	0.20
20	0.38	0.35	0.32	0.28	0.25	0.23	0.20

【BERTH_E2】

Peak Wave Period, Tp (sec)	Wave Direction(degrees)						
	205	210	215	220	225	230	235
6		0.32	0.30	0.27	0.23	0.19	0.15
8		0.29	0.25	0.21	0.17	0.16	0.18
10	0.34	0.29	0.26	0.23	0.19	0.18	0.14
12	0.33	0.30	0.28	0.24	0.22	0.18	0.17
14	0.40	0.35	0.33	0.28	0.26	0.22	0.20
16	0.39	0.35	0.30	0.28	0.25	0.21	0.19
18	0.40	0.38	0.34	0.31	0.28	0.25	0.22
20	0.41	0.38	0.35	0.31	0.28	0.25	0.22

【BERTH_E3】

Peak Wave Period, Tp (sec)	Wave Direction(degrees)						
	205	210	215	220	225	230	235
6		0.33	0.30	0.26	0.22	0.17	0.16
8		0.26	0.23	0.21	0.17	0.15	0.14
10	0.33	0.30	0.27	0.23	0.20	0.18	0.15
12	0.34	0.31	0.29	0.25	0.22	0.18	0.18
14	0.39	0.35	0.32	0.28	0.25	0.21	0.19
16	0.38	0.35	0.31	0.29	0.27	0.23	0.20
18	0.39	0.36	0.31	0.28	0.25	0.23	0.20
20	0.40	0.37	0.34	0.30	0.27	0.24	0.22

Table A.2.4.3(b) Results of Analysis of Calmness at the Case of Plan-B

- Ratio of Wave Height against Offshore Wave Height

【BERTH_E4】

Peak Wave Period, Tp (sec)	Wave Direction(degrees)						
	205	210	215	220	225	230	235
6		0.30	0.27	0.26	0.22	0.21	0.18
8		0.30	0.25	0.23	0.20	0.18	0.17
10	0.31	0.28	0.26	0.22	0.18	0.18	0.15
12	0.33	0.30	0.28	0.24	0.21	0.18	0.16
14	0.38	0.33	0.30	0.26	0.23	0.19	0.17
16	0.38	0.35	0.31	0.29	0.26	0.22	0.20
18	0.37	0.34	0.30	0.27	0.24	0.22	0.19
20	0.39	0.36	0.34	0.29	0.26	0.23	0.21

【BERTH_W1】

Peak Wave Period, Tp (sec)	Wave Direction(degrees)						
	205	210	215	220	225	230	235
6		0.37	0.32	0.29	0.27	0.23	0.19
8		0.29	0.27	0.23	0.21	0.19	0.17
10	0.29	0.29	0.26	0.22	0.19	0.17	0.15
12	0.31	0.27	0.25	0.22	0.20	0.17	0.16
14	0.32	0.29	0.26	0.23	0.21	0.17	0.16
16	0.30	0.27	0.24	0.22	0.20	0.17	0.15
18	0.31	0.29	0.25	0.23	0.21	0.18	0.16
20	0.30	0.29	0.26	0.23	0.20	0.19	0.17

【BERTH_W2】

Peak Wave Period, Tp (sec)	Wave Direction(degrees)						
	205	210	215	220	225	230	235
6		0.36	0.32	0.30	0.26	0.25	0.19
8		0.33	0.31	0.26	0.22	0.19	0.18
10	0.31	0.28	0.28	0.24	0.21	0.20	0.16
12	0.31	0.28	0.25	0.22	0.21	0.18	0.18
14	0.27	0.25	0.24	0.23	0.22	0.18	0.16
16	0.27	0.25	0.22	0.19	0.17	0.15	0.14
18	0.24	0.23	0.21	0.20	0.19	0.16	0.15
20	0.25	0.24	0.23	0.20	0.18	0.15	0.14

Table A.2.4.4(a) Results of Analysis of Calmness at the Case of Plan-C
- Ratio of Wave Height against Offshore Wave Height

【BERTH_E1】

Peak Wave Period, Tp (sec)	Wave Direction(degrees)						
	205	210	215	220	225	230	235
6		0.28	0.24	0.22	0.21	0.18	0.17
8		0.28	0.24	0.20	0.17	0.22	0.12
10	0.33	0.30	0.26	0.23	0.19	0.18	0.15
12	0.36	0.31	0.28	0.24	0.21	0.18	0.17
14	0.35	0.31	0.29	0.26	0.24	0.20	0.19
16	0.37	0.33	0.29	0.26	0.24	0.20	0.17
18	0.36	0.34	0.30	0.28	0.25	0.22	0.20
20	0.38	0.35	0.32	0.28	0.25	0.22	0.20

【BERTH_E2】

Peak Wave Period, Tp (sec)	Wave Direction(degrees)						
	205	210	215	220	225	230	235
6		0.28	0.27	0.26	0.22	0.21	0.17
8		0.29	0.25	0.21	0.18	0.17	0.17
10	0.34	0.29	0.26	0.23	0.19	0.18	0.15
12	0.34	0.30	0.27	0.24	0.22	0.19	0.18
14	0.39	0.35	0.33	0.28	0.26	0.21	0.20
16	0.40	0.36	0.31	0.28	0.25	0.21	0.19
18	0.40	0.37	0.33	0.30	0.27	0.25	0.22
20	0.41	0.38	0.35	0.31	0.28	0.25	0.22

【BERTH_E3】

Peak Wave Period, Tp (sec)	Wave Direction(degrees)						
	205	210	215	220	225	230	235
6		0.29	0.27	0.28	0.24	0.21	0.17
8		0.26	0.22	0.18	0.15	0.14	0.13
10	0.33	0.29	0.25	0.22	0.19	0.17	0.14
12	0.33	0.30	0.28	0.25	0.23	0.19	0.17
14	0.39	0.35	0.32	0.28	0.25	0.21	0.19
16	0.37	0.33	0.29	0.27	0.25	0.22	0.19
18	0.39	0.36	0.32	0.29	0.26	0.24	0.21
20	0.38	0.36	0.33	0.29	0.27	0.24	0.21

Table A.2.4.4(b) Results of Analysis of Calmness at the Case of Plan-C

- Ratio of Wave Height against Offshore Wave Height

【BERTH_E4】

Peak Wave Period, Tp (sec)	Wave Direction(degrees)						
	205	210	215	220	225	230	235
6		0.29	0.31	0.31	0.24	0.20	0.18
8		0.25	0.23	0.19	0.16	0.15	0.14
10	0.31	0.29	0.26	0.22	0.18	0.17	0.15
12	0.33	0.30	0.27	0.23	0.21	0.17	0.17
14	0.39	0.35	0.32	0.27	0.25	0.20	0.18
16	0.39	0.35	0.32	0.29	0.27	0.23	0.20
18	0.40	0.36	0.32	0.29	0.26	0.23	0.21
20	0.41	0.38	0.35	0.31	0.28	0.25	0.22

【BERTH_E5】

Peak Wave Period, Tp (sec)	Wave Direction(degrees)						
	205	210	215	220	225	230	235
6		0.33	0.39	0.31	0.26	0.20	0.19
8		0.27	0.23	0.20	0.18	0.16	0.15
10	0.31	0.28	0.25	0.21	0.19	0.18	0.14
12	0.33	0.30	0.27	0.23	0.21	0.17	0.17
14	0.37	0.33	0.30	0.26	0.23	0.19	0.17
16	0.40	0.36	0.32	0.29	0.26	0.22	0.19
18	0.38	0.35	0.31	0.28	0.25	0.23	0.21
20	0.40	0.37	0.34	0.29	0.27	0.24	0.21

【BERTH_E6】

Peak Wave Period, Tp (sec)	Wave Direction(degrees)						
	205	210	215	220	225	230	235
6		0.34	0.30	0.27	0.23	0.21	0.18
8		0.28	0.24	0.24	0.20	0.18	0.16
10	0.30	0.27	0.24	0.21	0.19	0.17	0.14
12	0.34	0.30	0.28	0.24	0.21	0.17	0.16
14	0.33	0.29	0.27	0.23	0.21	0.18	0.17
16	0.38	0.34	0.30	0.27	0.24	0.20	0.17
18	0.35	0.32	0.29	0.27	0.25	0.22	0.20
20	0.37	0.34	0.31	0.27	0.24	0.22	0.19

A.2.5 The Maximum Wave Height at Each Container Berth

In this section, **Table A.2.5.1** to **Table A.2.5.24** shows the maximum wave height at each container berth for each Plan. The wave height data over 0.7 meters were painted yellow. A column named ' Total Percent Occurrence' represents sum of percent occurrence that is over 0.7 meters.

Wharf Operation Efficiency at each container berth could be calculated by subtracting the sum of Total Percent Occurrence about a berth from 100 percent.

Table A.2.5.1 Wave Height and Total Percent Occurrence at Berth E1 in the case of Plan-A (units : m)

【Peak Wave Period, Tp=6sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.07	0.07	0.06	0.06	0.05	0.05	0.000%
0.5	0.00	0.15	0.14	0.13	0.11	0.09	0.09	0.000%
0.75	0.00	0.22	0.20	0.19	0.17	0.14	0.14	0.000%
1	0.00	0.29	0.27	0.26	0.23	0.18	0.18	0.000%
1.25	0.00	0.36	0.34	0.32	0.28	0.23	0.23	0.000%
1.5	0.00	0.44	0.41	0.38	0.34	0.27	0.27	0.000%
1.75	0.00	0.51	0.48	0.45	0.39	0.32	0.32	0.000%
2	0.00	0.58	0.54	0.51	0.45	0.37	0.36	0.000%
2.25	0.00	0.66	0.61	0.57	0.51	0.41	0.41	0.000%
2.5	0.00	0.73	0.68	0.64	0.56	0.46	0.46	0.003%
2.75	0.00	0.80	0.75	0.703	0.62	0.50	0.50	0.000%
3	0.00	0.87	0.82	0.77	0.68	0.55	0.55	0.000%
Total Percent Occurrence	0.000%	0.003%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=8sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.07	0.06	0.05	0.04	0.06	0.04	0.000%
0.5	0.00	0.14	0.12	0.10	0.08	0.12	0.07	0.000%
0.75	0.00	0.22	0.18	0.15	0.13	0.18	0.11	0.000%
1	0.00	0.29	0.24	0.21	0.17	0.24	0.14	0.000%
1.25	0.00	0.36	0.30	0.26	0.21	0.29	0.18	0.000%
1.5	0.00	0.43	0.36	0.31	0.25	0.35	0.21	0.000%
1.75	0.00	0.50	0.42	0.36	0.30	0.41	0.25	0.000%
2	0.00	0.57	0.48	0.41	0.34	0.47	0.28	0.000%
2.25	0.00	0.65	0.54	0.46	0.38	0.53	0.32	0.000%
2.5	0.00	0.72	0.60	0.52	0.42	0.59	0.35	0.007%
2.75	0.00	0.79	0.66	0.57	0.47	0.65	0.39	0.006%
3	0.00	0.86	0.72	0.62	0.51	0.71	0.42	0.010%
Total Percent Occurrence	0.00%	0.02%	0.005%	0.000%	0.000%	0.002%	0.000%	0.02%

【Peak Wave Period, Tp=10sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.08	0.07	0.07	0.06	0.05	0.05	0.04	0.000%
0.5	0.17	0.14	0.13	0.12	0.10	0.09	0.08	0.000%
0.75	0.25	0.22	0.20	0.17	0.15	0.14	0.11	0.000%
1	0.33	0.29	0.26	0.23	0.20	0.18	0.15	0.000%
1.25	0.41	0.36	0.33	0.29	0.25	0.23	0.19	0.000%
1.5	0.50	0.43	0.39	0.35	0.30	0.28	0.23	0.000%
1.75	0.58	0.50	0.46	0.41	0.35	0.32	0.26	0.000%
2	0.66	0.58	0.53	0.47	0.39	0.37	0.30	0.000%
2.25	0.75	0.65	0.59	0.52	0.44	0.42	0.34	0.005%
2.5	0.83	0.72	0.66	0.58	0.49	0.46	0.38	0.000%
2.75	0.91	0.79	0.72	0.64	0.54	0.51	0.41	0.000%
3	0.99	0.86	0.79	0.700	0.59	0.55	0.45	0.000%
Total Percent Occurrence	0.005%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.01%

【Peak Wave Period, Tp=12sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.09	0.08	0.07	0.06	0.05	0.05	0.04	0.000%
0.5	0.18	0.16	0.14	0.12	0.11	0.09	0.09	0.000%
0.75	0.27	0.23	0.21	0.18	0.16	0.14	0.13	0.000%
1	0.36	0.31	0.28	0.24	0.21	0.18	0.17	0.000%
1.25	0.45	0.39	0.35	0.30	0.27	0.23	0.21	0.000%
1.5	0.54	0.47	0.42	0.36	0.32	0.27	0.26	0.000%
1.75	0.62	0.54	0.49	0.42	0.37	0.32	0.30	0.000%
2	0.71	0.62	0.56	0.48	0.43	0.36	0.34	0.067%
2.25	0.80	0.700	0.62	0.54	0.48	0.41	0.39	0.035%
2.5	0.89	0.78	0.69	0.60	0.53	0.46	0.43	0.009%
2.75	0.98	0.86	0.76	0.66	0.59	0.50	0.47	0.000%
3	1.07	0.93	0.83	0.73	0.64	0.55	0.51	0.000%
Total Percent Occurrence	0.080%	0.031%	0.000%	0.000%	0.000%	0.000%	0.000%	0.11%

【Peak Wave Period, Tp=14sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.09	0.08	0.08	0.07	0.06	0.05	0.05	0.000%
0.5	0.18	0.16	0.15	0.13	0.12	0.10	0.10	0.000%
0.75	0.27	0.24	0.23	0.20	0.18	0.16	0.15	0.000%
1	0.36	0.32	0.30	0.27	0.25	0.21	0.19	0.000%
1.25	0.45	0.41	0.38	0.33	0.31	0.26	0.24	0.000%
1.5	0.54	0.49	0.45	0.40	0.37	0.31	0.29	0.000%
1.75	0.63	0.57	0.53	0.47	0.43	0.37	0.34	0.000%
2	0.72	0.65	0.60	0.53	0.49	0.42	0.39	0.067%
2.25	0.81	0.73	0.68	0.60	0.55	0.47	0.44	0.081%
2.5	0.90	0.81	0.76	0.67	0.62	0.52	0.48	0.033%
2.75	0.99	0.89	0.83	0.74	0.68	0.57	0.53	0.013%
3	1.08	0.97	0.91	0.80	0.74	0.63	0.58	0.000%
Total Percent Occurrence	0.093%	0.074%	0.023%	0.005%	0.000%	0.000%	0.000%	0.19%

【Peak Wave Period, Tp=16sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.10	0.09	0.08	0.07	0.06	0.05	0.04	0.000%
0.5	0.19	0.17	0.15	0.14	0.12	0.10	0.09	0.000%
0.75	0.29	0.26	0.23	0.20	0.18	0.15	0.13	0.000%
1	0.38	0.34	0.30	0.27	0.24	0.20	0.18	0.000%
1.25	0.48	0.43	0.38	0.34	0.30	0.26	0.22	0.000%
1.5	0.57	0.51	0.45	0.41	0.36	0.31	0.27	0.000%
1.75	0.67	0.60	0.53	0.47	0.42	0.36	0.31	0.000%
2	0.76	0.68	0.60	0.54	0.48	0.41	0.36	0.052%
2.25	0.86	0.77	0.68	0.61	0.55	0.46	0.40	0.087%
2.5	0.95	0.86	0.75	0.68	0.61	0.51	0.45	0.062%
2.75	1.05	0.94	0.83	0.75	0.67	0.56	0.49	0.020%
3	1.14	1.03	0.90	0.81	0.73	0.61	0.54	0.009%
Total Percent Occurrence	0.078%	0.091%	0.048%	0.012%	0.002%	0.000%	0.000%	0.23%

【Peak Wave Period, Tp=18sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.09	0.09	0.08	0.07	0.06	0.06	0.05	0.000%
0.5	0.18	0.17	0.15	0.14	0.13	0.11	0.10	0.000%
0.75	0.27	0.26	0.23	0.21	0.19	0.17	0.15	0.000%
1	0.37	0.34	0.30	0.28	0.25	0.23	0.20	0.000%
1.25	0.46	0.43	0.38	0.35	0.32	0.28	0.25	0.000%
1.5	0.55	0.51	0.46	0.42	0.38	0.34	0.30	0.000%
1.75	0.64	0.60	0.53	0.49	0.45	0.40	0.35	0.000%
2	0.73	0.68	0.61	0.56	0.51	0.46	0.40	0.039%
2.25	0.82	0.77	0.68	0.63	0.57	0.51	0.45	0.062%
2.5	0.92	0.85	0.76	0.700	0.64	0.57	0.50	0.088%
2.75	1.01	0.94	0.84	0.77	0.700	0.63	0.55	0.026%
3	1.10	1.02	0.91	0.84	0.76	0.68	0.60	0.009%
Total Percent Occurrence	0.059%	0.085%	0.043%	0.049%	0.008%	0.000%	0.000%	0.22%

【Peak Wave Period, Tp=20sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.09	0.09	0.08	0.07	0.06	0.06	0.05	0.000%
0.5	0.19	0.17	0.16	0.14	0.13	0.11	0.10	0.000%
0.75	0.28	0.26	0.24	0.21	0.19	0.17	0.15	0.000%
1	0.38	0.35	0.32	0.28	0.25	0.23	0.20	0.000%
1.25	0.47	0.43	0.40	0.35	0.32	0.28	0.25	0.000%
1.5	0.56	0.52	0.48	0.42	0.38	0.34	0.30	0.000%
1.75	0.66	0.61	0.56	0.49	0.44	0.39	0.35	0.000%
2	0.75	0.696	0.64	0.56	0.51	0.45	0.40	0.010%
2.25	0.84	0.78	0.72	0.63	0.57	0.51	0.45	0.052%
2.5	0.94	0.87	0.80	0.700	0.63	0.56	0.50	0.028%
2.75	1.03	0.96	0.88	0.77	0.69	0.62	0.55	0.007%
3	1.13	1.04	0.96	0.84	0.76	0.68	0.60	0.000%
Total Percent Occurrence	0.014%	0.019%	0.047%	0.016%	0.000%	0.000%	0.000%	0.10%

Table A.2.5.2 Wave Height and Total Percent Occurrence at Berth E2 in the case of Plan-A (units : m)

【Peak Wave Period, Tp=6sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.08	0.07	0.07	0.06	0.05	0.04	0.000%
0.5	0.00	0.16	0.15	0.14	0.12	0.09	0.08	0.000%
0.75	0.00	0.24	0.22	0.20	0.17	0.14	0.12	0.000%
1	0.00	0.32	0.30	0.27	0.23	0.19	0.15	0.000%
1.25	0.00	0.41	0.37	0.34	0.29	0.23	0.19	0.000%
1.5	0.00	0.49	0.45	0.41	0.35	0.28	0.23	0.000%
1.75	0.00	0.57	0.52	0.47	0.41	0.33	0.27	0.000%
2	0.00	0.65	0.60	0.54	0.47	0.37	0.31	0.000%
2.25	0.00	0.73	0.67	0.61	0.52	0.42	0.35	0.011%
2.5	0.00	0.81	0.75	0.68	0.58	0.47	0.39	0.003%
2.75	0.00	0.89	0.82	0.74	0.64	0.51	0.42	0.000%
3	0.00	0.97	0.90	0.81	0.700	0.56	0.46	0.000%
Total Percent Occurrence	0.000%	0.014%	0.010%	0.000%	0.000%	0.000%	0.000%	0.02%

【Peak Wave Period, Tp=8sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.07	0.06	0.05	0.04	0.04	0.05	0.000%
0.5	0.00	0.15	0.12	0.10	0.09	0.08	0.09	0.000%
0.75	0.00	0.22	0.19	0.16	0.13	0.12	0.14	0.000%
1	0.00	0.29	0.25	0.21	0.17	0.16	0.18	0.000%
1.25	0.00	0.37	0.31	0.26	0.22	0.21	0.23	0.000%
1.5	0.00	0.44	0.37	0.31	0.26	0.25	0.28	0.000%
1.75	0.00	0.52	0.44	0.36	0.31	0.29	0.32	0.000%
2	0.00	0.59	0.50	0.42	0.35	0.33	0.37	0.000%
2.25	0.00	0.66	0.56	0.47	0.39	0.37	0.41	0.000%
2.5	0.00	0.74	0.62	0.52	0.44	0.41	0.46	0.007%
2.75	0.00	0.81	0.69	0.57	0.48	0.45	0.50	0.006%
3	0.00	0.88	0.75	0.63	0.52	0.49	0.55	0.007%
Total Percent Occurrence	0.00%	0.016%	0.005%	0.000%	0.000%	0.000%	0.000%	0.02%

【Peak Wave Period, Tp=10sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.08	0.07	0.07	0.06	0.05	0.04	0.04	0.000%
0.5	0.17	0.15	0.13	0.12	0.10	0.09	0.07	0.000%
0.75	0.25	0.22	0.20	0.17	0.14	0.13	0.11	0.000%
1	0.34	0.29	0.26	0.23	0.19	0.18	0.14	0.000%
1.25	0.42	0.37	0.33	0.29	0.24	0.22	0.18	0.000%
1.5	0.51	0.44	0.39	0.35	0.29	0.26	0.22	0.000%
1.75	0.59	0.51	0.46	0.40	0.33	0.31	0.25	0.000%
2	0.68	0.59	0.53	0.46	0.38	0.35	0.29	0.000%
2.25	0.76	0.66	0.59	0.52	0.43	0.39	0.32	0.005%
2.5	0.85	0.74	0.66	0.58	0.48	0.44	0.36	0.000%
2.75	0.93	0.81	0.72	0.64	0.52	0.48	0.40	0.000%
3	1.02	0.88	0.79	0.69	0.57	0.53	0.43	0.000%
Total Percent Occurrence	0.005%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.01%

【Peak Wave Period, Tp=12sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.08	0.07	0.07	0.06	0.06	0.05	0.04	0.000%
0.5	0.17	0.15	0.14	0.12	0.11	0.09	0.09	0.000%
0.75	0.25	0.22	0.21	0.18	0.17	0.14	0.13	0.000%
1	0.33	0.30	0.28	0.24	0.22	0.18	0.17	0.000%
1.25	0.42	0.37	0.35	0.30	0.28	0.23	0.21	0.000%
1.5	0.50	0.44	0.41	0.37	0.33	0.27	0.26	0.000%
1.75	0.58	0.52	0.48	0.43	0.39	0.32	0.30	0.000%
2	0.67	0.59	0.55	0.49	0.44	0.37	0.34	0.000%
2.25	0.75	0.66	0.62	0.55	0.50	0.41	0.38	0.011%
2.5	0.83	0.74	0.69	0.61	0.55	0.46	0.43	0.009%
2.75	0.92	0.81	0.76	0.67	0.61	0.50	0.47	0.000%
3	1.00	0.89	0.83	0.73	0.66	0.55	0.51	0.000%
Total Percent Occurrence	0.013%	0.006%	0.000%	0.000%	0.000%	0.000%	0.000%	0.02%

【Peak Wave Period, Tp=14sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.10	0.09	0.08	0.07	0.06	0.05	0.05	0.000%
0.5	0.20	0.18	0.16	0.14	0.13	0.11	0.10	0.000%
0.75	0.30	0.27	0.24	0.21	0.19	0.16	0.15	0.000%
1	0.39	0.35	0.33	0.28	0.26	0.21	0.20	0.000%
1.25	0.49	0.44	0.41	0.35	0.32	0.27	0.25	0.000%
1.5	0.59	0.53	0.49	0.42	0.38	0.32	0.30	0.000%
1.75	0.69	0.62	0.57	0.50	0.45	0.38	0.35	0.000%
2	0.79	0.71	0.65	0.57	0.51	0.43	0.40	0.262%
2.25	0.88	0.80	0.73	0.64	0.58	0.48	0.45	0.182%
2.5	0.99	0.88	0.81	0.71	0.64	0.54	0.50	0.053%
2.75	1.09	0.97	0.90	0.78	0.71	0.59	0.55	0.017%
3	1.18	1.06	0.98	0.85	0.77	0.64	0.60	0.000%
Total Percent Occurrence	0.093%	0.270%	0.123%	0.025%	0.004%	0.000%	0.000%	0.51%

【Peak Wave Period, Tp=16sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.10	0.09	0.08	0.07	0.06	0.05	0.05	0.000%
0.5	0.20	0.17	0.15	0.14	0.12	0.11	0.10	0.000%
0.75	0.29	0.26	0.23	0.21	0.19	0.16	0.14	0.000%
1	0.39	0.35	0.30	0.28	0.25	0.21	0.19	0.000%
1.25	0.49	0.43	0.38	0.35	0.31	0.26	0.24	0.000%
1.5	0.59	0.52	0.46	0.41	0.37	0.32	0.29	0.000%
1.75	0.69	0.61	0.53	0.48	0.44	0.37	0.33	0.000%
2	0.79	0.696	0.61	0.55	0.50	0.42	0.38	0.239%
2.25	0.88	0.78	0.68	0.62	0.56	0.48	0.43	0.087%
2.5	0.98	0.87	0.76	0.69	0.62	0.53	0.48	0.062%
2.75	1.08	0.96	0.84	0.76	0.69	0.58	0.52	0.020%
3	1.18	1.04	0.91	0.83	0.75	0.63	0.57	0.009%
Total Percent Occurrence	0.078%	0.278%	0.048%	0.012%	0.002%	0.000%	0.000%	0.42%

【Peak Wave Period, Tp=18sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.10	0.09	0.08	0.08	0.07	0.06	0.05	0.000%
0.5	0.20	0.19	0.17	0.15	0.14	0.12	0.11	0.000%
0.75	0.30	0.28	0.25	0.23	0.21	0.19	0.16	0.000%
1	0.40	0.38	0.34	0.31	0.28	0.25	0.22	0.000%
1.25	0.50	0.47	0.42	0.39	0.35	0.31	0.27	0.000%
1.5	0.61	0.56	0.50	0.46	0.42	0.37	0.33	0.000%
1.75	0.71	0.66	0.59	0.54	0.49	0.43	0.38	0.079%
2	0.81	0.75	0.67	0.62	0.56	0.50	0.44	0.165%
2.25	0.91	0.84	0.76	0.695	0.63	0.56	0.49	0.180%
2.5	1.01	0.94	0.84	0.77	0.696	0.62	0.55	0.088%
2.75	1.11	1.03	0.92	0.85	0.77	0.68	0.60	0.026%
3	1.21	1.13	1.01	0.93	0.84	0.75	0.66	0.010%
Total Percent Occurrence	0.138%	0.192%	0.161%	0.049%	0.008%	0.001%	0.000%	0.55%

【Peak Wave Period, Tp=20sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.10	0.09	0.09	0.08	0.07	0.06	0.06	0.000%
0.5	0.20	0.19	0.17	0.15	0.14	0.13	0.11	0.000%
0.75	0.31	0.28	0.26	0.23	0.21	0.19	0.17	0.000%
1	0.41	0.38	0.35	0.31	0.28	0.25	0.22	0.000%
1.25	0.51	0.47	0.44	0.39	0.35	0.31	0.28	0.000%
1.5	0.61	0.57	0.52	0.46	0.42	0.38	0.33	0.000%
1.75	0.71	0.66	0.61	0.54	0.49	0.44	0.39	0.022%
2	0.81	0.75	0.698	0.62	0.56	0.50	0.44	0.049%
2.25	0.92	0.85	0.78	0.69	0.63	0.57	0.50	0.052%
2.5	1.02	0.94	0.87	0.77	0.701	0.63	0.55	0.036%
2.75	1.12	1.04	0.96	0.85	0.77	0.69	0.61	0.009%
3	1.22	1.13	1.05	0.92	0.84	0.75	0.66	0.000%
Total Percent Occurrence	0.036%	0.058%	0.047%	0.016%	0.010%	0.000%	0.000%	0.17%

Table A.2.5.3 Wave Height and Total Percent Occurrence at Berth E3 in the case of Plan-A (units : m)

【Peak Wave Period, Tp=6sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.08	0.07	0.07	0.05	0.04	0.04	0.000%
0.5	0.00	0.16	0.15	0.13	0.11	0.09	0.08	0.000%
0.75	0.00	0.25	0.22	0.20	0.16	0.13	0.12	0.000%
1	0.00	0.33	0.30	0.26	0.22	0.17	0.15	0.000%
1.25	0.00	0.41	0.37	0.33	0.27	0.22	0.19	0.000%
1.5	0.00	0.49	0.45	0.39	0.33	0.26	0.23	0.000%
1.75	0.00	0.57	0.52	0.46	0.38	0.31	0.27	0.000%
2	0.00	0.66	0.60	0.53	0.43	0.35	0.31	0.000%
2.25	0.00	0.74	0.67	0.59	0.49	0.39	0.35	0.011%
2.5	0.00	0.82	0.75	0.66	0.54	0.44	0.38	0.014%
2.75	0.00	0.90	0.82	0.72	0.60	0.48	0.42	0.000%
3	0.00	0.98	0.89	0.79	0.65	0.52	0.46	0.000%
Total Percent Occurrence	0.00%	0.014%	0.010%	0.000%	0.000%	0.000%	0.000%	0.02%

【Peak Wave Period, Tp=8sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.07	0.06	0.05	0.04	0.04	0.03	0.000%
0.5	0.00	0.13	0.12	0.10	0.08	0.08	0.07	0.000%
0.75	0.00	0.20	0.17	0.16	0.13	0.11	0.10	0.000%
1	0.00	0.26	0.23	0.21	0.17	0.15	0.14	0.000%
1.25	0.00	0.33	0.29	0.26	0.21	0.19	0.17	0.000%
1.5	0.00	0.40	0.35	0.31	0.25	0.23	0.20	0.000%
1.75	0.00	0.46	0.40	0.36	0.30	0.27	0.24	0.000%
2	0.00	0.53	0.46	0.41	0.34	0.31	0.27	0.000%
2.25	0.00	0.59	0.52	0.47	0.38	0.34	0.31	0.000%
2.5	0.00	0.66	0.58	0.52	0.42	0.38	0.34	0.000%
2.75	0.00	0.73	0.63	0.57	0.46	0.42	0.37	0.006%
3	0.00	0.79	0.69	0.62	0.51	0.46	0.41	0.002%
Total Percent Occurrence	0.00%	0.009%	0.000%	0.000%	0.000%	0.000%	0.000%	0.01%

【Peak Wave Period, Tp=10sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.08	0.08	0.07	0.06	0.05	0.04	0.04	0.000%
0.5	0.17	0.15	0.13	0.12	0.10	0.09	0.07	0.000%
0.75	0.25	0.23	0.20	0.17	0.15	0.13	0.11	0.000%
1	0.33	0.30	0.27	0.23	0.20	0.18	0.15	0.000%
1.25	0.41	0.38	0.33	0.29	0.25	0.22	0.18	0.000%
1.5	0.50	0.45	0.40	0.35	0.30	0.27	0.22	0.000%
1.75	0.58	0.53	0.46	0.41	0.35	0.31	0.26	0.000%
2	0.66	0.60	0.53	0.46	0.40	0.36	0.29	0.000%
2.25	0.75	0.68	0.60	0.52	0.44	0.40	0.33	0.005%
2.5	0.83	0.75	0.66	0.58	0.49	0.44	0.37	0.000%
2.75	0.91	0.83	0.73	0.64	0.54	0.49	0.40	0.000%
3	1.00	0.90	0.80	0.69	0.59	0.53	0.44	0.000%
Total Percent Occurrence	0.005%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.01%

【Peak Wave Period, Tp=12sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.08	0.08	0.07	0.06	0.06	0.05	0.04	0.000%
0.5	0.17	0.15	0.15	0.12	0.11	0.09	0.08	0.000%
0.75	0.25	0.23	0.22	0.19	0.17	0.14	0.13	0.000%
1	0.34	0.31	0.29	0.25	0.22	0.18	0.18	0.000%
1.25	0.42	0.38	0.37	0.31	0.28	0.23	0.22	0.000%
1.5	0.51	0.46	0.44	0.37	0.33	0.28	0.26	0.000%
1.75	0.59	0.54	0.51	0.44	0.39	0.32	0.31	0.000%
2	0.68	0.61	0.59	0.50	0.45	0.37	0.35	0.000%
2.25	0.76	0.69	0.66	0.56	0.50	0.41	0.39	0.011%
2.5	0.85	0.77	0.73	0.62	0.56	0.46	0.44	0.016%
2.75	0.93	0.84	0.80	0.69	0.61	0.51	0.48	0.000%
3	1.01	0.92	0.88	0.75	0.67	0.55	0.53	0.000%
Total Percent Occurrence	0.013%	0.006%	0.007%	0.000%	0.000%	0.000%	0.000%	0.03%

【Peak Wave Period, Tp=14sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.10	0.09	0.08	0.07	0.06	0.05	0.05	0.000%
0.5	0.20	0.17	0.16	0.14	0.12	0.10	0.10	0.000%
0.75	0.29	0.26	0.24	0.21	0.19	0.16	0.14	0.000%
1	0.39	0.35	0.32	0.28	0.25	0.21	0.19	0.000%
1.25	0.49	0.43	0.40	0.35	0.31	0.26	0.24	0.000%
1.5	0.59	0.52	0.48	0.42	0.37	0.31	0.29	0.000%
1.75	0.69	0.61	0.56	0.49	0.43	0.36	0.34	0.000%
2	0.78	0.69	0.64	0.55	0.50	0.42	0.38	0.087%
2.25	0.88	0.78	0.72	0.62	0.56	0.47	0.43	0.182%
2.5	0.98	0.87	0.80	0.69	0.62	0.52	0.48	0.033%
2.75	1.08	0.95	0.88	0.76	0.68	0.57	0.53	0.013%
3	1.17	1.04	0.95	0.83	0.75	0.62	0.58	0.000%
Total Percent Occurrence	0.093%	0.074%	0.123%	0.005%	0.000%	0.000%	0.000%	0.29%

【Peak Wave Period, Tp=16sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.09	0.09	0.08	0.07	0.07	0.06	0.05	0.000%
0.5	0.19	0.17	0.16	0.14	0.13	0.11	0.10	0.000%
0.75	0.28	0.26	0.23	0.22	0.20	0.17	0.15	0.000%
1	0.38	0.35	0.31	0.29	0.27	0.23	0.20	0.000%
1.25	0.47	0.43	0.39	0.36	0.33	0.28	0.25	0.000%
1.5	0.57	0.52	0.47	0.43	0.40	0.34	0.30	0.000%
1.75	0.66	0.61	0.55	0.51	0.47	0.40	0.35	0.000%
2	0.76	0.69	0.63	0.58	0.53	0.45	0.40	0.052%
2.25	0.85	0.78	0.704	0.65	0.60	0.51	0.45	0.232%
2.5	0.95	0.87	0.78	0.72	0.67	0.57	0.50	0.109%
2.75	1.04	0.95	0.86	0.79	0.73	0.63	0.55	0.026%
3	1.13	1.04	0.94	0.87	0.80	0.68	0.60	0.009%
Total Percent Occurrence	0.078%	0.091%	0.193%	0.058%	0.008%	0.000%	0.000%	0.43%

【Peak Wave Period, Tp=18sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.10	0.09	0.08	0.07	0.06	0.06	0.05	0.000%
0.5	0.19	0.18	0.16	0.14	0.13	0.11	0.10	0.000%
0.75	0.29	0.27	0.24	0.21	0.19	0.17	0.15	0.000%
1	0.39	0.36	0.31	0.29	0.25	0.23	0.20	0.000%
1.25	0.49	0.45	0.39	0.36	0.32	0.28	0.25	0.000%
1.5	0.58	0.54	0.47	0.43	0.38	0.34	0.30	0.000%
1.75	0.68	0.63	0.55	0.50	0.44	0.39	0.35	0.000%
2	0.78	0.72	0.63	0.57	0.51	0.45	0.40	0.165%
2.25	0.88	0.81	0.71	0.64	0.57	0.51	0.45	0.180%
2.5	0.97	0.90	0.79	0.71	0.64	0.56	0.50	0.088%
2.75	1.07	0.98	0.87	0.78	0.699	0.62	0.55	0.020%
3	1.17	1.07	0.94	0.86	0.76	0.68	0.60	0.009%
Total Percent Occurrence	0.059%	0.192%	0.161%	0.049%	0.002%	0.000%	0.000%	0.46%

【Peak Wave Period, Tp=20sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.10	0.09	0.09	0.08	0.07	0.06	0.05	0.000%
0.5	0.20	0.19	0.17	0.15	0.14	0.12	0.11	0.000%
0.75	0.30	0.28	0.26	0.23	0.20	0.18	0.16	0.000%
1	0.40	0.37	0.34	0.30	0.27	0.24	0.21	0.000%
1.25	0.50	0.46	0.43	0.38	0.34	0.30	0.27	0.000%
1.5	0.60	0.56	0.51	0.45	0.41	0.36	0.32	0.000%
1.75	0.696	0.65	0.60	0.53	0.47	0.42	0.38	0.000%
2	0.80	0.74	0.69	0.60	0.54	0.48	0.43	0.049%
2.25	0.90	0.83	0.77	0.68	0.61	0.54	0.48	0.052%
2.5	0.99	0.93	0.86	0.75	0.68	0.60	0.54	0.026%
2.75	1.09	1.02	0.94	0.83	0.75	0.66	0.59	0.009%
3	1.19	1.11	1.03	0.91	0.81	0.72	0.64	0.000%
Total Percent Occurrence	0.014%	0.058%	0.047%	0.016%	0.002%	0.000%	0.000%	0.14%

Table A.2.5.4 Wave Height and Total Percent Occurrence at Berth E4 in the case of Plan-A (units : m)

【Peak Wave Period, Tp=6sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.08	0.07	0.06	0.06	0.06	0.05	0.000%
0.5	0.00	0.15	0.14	0.13	0.11	0.12	0.09	0.000%
0.75	0.00	0.23	0.20	0.19	0.17	0.18	0.14	0.000%
1	0.00	0.30	0.27	0.26	0.22	0.23	0.18	0.000%
1.25	0.00	0.38	0.34	0.32	0.28	0.29	0.23	0.000%
1.5	0.00	0.45	0.41	0.39	0.33	0.35	0.27	0.000%
1.75	0.00	0.53	0.47	0.45	0.39	0.41	0.32	0.000%
2	0.00	0.60	0.54	0.52	0.44	0.47	0.37	0.000%
2.25	0.00	0.68	0.61	0.58	0.50	0.53	0.41	0.000%
2.5	0.00	0.75	0.68	0.65	0.56	0.59	0.46	0.003%
2.75	0.00	0.83	0.75	0.71	0.61	0.65	0.50	0.000%
3	0.00	0.90	0.81	0.78	0.67	0.70	0.55	0.000%
Total Percent Occurrence	0.000%	0.003%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=8sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.07	0.06	0.06	0.05	0.05	0.04	0.000%
0.5	0.00	0.15	0.13	0.12	0.10	0.09	0.08	0.000%
0.75	0.00	0.22	0.19	0.17	0.15	0.14	0.12	0.000%
1	0.00	0.30	0.25	0.23	0.20	0.18	0.17	0.000%
1.25	0.00	0.37	0.32	0.29	0.25	0.23	0.21	0.000%
1.5	0.00	0.45	0.38	0.35	0.30	0.27	0.25	0.000%
1.75	0.00	0.52	0.45	0.40	0.35	0.32	0.29	0.000%
2	0.00	0.60	0.51	0.46	0.40	0.36	0.33	0.000%
2.25	0.00	0.67	0.57	0.52	0.45	0.41	0.37	0.000%
2.5	0.00	0.74	0.64	0.58	0.50	0.45	0.42	0.007%
2.75	0.00	0.82	0.700	0.63	0.55	0.50	0.46	0.018%
3	0.00	0.89	0.76	0.69	0.60	0.54	0.50	0.007%
Total Percent Occurrence	0.000%	0.016%	0.017%	0.000%	0.000%	0.000%	0.000%	0.03%

【Peak Wave Period, Tp=10sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.08	0.07	0.06	0.06	0.05	0.04	0.04	0.000%
0.5	0.15	0.14	0.13	0.11	0.09	0.09	0.08	0.000%
0.75	0.23	0.21	0.19	0.17	0.14	0.13	0.11	0.000%
1	0.31	0.28	0.26	0.22	0.18	0.17	0.15	0.000%
1.25	0.39	0.35	0.32	0.28	0.23	0.22	0.19	0.000%
1.5	0.46	0.43	0.39	0.33	0.28	0.26	0.23	0.000%
1.75	0.54	0.50	0.45	0.39	0.32	0.31	0.26	0.000%
2	0.62	0.57	0.52	0.44	0.37	0.35	0.30	0.000%
2.25	0.697	0.64	0.58	0.50	0.41	0.39	0.34	0.005%
2.5	0.77	0.71	0.64	0.55	0.46	0.44	0.38	0.000%
2.75	0.85	0.78	0.71	0.61	0.51	0.48	0.41	0.000%
3	0.93	0.85	0.77	0.66	0.55	0.52	0.45	0.000%
Total Percent Occurrence	0.005%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.01%

【Peak Wave Period, Tp=12sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.08	0.08	0.07	0.06	0.05	0.04	0.04	0.000%
0.5	0.17	0.15	0.14	0.12	0.10	0.09	0.08	0.000%
0.75	0.25	0.23	0.21	0.18	0.16	0.13	0.12	0.000%
1	0.33	0.30	0.28	0.24	0.21	0.18	0.16	0.000%
1.25	0.42	0.38	0.34	0.30	0.26	0.22	0.20	0.000%
1.5	0.50	0.45	0.41	0.36	0.31	0.26	0.24	0.000%
1.75	0.58	0.53	0.48	0.42	0.37	0.31	0.28	0.000%
2	0.66	0.61	0.55	0.48	0.42	0.35	0.32	0.000%
2.25	0.75	0.68	0.62	0.53	0.47	0.40	0.37	0.011%
2.5	0.83	0.76	0.69	0.59	0.52	0.44	0.41	0.009%
2.75	0.91	0.83	0.76	0.65	0.58	0.48	0.45	0.000%
3	1.00	0.91	0.83	0.71	0.63	0.53	0.49	0.000%
Total Percent Occurrence	0.013%	0.006%	0.000%	0.000%	0.000%	0.000%	0.000%	0.02%

【Peak Wave Period, Tp=14sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.09	0.08	0.07	0.06	0.06	0.05	0.04	0.000%
0.5	0.19	0.17	0.15	0.13	0.11	0.09	0.09	0.000%
0.75	0.28	0.25	0.22	0.19	0.17	0.14	0.13	0.000%
1	0.38	0.33	0.30	0.26	0.23	0.19	0.17	0.000%
1.25	0.47	0.41	0.37	0.32	0.29	0.23	0.22	0.000%
1.5	0.57	0.50	0.45	0.39	0.34	0.28	0.26	0.000%
1.75	0.66	0.58	0.52	0.45	0.40	0.33	0.30	0.000%
2	0.75	0.66	0.60	0.52	0.46	0.37	0.35	0.067%
2.25	0.85	0.75	0.67	0.58	0.51	0.42	0.39	0.081%
2.5	0.94	0.83	0.75	0.64	0.57	0.47	0.43	0.033%
2.75	1.04	0.91	0.82	0.71	0.63	0.51	0.48	0.013%
3	1.13	1.00	0.90	0.77	0.69	0.56	0.52	0.000%
Total Percent Occurrence	0.093%	0.074%	0.023%	0.005%	0.000%	0.000%	0.000%	0.19%

【Peak Wave Period, Tp=16sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.09	0.09	0.08	0.07	0.07	0.06	0.05	0.000%
0.5	0.19	0.17	0.15	0.14	0.13	0.11	0.10	0.000%
0.75	0.28	0.26	0.23	0.21	0.20	0.17	0.15	0.000%
1	0.38	0.35	0.31	0.29	0.26	0.22	0.20	0.000%
1.25	0.47	0.43	0.39	0.36	0.33	0.28	0.25	0.000%
1.5	0.57	0.52	0.46	0.43	0.39	0.34	0.29	0.000%
1.75	0.66	0.61	0.54	0.50	0.46	0.39	0.34	0.000%
2	0.76	0.69	0.62	0.57	0.52	0.45	0.39	0.052%
2.25	0.85	0.78	0.697	0.64	0.59	0.50	0.44	0.232%
2.5	0.95	0.87	0.77	0.71	0.65	0.56	0.49	0.109%
2.75	1.04	0.95	0.85	0.79	0.72	0.62	0.54	0.026%
3	1.14	1.04	0.93	0.86	0.79	0.67	0.59	0.009%
Total Percent Occurrence	0.078%	0.091%	0.193%	0.058%	0.008%	0.000%	0.000%	0.43%

【Peak Wave Period, Tp=18sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.09	0.09	0.07	0.07	0.06	0.05	0.05	0.000%
0.5	0.19	0.17	0.15	0.13	0.12	0.11	0.10	0.000%
0.75	0.28	0.26	0.22	0.20	0.18	0.16	0.15	0.000%
1	0.37	0.34	0.30	0.27	0.24	0.22	0.19	0.000%
1.25	0.47	0.43	0.37	0.34	0.30	0.27	0.24	0.000%
1.5	0.56	0.51	0.45	0.40	0.36	0.33	0.29	0.000%
1.75	0.65	0.60	0.52	0.47	0.42	0.38	0.34	0.000%
2	0.75	0.69	0.60	0.54	0.48	0.43	0.39	0.039%
2.25	0.84	0.77	0.67	0.60	0.54	0.49	0.44	0.062%
2.5	0.93	0.86	0.75	0.67	0.60	0.54	0.48	0.051%
2.75	1.03	0.94	0.82	0.74	0.66	0.60	0.53	0.020%
3	1.12	1.03	0.90	0.81	0.72	0.650	0.58	0.009%
Total Percent Occurrence	0.059%	0.065%	0.043%	0.011%	0.002%	0.000%	0.000%	0.18%

【Peak Wave Period, Tp=20sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.10	0.09	0.08	0.07	0.07	0.06	0.05	0.000%
0.5	0.20	0.18	0.17	0.15	0.13	0.12	0.10	0.000%
0.75	0.29	0.27	0.25	0.22	0.20	0.17	0.15	0.000%
1	0.39	0.36	0.34	0.29	0.26	0.23	0.21	0.000%
1.25	0.49	0.45	0.42	0.37	0.33	0.29	0.26	0.000%
1.5	0.59	0.55	0.50	0.44	0.39	0.35	0.31	0.000%
1.75	0.68	0.64	0.59	0.51	0.46	0.41	0.36	0.000%
2	0.78	0.73	0.67	0.59	0.52	0.47	0.41	0.049%
2.25	0.88	0.82	0.76	0.66	0.59	0.52	0.46	0.052%
2.5	0.98	0.91	0.84	0.73	0.65	0.58	0.51	0.028%
2.75	1.08	1.00	0.92	0.80	0.72	0.64	0.56	0.009%
3	1.17	1.09	1.01	0.88	0.78	0.699	0.62	0.000%
Total Percent Occurrence	0.014%	0.058%	0.047%	0.016%	0.002%	0.000%	0.000%	0.14%

Table A.2.5.5 Wave Height and Total Percent Occurrence at Berth S1 in the case of Plan-A (units : m)

【Peak Wave Period, Tp=6sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.14	0.11	0.10	0.08	0.08	0.07	0.000%
0.5	0.00	0.27	0.23	0.20	0.17	0.16	0.14	0.000%
0.75	0.00	0.41	0.34	0.31	0.25	0.23	0.21	0.000%
1	0.00	0.55	0.46	0.41	0.34	0.31	0.28	0.000%
1.25	0.00	0.69	0.57	0.51	0.42	0.39	0.35	0.000%
1.5	0.00	0.82	0.69	0.61	0.50	0.47	0.42	0.025%
1.75	0.00	0.96	0.80	0.71	0.59	0.54	0.49	0.477%
2	0.00	1.10	0.92	0.82	0.67	0.62	0.56	0.311%
2.25	0.00	1.24	1.03	0.92	0.76	0.698	0.63	0.286%
2.5	0.00	1.37	1.15	1.02	0.84	0.78	0.700	0.107%
2.75	0.00	1.51	1.26	1.12	0.92	0.85	0.77	0.000%
3	0.00	1.65	1.37	1.22	1.01	0.93	0.84	0.000%
Total Percent Occurrence	0.000%	0.111%	0.258%	0.603%	0.116%	0.101%	0.017%	1.21%

【Peak Wave Period, Tp=8sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.10	0.09	0.08	0.07	0.07	0.06	0.000%
0.5	0.00	0.21	0.17	0.16	0.15	0.13	0.12	0.000%
0.75	0.00	0.31	0.26	0.24	0.22	0.20	0.18	0.000%
1	0.00	0.41	0.35	0.32	0.29	0.27	0.24	0.000%
1.25	0.00	0.51	0.43	0.40	0.37	0.34	0.30	0.000%
1.5	0.00	0.62	0.52	0.48	0.44	0.40	0.36	0.000%
1.75	0.00	0.72	0.61	0.56	0.51	0.47	0.42	0.011%
2	0.00	0.82	0.69	0.64	0.58	0.54	0.48	0.001%
2.25	0.00	0.92	0.78	0.72	0.66	0.60	0.54	0.006%
2.5	0.00	1.03	0.87	0.80	0.73	0.67	0.60	0.051%
2.75	0.00	1.13	0.95	0.88	0.80	0.74	0.66	0.049%
3	0.00	1.23	1.04	0.96	0.88	0.81	0.72	0.019%
Total Percent Occurrence	0.000%	0.029%	0.034%	0.034%	0.032%	0.009%	0.000%	0.14%

【Peak Wave Period, Tp=10sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.11	0.11	0.10	0.08	0.07	0.06	0.05	0.000%
0.5	0.22	0.21	0.19	0.16	0.14	0.13	0.10	0.000%
0.75	0.33	0.32	0.29	0.24	0.21	0.19	0.15	0.000%
1	0.44	0.43	0.38	0.32	0.28	0.25	0.20	0.000%
1.25	0.55	0.53	0.48	0.39	0.35	0.31	0.25	0.000%
1.5	0.66	0.64	0.58	0.47	0.42	0.38	0.30	0.000%
1.75	0.77	0.74	0.67	0.55	0.49	0.44	0.35	0.270%
2	0.89	0.85	0.77	0.63	0.56	0.50	0.40	0.107%
2.25	1.00	0.96	0.86	0.71	0.63	0.56	0.45	0.043%
2.5	1.11	1.06	0.96	0.79	0.700	0.63	0.50	0.000%
2.75	1.22	1.17	1.06	0.87	0.77	0.69	0.55	0.000%
3	1.33	1.28	1.15	0.95	0.84	0.75	0.60	0.000%
Total Percent Occurrence	0.106%	0.239%	0.064%	0.012%	0.000%	0.000%	0.000%	0.42%

【Peak Wave Period, Tp=12sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.11	0.10	0.09	0.08	0.08	0.07	0.06	0.000%
0.5	0.23	0.20	0.19	0.17	0.15	0.13	0.12	0.000%
0.75	0.34	0.30	0.28	0.25	0.23	0.20	0.17	0.000%
1	0.45	0.40	0.37	0.33	0.31	0.26	0.23	0.000%
1.25	0.56	0.49	0.47	0.42	0.38	0.33	0.29	0.000%
1.5	0.68	0.59	0.56	0.50	0.46	0.40	0.35	0.000%
1.75	0.79	0.69	0.65	0.58	0.53	0.46	0.41	0.159%
2	0.90	0.79	0.75	0.67	0.61	0.53	0.46	0.392%
2.25	1.01	0.89	0.84	0.75	0.69	0.59	0.52	0.090%
2.5	1.13	0.99	0.94	0.83	0.76	0.66	0.58	0.027%
2.75	1.24	1.09	1.03	0.92	0.84	0.72	0.64	0.000%
3	1.35	1.19	1.12	1.00	0.92	0.79	0.697	0.000%
Total Percent Occurrence	0.239%	0.184%	0.207%	0.035%	0.005%	0.000%	0.000%	0.67%

【Peak Wave Period, Tp=14sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.09	0.09	0.09	0.08	0.07	0.07	0.06	0.000%
0.5	0.19	0.18	0.17	0.16	0.15	0.13	0.13	0.000%
0.75	0.28	0.27	0.26	0.24	0.22	0.20	0.19	0.000%
1	0.38	0.36	0.34	0.32	0.30	0.27	0.25	0.000%
1.25	0.47	0.45	0.43	0.40	0.37	0.33	0.32	0.000%
1.5	0.57	0.54	0.52	0.47	0.44	0.40	0.38	0.000%
1.75	0.66	0.63	0.60	0.55	0.52	0.47	0.45	0.000%
2	0.75	0.72	0.69	0.63	0.59	0.53	0.51	0.262%
2.25	0.85	0.81	0.77	0.71	0.67	0.60	0.57	0.291%
2.5	0.94	0.90	0.86	0.79	0.74	0.67	0.64	0.068%
2.75	1.04	0.99	0.95	0.87	0.82	0.73	0.700	0.021%
3	1.13	1.08	1.03	0.95	0.89	0.80	0.76	0.000%
Total Percent Occurrence	0.093%	0.270%	0.123%	0.135%	0.019%	0.002%	0.001%	0.64%

【Peak Wave Period, Tp=16sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.12	0.11	0.09	0.09	0.08	0.06	0.06	0.000%
0.5	0.23	0.21	0.19	0.17	0.15	0.13	0.11	0.000%
0.75	0.35	0.32	0.28	0.26	0.23	0.19	0.17	0.000%
1	0.47	0.42	0.38	0.35	0.31	0.26	0.23	0.000%
1.25	0.58	0.53	0.47	0.43	0.39	0.32	0.28	0.000%
1.5	0.700	0.64	0.57	0.52	0.46	0.39	0.34	0.187%
1.75	0.82	0.74	0.66	0.61	0.54	0.45	0.40	0.563%
2	0.93	0.85	0.76	0.696	0.62	0.52	0.45	1.113%
2.25	1.05	0.96	0.85	0.78	0.69	0.58	0.51	0.407%
2.5	1.17	1.06	0.95	0.87	0.77	0.65	0.57	0.141%
2.75	1.28	1.17	1.04	0.96	0.85	0.71	0.62	0.030%
3	1.40	1.27	1.13	1.04	0.92	0.78	0.68	0.010%
Total Percent Occurrence	0.388%	0.718%	0.589%	0.712%	0.040%	0.004%	0.000%	2.45%

【Peak Wave Period, Tp=18sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.10	0.10	0.09	0.08	0.08	0.07	0.06	0.000%
0.5	0.20	0.19	0.18	0.17	0.15	0.14	0.13	0.000%
0.75	0.30	0.29	0.27	0.25	0.23	0.21	0.19	0.000%
1	0.40	0.38	0.36	0.33	0.30	0.28	0.25	0.000%
1.25	0.50	0.48	0.44	0.41	0.38	0.35	0.31	0.000%
1.5	0.60	0.58	0.53	0.50	0.46	0.42	0.38	0.000%
1.75	0.71	0.67	0.62	0.58	0.53	0.49	0.44	0.079%
2	0.81	0.77	0.71	0.66	0.61	0.56	0.50	0.476%
2.25	0.91	0.86	0.80	0.75	0.68	0.63	0.56	0.312%
2.5	1.01	0.96	0.89	0.83	0.76	0.702	0.63	0.127%
2.75	1.11	1.05	0.98	0.91	0.84	0.77	0.69	0.062%
3	1.21	1.15	1.07	1.00	0.91	0.84	0.75	0.010%
Total Percent Occurrence	0.138%	0.192%	0.472%	0.181%	0.034%	0.018%	0.001%	1.03%

【Peak Wave Period, Tp=20sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.09	0.09	0.08	0.07	0.06	0.06	0.05	0.000%
0.5	0.19	0.17	0.16	0.14	0.12	0.11	0.10	0.000%
0.75	0.28	0.26	0.24	0.20	0.18	0.17	0.15	0.000%
1	0.37	0.34	0.31	0.27	0.25	0.22	0.20	0.000%
1.25	0.47	0.43	0.39	0.34	0.31	0.28	0.25	0.000%
1.5	0.56	0.52	0.47	0.41	0.37	0.33	0.30	0.000%
1.75	0.66	0.60	0.55	0.47	0.43	0.39	0.35	0.000%
2	0.75	0.69	0.63	0.54	0.49	0.44	0.39	0.010%
2.25	0.84	0.78	0.71	0.61	0.55	0.50	0.44	0.052%
2.5	0.94	0.86	0.78	0.68	0.61	0.56	0.49	0.015%
2.75	1.03	0.95	0.86	0.74	0.67	0.61	0.54	0.007%
3	1.12	1.03	0.94	0.81	0.74	0.67	0.59	0.000%
Total Percent Occurrence	0.014%	0.019%	0.047%	0.003%	0.000%	0.000%	0.000%	0.08%

Table A.2.5.6 Wave Height and Total Percent Occurrence at Berth S2 in the case of Plan-A (units : m)

【Peak Wave Period, Tp=6sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.14	0.12	0.10	0.09	0.08	0.07	0.000%
0.5	0.00	0.28	0.24	0.20	0.17	0.16	0.14	0.000%
0.75	0.00	0.42	0.35	0.31	0.26	0.24	0.21	0.000%
1	0.00	0.57	0.47	0.41	0.34	0.32	0.28	0.000%
1.25	0.00	0.71	0.59	0.51	0.43	0.40	0.35	0.000%
1.5	0.00	0.85	0.71	0.61	0.51	0.48	0.42	0.101%
1.75	0.00	0.99	0.83	0.72	0.60	0.56	0.49	0.174%
2	0.00	1.13	0.94	0.82	0.68	0.64	0.56	0.311%
2.25	0.00	1.27	1.06	0.92	0.77	0.72	0.63	0.209%
2.5	0.00	1.41	1.18	1.02	0.85	0.80	0.697	0.090%
2.75	0.00	1.56	1.30	1.13	0.94	0.88	0.77	0.000%
3	0.00	1.70	1.42	1.23	1.02	0.96	0.84	0.000%
Total Percent Occurrence	0.000%	0.117%	0.334%	0.603%	0.116%	0.101%	0.017%	1.29%

【Peak Wave Period, Tp=8sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.11	0.09	0.08	0.08	0.07	0.06	0.000%
0.5	0.00	0.21	0.17	0.16	0.15	0.14	0.12	0.000%
0.75	0.00	0.32	0.26	0.24	0.23	0.21	0.18	0.000%
1	0.00	0.43	0.35	0.32	0.30	0.29	0.24	0.000%
1.25	0.00	0.53	0.44	0.40	0.38	0.36	0.30	0.000%
1.5	0.00	0.64	0.52	0.48	0.45	0.43	0.36	0.000%
1.75	0.00	0.75	0.61	0.55	0.53	0.50	0.42	0.011%
2	0.00	0.85	0.699	0.63	0.60	0.57	0.48	0.004%
2.25	0.00	0.96	0.79	0.71	0.68	0.64	0.54	0.006%
2.5	0.00	1.07	0.87	0.79	0.75	0.71	0.60	0.058%
2.75	0.00	1.17	0.96	0.87	0.83	0.79	0.66	0.049%
3	0.00	1.28	1.05	0.95	0.90	0.86	0.72	0.019%
Total Percent Occurrence	0.000%	0.029%	0.037%	0.034%	0.032%	0.016%	0.000%	0.15%

【Peak Wave Period, Tp=10sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.11	0.11	0.09	0.08	0.07	0.07	0.05	0.000%
0.5	0.22	0.21	0.19	0.16	0.14	0.13	0.10	0.000%
0.75	0.34	0.32	0.28	0.24	0.21	0.20	0.14	0.000%
1	0.45	0.43	0.37	0.31	0.28	0.27	0.19	0.000%
1.25	0.56	0.54	0.46	0.39	0.35	0.33	0.24	0.000%
1.5	0.67	0.64	0.56	0.47	0.42	0.40	0.29	0.000%
1.75	0.78	0.75	0.65	0.55	0.49	0.46	0.34	0.270%
2	0.89	0.86	0.74	0.63	0.56	0.53	0.38	0.107%
2.25	1.01	0.97	0.84	0.71	0.63	0.60	0.43	0.043%
2.5	1.12	1.07	0.93	0.78	0.70	0.66	0.48	0.000%
2.75	1.23	1.18	1.02	0.86	0.77	0.73	0.53	0.000%
3	1.34	1.29	1.11	0.94	0.84	0.80	0.58	0.000%
Total Percent Occurrence	0.106%	0.239%	0.064%	0.012%	0.000%	0.000%	0.000%	0.42%

【Peak Wave Period, Tp=12sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.11	0.10	0.09	0.08	0.08	0.07	0.06	0.000%
0.5	0.22	0.20	0.18	0.17	0.16	0.13	0.12	0.000%
0.75	0.33	0.30	0.28	0.25	0.23	0.20	0.18	0.000%
1	0.45	0.40	0.37	0.34	0.31	0.27	0.24	0.000%
1.25	0.56	0.50	0.46	0.42	0.39	0.33	0.30	0.000%
1.5	0.67	0.60	0.55	0.50	0.47	0.40	0.36	0.000%
1.75	0.78	0.697	0.64	0.59	0.54	0.46	0.42	0.524%
2	0.89	0.80	0.74	0.67	0.62	0.53	0.48	0.392%
2.25	1.00	0.90	0.83	0.76	0.701	0.60	0.53	0.090%
2.5	1.11	1.00	0.92	0.84	0.78	0.66	0.59	0.027%
2.75	1.23	1.10	1.01	0.93	0.86	0.73	0.654	0.000%
3	1.34	1.20	1.10	1.01	0.93	0.80	0.71	0.000%
Total Percent Occurrence	0.239%	0.549%	0.207%	0.035%	0.005%	0.000%	0.000%	1.03%

【Peak Wave Period, Tp=14sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.10	0.09	0.09	0.08	0.08	0.07	0.06	0.000%
0.5	0.19	0.18	0.18	0.17	0.16	0.13	0.12	0.000%
0.75	0.29	0.27	0.27	0.25	0.23	0.20	0.18	0.000%
1	0.39	0.36	0.36	0.33	0.31	0.26	0.24	0.000%
1.25	0.49	0.46	0.45	0.42	0.39	0.33	0.30	0.000%
1.5	0.58	0.55	0.54	0.50	0.47	0.40	0.36	0.000%
1.75	0.68	0.64	0.63	0.58	0.55	0.46	0.42	0.000%
2	0.78	0.73	0.72	0.67	0.62	0.53	0.48	0.067%
2.25	0.87	0.82	0.80	0.75	0.702	0.59	0.55	0.182%
2.5	0.97	0.91	0.89	0.83	0.78	0.66	0.61	0.068%
2.75	1.07	1.00	0.98	0.91	0.86	0.73	0.666	0.017%
3	1.16	1.09	1.07	1.00	0.94	0.79	0.73	0.000%
Total Percent Occurrence	0.093%	0.270%	0.447%	0.135%	0.104%	0.002%	0.000%	1.05%

【Peak Wave Period, Tp=16sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.13	0.11	0.10	0.09	0.08	0.07	0.06	0.000%
0.5	0.25	0.22	0.19	0.17	0.16	0.13	0.12	0.000%
0.75	0.38	0.34	0.29	0.26	0.24	0.20	0.17	0.000%
1	0.51	0.45	0.38	0.35	0.32	0.27	0.23	0.000%
1.25	0.64	0.56	0.48	0.43	0.40	0.33	0.29	0.000%
1.5	0.76	0.67	0.58	0.52	0.48	0.40	0.35	0.187%
1.75	0.89	0.79	0.67	0.61	0.56	0.47	0.41	0.563%
2	1.02	0.90	0.77	0.69	0.63	0.53	0.46	0.635%
2.25	1.14	1.01	0.86	0.78	0.71	0.60	0.52	0.528%
2.5	1.27	1.12	0.96	0.87	0.79	0.67	0.58	0.141%
2.75	1.40	1.23	1.06	0.95	0.87	0.74	0.638	0.030%
3	1.53	1.35	1.15	1.04	0.95	0.80	0.698	0.011%
Total Percent Occurrence	0.388%	0.718%	0.589%	0.233%	0.160%	0.004%	0.001%	2.09%

【Peak Wave Period, Tp=18sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.11	0.10	0.10	0.09	0.08	0.08	0.07	0.000%
0.5	0.21	0.21	0.19	0.18	0.17	0.15	0.14	0.000%
0.75	0.32	0.31	0.29	0.27	0.25	0.23	0.20	0.000%
1	0.43	0.42	0.38	0.36	0.34	0.30	0.27	0.000%
1.25	0.54	0.52	0.48	0.45	0.42	0.38	0.34	0.000%
1.5	0.64	0.63	0.57	0.55	0.50	0.46	0.41	0.000%
1.75	0.75	0.73	0.67	0.64	0.59	0.53	0.47	0.336%
2	0.86	0.84	0.77	0.73	0.67	0.61	0.54	2.528%
2.25	0.97	0.94	0.86	0.82	0.76	0.68	0.61	0.953%
2.5	1.07	1.05	0.96	0.91	0.84	0.76	0.68	0.127%
2.75	1.18	1.15	1.05	1.00	0.93	0.84	0.74	0.031%
3	1.29	1.26	1.15	1.09	1.01	0.91	0.81	0.010%
Total Percent Occurrence	0.138%	0.449%	0.472%	0.531%	0.126%	0.018%	0.002%	1.73%

【Peak Wave Period, Tp=20sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.11	0.11	0.10	0.08	0.07	0.07	0.06	0.000%
0.5	0.23	0.21	0.19	0.17	0.15	0.13	0.12	0.000%
0.75	0.34	0.32	0.29	0.25	0.22	0.20	0.17	0.000%
1	0.45	0.42	0.39	0.33	0.30	0.26	0.23	0.000%
1.25	0.57	0.53	0.48	0.42	0.37	0.33	0.29	0.000%
1.5	0.68	0.63	0.58	0.50	0.45	0.40	0.35	0.000%
1.75	0.79	0.74	0.68	0.58	0.52	0.46	0.40	0.108%
2	0.90	0.84	0.77	0.67	0.60	0.53	0.46	0.146%
2.25	1.02	0.95	0.87	0.75	0.67	0.59	0.52	0.098%
2.5	1.13	1.05	0.97	0.83	0.74	0.66	0.58	0.036%
2.75	1.24	1.16	1.06	0.92	0.82	0.73	0.63	0.010%
3	1.36	1.27	1.16	1.00	0.89	0.79	0.69	0.000%
Total Percent Occurrence	0.036%	0.144%	0.144%	0.061%	0.010%	0.001%	0.000%	0.40%

Table A.2.5.7 Wave Height and Total Percent Occurrence at Berth E1 in the case of Plan-A with a Breakwater (units : m)

【Peak Wave Period, Tp=6sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.03	0.03	0.03	0.03	0.02	0.02	0.000%
0.5	0.00	0.07	0.05	0.06	0.05	0.04	0.04	0.000%
0.75	0.00	0.10	0.08	0.09	0.08	0.06	0.05	0.000%
1	0.00	0.13	0.10	0.12	0.10	0.08	0.07	0.000%
1.25	0.00	0.16	0.13	0.15	0.13	0.10	0.09	0.000%
1.5	0.00	0.20	0.15	0.18	0.15	0.12	0.11	0.000%
1.75	0.00	0.23	0.18	0.20	0.18	0.14	0.13	0.000%
2	0.00	0.26	0.20	0.23	0.20	0.16	0.14	0.000%
2.25	0.00	0.30	0.23	0.26	0.23	0.18	0.16	0.000%
2.5	0.00	0.33	0.25	0.29	0.25	0.20	0.18	0.000%
2.75	0.00	0.36	0.28	0.32	0.28	0.22	0.20	0.000%
3	0.00	0.40	0.30	0.35	0.31	0.24	0.21	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=8sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.04	0.03	0.03	0.02	0.02	0.01	0.000%
0.5	0.00	0.07	0.06	0.06	0.05	0.04	0.03	0.000%
0.75	0.00	0.11	0.09	0.08	0.07	0.05	0.04	0.000%
1	0.00	0.14	0.12	0.11	0.09	0.07	0.05	0.000%
1.25	0.00	0.18	0.16	0.14	0.12	0.09	0.07	0.000%
1.5	0.00	0.21	0.19	0.17	0.14	0.11	0.08	0.000%
1.75	0.00	0.25	0.22	0.19	0.16	0.13	0.09	0.000%
2	0.00	0.28	0.25	0.22	0.19	0.14	0.11	0.000%
2.25	0.00	0.32	0.28	0.25	0.21	0.16	0.12	0.000%
2.5	0.00	0.35	0.31	0.28	0.23	0.18	0.13	0.000%
2.75	0.00	0.39	0.34	0.30	0.26	0.20	0.15	0.000%
3	0.00	0.42	0.37	0.33	0.28	0.22	0.16	0.000%
Total Percent Occurrence	0.00%	0.00%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=10sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.000%
0.5	0.09	0.08	0.07	0.06	0.05	0.05	0.04	0.000%
0.75	0.13	0.11	0.10	0.09	0.08	0.07	0.06	0.000%
1	0.17	0.15	0.14	0.12	0.10	0.10	0.08	0.000%
1.25	0.21	0.19	0.17	0.15	0.13	0.12	0.10	0.000%
1.5	0.26	0.23	0.20	0.18	0.16	0.15	0.12	0.000%
1.75	0.30	0.27	0.24	0.21	0.18	0.17	0.14	0.000%
2	0.34	0.31	0.27	0.24	0.21	0.20	0.16	0.000%
2.25	0.38	0.34	0.31	0.27	0.24	0.22	0.18	0.000%
2.5	0.43	0.38	0.34	0.30	0.26	0.25	0.21	0.000%
2.75	0.47	0.42	0.37	0.34	0.29	0.27	0.23	0.000%
3	0.51	0.46	0.41	0.37	0.31	0.30	0.25	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=12sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.000%
0.5	0.09	0.08	0.07	0.06	0.05	0.05	0.04	0.000%
0.75	0.13	0.11	0.10	0.09	0.08	0.07	0.07	0.000%
1	0.17	0.15	0.14	0.12	0.11	0.09	0.09	0.000%
1.25	0.22	0.19	0.17	0.15	0.13	0.11	0.11	0.000%
1.5	0.26	0.23	0.20	0.17	0.16	0.14	0.13	0.000%
1.75	0.30	0.28	0.24	0.20	0.19	0.16	0.15	0.000%
2	0.34	0.30	0.27	0.23	0.21	0.18	0.17	0.000%
2.25	0.39	0.34	0.31	0.26	0.24	0.20	0.20	0.000%
2.5	0.43	0.38	0.34	0.29	0.27	0.23	0.22	0.000%
2.75	0.47	0.42	0.38	0.32	0.29	0.25	0.24	0.000%
3	0.52	0.45	0.41	0.35	0.32	0.27	0.26	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=14sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.05	0.04	0.04	0.04	0.03	0.03	0.03	0.000%
0.5	0.10	0.09	0.08	0.07	0.07	0.05	0.05	0.000%
0.75	0.15	0.13	0.12	0.11	0.10	0.08	0.08	0.000%
1	0.19	0.18	0.16	0.14	0.13	0.11	0.10	0.000%
1.25	0.24	0.22	0.20	0.18	0.16	0.14	0.13	0.000%
1.5	0.29	0.26	0.24	0.22	0.20	0.16	0.15	0.000%
1.75	0.34	0.31	0.29	0.25	0.23	0.19	0.18	0.000%
2	0.39	0.35	0.33	0.29	0.26	0.22	0.20	0.000%
2.25	0.44	0.39	0.37	0.32	0.30	0.25	0.23	0.000%
2.5	0.49	0.44	0.41	0.36	0.33	0.27	0.25	0.000%
2.75	0.53	0.48	0.45	0.39	0.36	0.30	0.28	0.000%
3	0.58	0.53	0.49	0.43	0.39	0.33	0.30	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=16sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.05	0.05	0.04	0.04	0.03	0.03	0.03	0.000%
0.5	0.10	0.09	0.08	0.08	0.07	0.06	0.05	0.000%
0.75	0.16	0.14	0.12	0.11	0.10	0.09	0.08	0.000%
1	0.21	0.19	0.16	0.15	0.14	0.12	0.10	0.000%
1.25	0.26	0.23	0.21	0.19	0.17	0.14	0.13	0.000%
1.5	0.31	0.28	0.25	0.23	0.20	0.17	0.15	0.000%
1.75	0.37	0.33	0.29	0.26	0.24	0.20	0.18	0.000%
2	0.42	0.37	0.33	0.30	0.27	0.23	0.20	0.000%
2.25	0.47	0.42	0.37	0.34	0.31	0.26	0.23	0.000%
2.5	0.52	0.47	0.41	0.38	0.34	0.29	0.25	0.000%
2.75	0.58	0.51	0.45	0.41	0.37	0.32	0.28	0.000%
3	0.63	0.56	0.49	0.45	0.41	0.35	0.30	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=18sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.05	0.05	0.04	0.04	0.04	0.03	0.03	0.000%
0.5	0.11	0.10	0.09	0.08	0.07	0.06	0.06	0.000%
0.75	0.16	0.15	0.13	0.12	0.11	0.10	0.08	0.000%
1	0.22	0.20	0.18	0.16	0.15	0.13	0.11	0.000%
1.25	0.27	0.25	0.22	0.20	0.18	0.16	0.14	0.000%
1.5	0.33	0.30	0.27	0.24	0.22	0.19	0.17	0.000%
1.75	0.38	0.36	0.31	0.28	0.25	0.23	0.20	0.000%
2	0.44	0.41	0.36	0.32	0.29	0.26	0.23	0.000%
2.25	0.49	0.46	0.40	0.36	0.33	0.29	0.25	0.000%
2.5	0.55	0.51	0.45	0.40	0.36	0.32	0.28	0.000%
2.75	0.60	0.56	0.49	0.44	0.40	0.36	0.31	0.000%
3	0.66	0.61	0.54	0.49	0.44	0.39	0.34	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=20sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.06	0.05	0.05	0.04	0.04	0.03	0.03	0.000%
0.5	0.11	0.10	0.10	0.08	0.08	0.07	0.06	0.000%
0.75	0.17	0.16	0.14	0.13	0.11	0.10	0.09	0.000%
1	0.23	0.21	0.19	0.17	0.15	0.13	0.12	0.000%
1.25	0.28	0.26	0.24	0.21	0.19	0.17	0.15	0.000%
1.5	0.34	0.31	0.29	0.25	0.23	0.20	0.18	0.000%
1.75	0.40	0.37	0.34	0.29	0.26	0.23	0.21	0.000%
2	0.45	0.42	0.38	0.33	0.30	0.27	0.24	0.000%
2.25	0.51	0.47	0.43	0.38	0.34	0.30	0.27	0.000%
2.5	0.56	0.52	0.48	0.42	0.38	0.34	0.30	0.000%
2.75	0.62	0.57	0.53	0.46	0.41	0.37	0.32	0.000%
3	0.68	0.63	0.58	0.50	0.45	0.40	0.35	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

Table A.2.5.8 Wave Height and Total Percent Occurrence at Berth E2 in the case of Plan-A with a Breakwater (units : m)

【Peak Wave Period, Tp=6sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.03	0.02	0.02	0.03	0.02	0.02	0.000%
0.5	0.00	0.07	0.04	0.05	0.05	0.04	0.04	0.000%
0.75	0.00	0.10	0.07	0.07	0.08	0.06	0.06	0.000%
1	0.00	0.13	0.09	0.09	0.10	0.08	0.08	0.000%
1.25	0.00	0.16	0.11	0.12	0.13	0.10	0.10	0.000%
1.5	0.00	0.20	0.13	0.14	0.15	0.12	0.12	0.000%
1.75	0.00	0.23	0.16	0.16	0.18	0.14	0.14	0.000%
2	0.00	0.26	0.18	0.19	0.20	0.16	0.16	0.000%
2.25	0.00	0.30	0.20	0.21	0.23	0.18	0.18	0.000%
2.5	0.00	0.33	0.22	0.23	0.25	0.20	0.20	0.000%
2.75	0.00	0.36	0.24	0.26	0.28	0.22	0.22	0.000%
3	0.00	0.40	0.27	0.28	0.30	0.24	0.24	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=8sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.03	0.02	0.02	0.01	0.01	0.01	0.000%
0.5	0.00	0.06	0.04	0.04	0.03	0.02	0.02	0.000%
0.75	0.00	0.09	0.07	0.05	0.04	0.03	0.03	0.000%
1	0.00	0.12	0.09	0.07	0.05	0.04	0.04	0.000%
1.25	0.00	0.15	0.11	0.09	0.07	0.05	0.05	0.000%
1.5	0.00	0.17	0.13	0.11	0.08	0.06	0.06	0.000%
1.75	0.00	0.20	0.15	0.12	0.09	0.07	0.07	0.000%
2	0.00	0.23	0.18	0.14	0.11	0.08	0.08	0.000%
2.25	0.00	0.26	0.20	0.16	0.12	0.09	0.09	0.000%
2.5	0.00	0.29	0.22	0.18	0.13	0.10	0.10	0.000%
2.75	0.00	0.32	0.24	0.20	0.15	0.11	0.11	0.000%
3	0.00	0.35	0.27	0.21	0.16	0.12	0.12	0.000%
Total Percent Occurrence	0.00%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=10sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.04	0.03	0.03	0.03	0.02	0.02	0.01	0.000%
0.5	0.08	0.07	0.06	0.05	0.04	0.04	0.03	0.000%
0.75	0.12	0.10	0.10	0.08	0.07	0.06	0.04	0.000%
1	0.16	0.14	0.13	0.11	0.09	0.08	0.06	0.000%
1.25	0.21	0.17	0.16	0.13	0.11	0.10	0.07	0.000%
1.5	0.25	0.21	0.19	0.16	0.13	0.12	0.09	0.000%
1.75	0.29	0.24	0.22	0.19	0.15	0.14	0.10	0.000%
2	0.33	0.28	0.26	0.22	0.18	0.16	0.12	0.000%
2.25	0.37	0.31	0.29	0.24	0.20	0.17	0.13	0.000%
2.5	0.41	0.35	0.32	0.27	0.22	0.19	0.15	0.000%
2.75	0.45	0.38	0.35	0.30	0.24	0.21	0.16	0.000%
3	0.49	0.42	0.39	0.32	0.27	0.23	0.18	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=12sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.000%
0.5	0.08	0.07	0.07	0.06	0.05	0.05	0.04	0.000%
0.75	0.13	0.11	0.10	0.09	0.08	0.07	0.06	0.000%
1	0.17	0.15	0.13	0.12	0.11	0.09	0.09	0.000%
1.25	0.21	0.19	0.17	0.15	0.14	0.11	0.11	0.000%
1.5	0.25	0.22	0.20	0.18	0.16	0.14	0.13	0.000%
1.75	0.29	0.26	0.24	0.21	0.19	0.16	0.15	0.000%
2	0.34	0.30	0.27	0.24	0.22	0.18	0.17	0.000%
2.25	0.38	0.33	0.30	0.27	0.24	0.21	0.19	0.000%
2.5	0.42	0.37	0.34	0.29	0.27	0.23	0.22	0.000%
2.75	0.46	0.41	0.37	0.32	0.30	0.25	0.24	0.000%
3	0.50	0.45	0.40	0.35	0.32	0.27	0.26	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=14sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.05	0.04	0.04	0.03	0.03	0.03	0.02	0.000%
0.5	0.10	0.08	0.08	0.07	0.06	0.05	0.05	0.000%
0.75	0.14	0.13	0.12	0.10	0.09	0.08	0.07	0.000%
1	0.19	0.17	0.16	0.13	0.12	0.10	0.09	0.000%
1.25	0.24	0.21	0.19	0.17	0.15	0.13	0.12	0.000%
1.5	0.29	0.25	0.23	0.20	0.18	0.15	0.14	0.000%
1.75	0.33	0.30	0.27	0.23	0.21	0.18	0.17	0.000%
2	0.38	0.34	0.31	0.27	0.24	0.20	0.19	0.000%
2.25	0.43	0.38	0.35	0.30	0.27	0.23	0.21	0.000%
2.5	0.48	0.42	0.39	0.33	0.30	0.25	0.24	0.000%
2.75	0.52	0.47	0.43	0.37	0.33	0.28	0.26	0.000%
3	0.57	0.51	0.47	0.40	0.36	0.30	0.28	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=16sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.05	0.05	0.04	0.04	0.03	0.03	0.02	0.000%
0.5	0.10	0.09	0.08	0.07	0.07	0.05	0.05	0.000%
0.75	0.15	0.14	0.12	0.11	0.10	0.08	0.07	0.000%
1	0.20	0.18	0.16	0.15	0.13	0.11	0.10	0.000%
1.25	0.25	0.23	0.20	0.18	0.16	0.14	0.12	0.000%
1.5	0.30	0.27	0.24	0.22	0.20	0.16	0.14	0.000%
1.75	0.35	0.32	0.28	0.25	0.23	0.19	0.17	0.000%
2	0.40	0.36	0.32	0.29	0.26	0.22	0.19	0.000%
2.25	0.45	0.41	0.36	0.33	0.29	0.25	0.21	0.000%
2.5	0.50	0.45	0.40	0.36	0.33	0.27	0.24	0.000%
2.75	0.55	0.50	0.44	0.40	0.36	0.30	0.26	0.000%
3	0.60	0.54	0.48	0.44	0.39	0.33	0.29	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=18sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.05	0.05	0.04	0.04	0.03	0.03	0.03	0.000%
0.5	0.10	0.09	0.08	0.08	0.07	0.06	0.06	0.000%
0.75	0.15	0.14	0.12	0.11	0.10	0.09	0.08	0.000%
1	0.20	0.18	0.16	0.15	0.14	0.12	0.11	0.000%
1.25	0.25	0.23	0.20	0.19	0.17	0.16	0.14	0.000%
1.5	0.29	0.27	0.25	0.23	0.21	0.19	0.17	0.000%
1.75	0.34	0.32	0.29	0.26	0.24	0.22	0.19	0.000%
2	0.39	0.37	0.33	0.30	0.28	0.25	0.22	0.000%
2.25	0.44	0.41	0.37	0.34	0.31	0.28	0.25	0.000%
2.5	0.49	0.46	0.41	0.38	0.35	0.31	0.28	0.000%
2.75	0.54	0.50	0.45	0.42	0.38	0.34	0.30	0.000%
3	0.59	0.55	0.49	0.45	0.41	0.37	0.33	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=20sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.05	0.05	0.04	0.04	0.03	0.03	0.03	0.000%
0.5	0.10	0.10	0.09	0.08	0.07	0.06	0.05	0.000%
0.75	0.15	0.14	0.13	0.12	0.10	0.09	0.08	0.000%
1	0.21	0.19	0.18	0.15	0.14	0.12	0.11	0.000%
1.25	0.26	0.24	0.22	0.19	0.17	0.15	0.14	0.000%
1.5	0.31	0.29	0.26	0.23	0.21	0.18	0.16	0.000%
1.75	0.36	0.33	0.31	0.27	0.24	0.22	0.19	0.000%
2	0.41	0.38	0.35	0.31	0.28	0.25	0.22	0.000%
2.25	0.46	0.43	0.39	0.35	0.31	0.28	0.25	0.000%
2.5	0.52	0.48	0.44	0.38	0.35	0.31	0.27	0.000%
2.75	0.57	0.52	0.48	0.42	0.38	0.34	0.30	0.000%
3	0.62	0.57	0.53	0.46	0.41	0.37	0.33	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

Table A.2.5.9 Wave Height and Total Percent Occurrence at Berth E3 in the case of Plan-A with a Breakwater (units : m)

【Peak Wave Period, Tp=6sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.02	0.02	0.01	0.02	0.03	0.02	0.000%
0.5	0.00	0.03	0.03	0.03	0.04	0.05	0.03	0.000%
0.75	0.00	0.05	0.05	0.04	0.06	0.08	0.05	0.000%
1	0.00	0.06	0.07	0.05	0.08	0.11	0.07	0.000%
1.25	0.00	0.08	0.08	0.06	0.11	0.13	0.08	0.000%
1.5	0.00	0.09	0.10	0.08	0.13	0.16	0.10	0.000%
1.75	0.00	0.11	0.11	0.09	0.15	0.18	0.12	0.000%
2	0.00	0.12	0.13	0.10	0.17	0.21	0.14	0.000%
2.25	0.00	0.14	0.15	0.11	0.19	0.24	0.16	0.000%
2.5	0.00	0.15	0.16	0.13	0.21	0.26	0.17	0.000%
2.75	0.00	0.17	0.18	0.14	0.23	0.29	0.19	0.000%
3	0.00	0.18	0.20	0.15	0.25	0.32	0.21	0.000%
Total Percent Occurrence	0.00%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=8sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.000%
0.5	0.00	0.03	0.02	0.02	0.01	0.01	0.01	0.000%
0.75	0.00	0.04	0.03	0.03	0.02	0.02	0.02	0.000%
1	0.00	0.06	0.04	0.03	0.03	0.03	0.03	0.000%
1.25	0.00	0.07	0.05	0.04	0.04	0.03	0.03	0.000%
1.5	0.00	0.08	0.07	0.05	0.04	0.04	0.04	0.000%
1.75	0.00	0.10	0.08	0.06	0.05	0.05	0.04	0.000%
2	0.00	0.11	0.09	0.07	0.06	0.05	0.05	0.000%
2.25	0.00	0.12	0.10	0.08	0.07	0.06	0.06	0.000%
2.5	0.00	0.14	0.11	0.09	0.07	0.07	0.06	0.000%
2.75	0.00	0.15	0.12	0.10	0.08	0.07	0.07	0.000%
3	0.00	0.17	0.13	0.10	0.09	0.08	0.08	0.000%
Total Percent Occurrence	0.00%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=10sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.000%
0.5	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.000%
0.75	0.08	0.06	0.05	0.04	0.03	0.03	0.02	0.000%
1	0.10	0.08	0.06	0.05	0.04	0.04	0.03	0.000%
1.25	0.13	0.10	0.08	0.07	0.05	0.05	0.04	0.000%
1.5	0.15	0.12	0.10	0.08	0.07	0.06	0.05	0.000%
1.75	0.18	0.14	0.11	0.09	0.08	0.07	0.05	0.000%
2	0.20	0.16	0.13	0.11	0.09	0.08	0.06	0.000%
2.25	0.23	0.17	0.14	0.12	0.10	0.09	0.07	0.000%
2.5	0.25	0.19	0.16	0.13	0.11	0.10	0.08	0.000%
2.75	0.28	0.21	0.17	0.15	0.12	0.11	0.08	0.000%
3	0.30	0.23	0.19	0.16	0.13	0.12	0.09	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=12sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.03	0.03	0.03	0.02	0.02	0.01	0.01	0.000%
0.5	0.07	0.06	0.05	0.04	0.04	0.03	0.02	0.000%
0.75	0.10	0.09	0.08	0.07	0.05	0.04	0.04	0.000%
1	0.13	0.11	0.10	0.09	0.07	0.06	0.05	0.000%
1.25	0.17	0.14	0.13	0.11	0.09	0.07	0.06	0.000%
1.5	0.20	0.17	0.16	0.13	0.11	0.09	0.07	0.000%
1.75	0.23	0.20	0.18	0.15	0.13	0.10	0.09	0.000%
2	0.27	0.23	0.21	0.18	0.14	0.12	0.10	0.000%
2.25	0.30	0.26	0.23	0.20	0.16	0.13	0.11	0.000%
2.5	0.33	0.28	0.26	0.22	0.18	0.15	0.12	0.000%
2.75	0.36	0.31	0.29	0.24	0.20	0.16	0.14	0.000%
3	0.40	0.34	0.31	0.26	0.21	0.18	0.15	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=14sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.000%
0.5	0.08	0.07	0.07	0.06	0.05	0.04	0.04	0.000%
0.75	0.12	0.11	0.10	0.09	0.08	0.07	0.06	0.000%
1	0.16	0.14	0.13	0.12	0.10	0.09	0.08	0.000%
1.25	0.20	0.18	0.17	0.15	0.13	0.11	0.10	0.000%
1.5	0.24	0.21	0.20	0.18	0.16	0.13	0.12	0.000%
1.75	0.28	0.25	0.23	0.20	0.18	0.15	0.14	0.000%
2	0.32	0.29	0.26	0.23	0.21	0.17	0.16	0.000%
2.25	0.36	0.32	0.30	0.26	0.24	0.20	0.18	0.000%
2.5	0.40	0.36	0.33	0.29	0.26	0.22	0.20	0.000%
2.75	0.44	0.39	0.38	0.32	0.29	0.24	0.22	0.000%
3	0.48	0.43	0.40	0.35	0.31	0.26	0.24	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=16sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.05	0.04	0.03	0.03	0.03	0.02	0.02	0.000%
0.5	0.09	0.08	0.07	0.06	0.06	0.05	0.04	0.000%
0.75	0.14	0.12	0.10	0.09	0.08	0.07	0.06	0.000%
1	0.18	0.16	0.14	0.12	0.11	0.09	0.08	0.000%
1.25	0.23	0.20	0.17	0.16	0.14	0.12	0.10	0.000%
1.5	0.27	0.24	0.21	0.19	0.17	0.14	0.12	0.000%
1.75	0.32	0.28	0.24	0.22	0.19	0.16	0.14	0.000%
2	0.36	0.32	0.28	0.25	0.22	0.18	0.16	0.000%
2.25	0.41	0.36	0.31	0.28	0.25	0.21	0.18	0.000%
2.5	0.45	0.40	0.35	0.31	0.28	0.23	0.20	0.000%
2.75	0.50	0.44	0.38	0.34	0.30	0.25	0.22	0.000%
3	0.54	0.48	0.42	0.37	0.33	0.28	0.24	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=18sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.05	0.05	0.04	0.04	0.03	0.03	0.02	0.000%
0.5	0.10	0.09	0.08	0.07	0.06	0.06	0.05	0.000%
0.75	0.15	0.14	0.12	0.11	0.10	0.09	0.07	0.000%
1	0.19	0.18	0.16	0.14	0.13	0.11	0.10	0.000%
1.25	0.24	0.23	0.20	0.18	0.16	0.14	0.12	0.000%
1.5	0.29	0.27	0.24	0.22	0.19	0.17	0.15	0.000%
1.75	0.34	0.32	0.28	0.25	0.23	0.20	0.17	0.000%
2	0.39	0.36	0.32	0.29	0.26	0.23	0.20	0.000%
2.25	0.44	0.41	0.36	0.32	0.29	0.26	0.22	0.000%
2.5	0.49	0.45	0.40	0.36	0.32	0.28	0.25	0.000%
2.75	0.54	0.50	0.44	0.39	0.35	0.31	0.27	0.000%
3	0.58	0.54	0.48	0.43	0.39	0.34	0.30	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=20sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.05	0.05	0.04	0.04	0.03	0.03	0.03	0.000%
0.5	0.10	0.09	0.09	0.08	0.07	0.06	0.05	0.000%
0.75	0.15	0.14	0.13	0.11	0.10	0.09	0.08	0.000%
1	0.20	0.19	0.18	0.15	0.14	0.12	0.11	0.000%
1.25	0.25	0.24	0.22	0.19	0.17	0.15	0.13	0.000%
1.5	0.31	0.28	0.26	0.23	0.20	0.18	0.16	0.000%
1.75	0.36	0.33	0.31	0.27	0.24	0.21	0.19	0.000%
2	0.41	0.38	0.35	0.30	0.27	0.24	0.22	0.000%
2.25	0.46	0.43	0.39	0.34	0.31	0.27	0.24	0.000%
2.5	0.51	0.47	0.44	0.38	0.34	0.30	0.27	0.000%
2.75	0.56	0.52	0.48	0.42	0.37	0.33	0.30	0.000%
3	0.61	0.57	0.53	0.46	0.41	0.36	0.32	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

Table A.2.5.10 Wave Height and Total Percent Occurrence at Berth E4 in the case of Plan-A with a Breakwater (units : m)

【Peak Wave Period, Tp=6sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.02	0.03	0.03	0.02	0.03	0.03	0.000%
0.5	0.00	0.03	0.05	0.06	0.04	0.05	0.07	0.000%
0.75	0.00	0.05	0.08	0.09	0.06	0.08	0.10	0.000%
1	0.00	0.06	0.10	0.12	0.08	0.11	0.14	0.000%
1.25	0.00	0.08	0.13	0.15	0.09	0.13	0.17	0.000%
1.5	0.00	0.10	0.15	0.18	0.11	0.16	0.21	0.000%
1.75	0.00	0.11	0.18	0.21	0.13	0.19	0.24	0.000%
2	0.00	0.13	0.21	0.24	0.15	0.21	0.28	0.000%
2.25	0.00	0.14	0.23	0.26	0.17	0.24	0.31	0.000%
2.5	0.00	0.16	0.26	0.29	0.19	0.27	0.34	0.000%
2.75	0.00	0.18	0.28	0.32	0.21	0.29	0.38	0.000%
3	0.00	0.19	0.31	0.35	0.23	0.32	0.41	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=8sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.02	0.01	0.01	0.01	0.01	0.01	0.000%
0.5	0.00	0.03	0.03	0.02	0.02	0.03	0.03	0.000%
0.75	0.00	0.05	0.04	0.03	0.04	0.04	0.04	0.000%
1	0.00	0.06	0.05	0.04	0.05	0.05	0.06	0.000%
1.25	0.00	0.08	0.06	0.05	0.06	0.07	0.07	0.000%
1.5	0.00	0.10	0.08	0.06	0.07	0.08	0.08	0.000%
1.75	0.00	0.11	0.09	0.07	0.08	0.09	0.10	0.000%
2	0.00	0.13	0.10	0.08	0.10	0.11	0.11	0.000%
2.25	0.00	0.15	0.12	0.09	0.11	0.12	0.13	0.000%
2.5	0.00	0.16	0.13	0.10	0.12	0.13	0.14	0.000%
2.75	0.00	0.18	0.14	0.11	0.13	0.15	0.15	0.000%
3	0.00	0.19	0.16	0.12	0.14	0.16	0.17	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=10sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.000%
0.5	0.03	0.02	0.02	0.02	0.03	0.03	0.03	0.000%
0.75	0.04	0.03	0.03	0.03	0.04	0.05	0.05	0.000%
1	0.05	0.04	0.04	0.05	0.05	0.07	0.07	0.000%
1.25	0.06	0.05	0.06	0.06	0.06	0.08	0.08	0.000%
1.5	0.08	0.07	0.07	0.07	0.08	0.10	0.10	0.000%
1.75	0.09	0.08	0.08	0.08	0.09	0.12	0.12	0.000%
2	0.10	0.09	0.09	0.09	0.10	0.13	0.14	0.000%
2.25	0.12	0.10	0.10	0.10	0.11	0.15	0.15	0.000%
2.5	0.13	0.11	0.11	0.11	0.13	0.17	0.17	0.000%
2.75	0.14	0.12	0.12	0.13	0.14	0.18	0.19	0.000%
3	0.16	0.13	0.13	0.14	0.15	0.20	0.20	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=12sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.000%
0.5	0.04	0.03	0.03	0.02	0.02	0.02	0.02	0.000%
0.75	0.06	0.05	0.04	0.03	0.03	0.03	0.03	0.000%
1	0.08	0.07	0.05	0.04	0.04	0.03	0.03	0.000%
1.25	0.10	0.08	0.07	0.05	0.05	0.04	0.04	0.000%
1.5	0.12	0.10	0.08	0.06	0.06	0.05	0.05	0.000%
1.75	0.13	0.12	0.10	0.07	0.07	0.06	0.06	0.000%
2	0.15	0.13	0.11	0.09	0.08	0.07	0.07	0.000%
2.25	0.17	0.15	0.12	0.10	0.09	0.08	0.08	0.000%
2.5	0.19	0.17	0.14	0.11	0.10	0.09	0.09	0.000%
2.75	0.21	0.18	0.15	0.12	0.11	0.09	0.09	0.000%
3	0.23	0.20	0.16	0.13	0.12	0.10	0.10	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=14sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.000%
0.5	0.06	0.05	0.05	0.04	0.03	0.03	0.02	0.000%
0.75	0.09	0.08	0.07	0.06	0.05	0.04	0.03	0.000%
1	0.12	0.11	0.10	0.08	0.07	0.05	0.04	0.000%
1.25	0.15	0.13	0.12	0.10	0.08	0.07	0.06	0.000%
1.5	0.18	0.16	0.14	0.12	0.10	0.08	0.07	0.000%
1.75	0.21	0.19	0.17	0.14	0.12	0.09	0.08	0.000%
2	0.24	0.22	0.19	0.16	0.14	0.11	0.09	0.000%
2.25	0.27	0.24	0.21	0.18	0.16	0.12	0.10	0.000%
2.5	0.30	0.27	0.24	0.20	0.17	0.13	0.11	0.000%
2.75	0.33	0.30	0.26	0.22	0.19	0.14	0.12	0.000%
3	0.36	0.32	0.28	0.24	0.21	0.16	0.13	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=16sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.000%
0.5	0.06	0.06	0.05	0.05	0.04	0.03	0.03	0.000%
0.75	0.10	0.09	0.08	0.07	0.06	0.05	0.05	0.000%
1	0.13	0.12	0.10	0.09	0.08	0.07	0.06	0.000%
1.25	0.16	0.14	0.13	0.12	0.10	0.09	0.08	0.000%
1.5	0.19	0.17	0.16	0.14	0.13	0.10	0.09	0.000%
1.75	0.22	0.20	0.18	0.16	0.15	0.12	0.11	0.000%
2	0.26	0.23	0.21	0.19	0.17	0.14	0.12	0.000%
2.25	0.29	0.26	0.23	0.21	0.19	0.16	0.14	0.000%
2.5	0.32	0.29	0.26	0.24	0.21	0.17	0.15	0.000%
2.75	0.35	0.32	0.29	0.26	0.23	0.19	0.17	0.000%
3	0.39	0.35	0.31	0.28	0.25	0.21	0.18	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=18sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.04	0.03	0.03	0.03	0.02	0.02	0.02	0.000%
0.5	0.08	0.07	0.06	0.05	0.05	0.04	0.03	0.000%
0.75	0.11	0.10	0.09	0.08	0.07	0.06	0.05	0.000%
1	0.15	0.14	0.12	0.11	0.09	0.08	0.07	0.000%
1.25	0.19	0.17	0.15	0.13	0.11	0.10	0.08	0.000%
1.5	0.23	0.21	0.18	0.16	0.14	0.12	0.10	0.000%
1.75	0.26	0.24	0.21	0.19	0.16	0.14	0.12	0.000%
2	0.30	0.28	0.24	0.22	0.18	0.16	0.14	0.000%
2.25	0.34	0.31	0.27	0.24	0.21	0.18	0.15	0.000%
2.5	0.38	0.35	0.30	0.27	0.23	0.19	0.17	0.000%
2.75	0.41	0.38	0.33	0.30	0.25	0.21	0.19	0.000%
3	0.45	0.42	0.36	0.32	0.28	0.234	0.20	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=20sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.000%
0.5	0.08	0.07	0.07	0.06	0.05	0.05	0.04	0.000%
0.75	0.12	0.11	0.10	0.09	0.08	0.07	0.06	0.000%
1	0.16	0.15	0.13	0.11	0.10	0.09	0.08	0.000%
1.25	0.20	0.19	0.17	0.14	0.13	0.12	0.10	0.000%
1.5	0.24	0.22	0.20	0.17	0.15	0.14	0.12	0.000%
1.75	0.28	0.26	0.23	0.20	0.18	0.16	0.14	0.000%
2	0.33	0.30	0.27	0.23	0.21	0.18	0.16	0.000%
2.25	0.37	0.33	0.30	0.26	0.23	0.21	0.18	0.000%
2.5	0.41	0.37	0.33	0.29	0.26	0.23	0.20	0.000%
2.75	0.45	0.41	0.37	0.32	0.28	0.25	0.22	0.000%
3	0.49	0.44	0.40	0.34	0.31	0.28	0.24	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

Table A.2.5.11 Wave Height and Total Percent Occurrence at Berth S1 in the case of Plan-A with a Breakwater (units : m)

【Peak Wave Period, Tp=6sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.01	0.00	0.00	0.00	0.02	0.01	0.000%
0.5	0.00	0.01	0.01	0.01	0.01	0.03	0.02	0.000%
0.75	0.00	0.02	0.01	0.01	0.01	0.05	0.03	0.000%
1	0.00	0.02	0.02	0.01	0.02	0.07	0.03	0.000%
1.25	0.00	0.03	0.02	0.01	0.02	0.08	0.04	0.000%
1.5	0.00	0.03	0.02	0.02	0.03	0.10	0.05	0.000%
1.75	0.00	0.04	0.03	0.02	0.03	0.12	0.06	0.000%
2	0.00	0.04	0.03	0.02	0.04	0.13	0.07	0.000%
2.25	0.00	0.05	0.04	0.03	0.04	0.15	0.08	0.000%
2.5	0.00	0.05	0.04	0.03	0.05	0.17	0.09	0.000%
2.75	0.00	0.06	0.05	0.03	0.05	0.18	0.09	0.000%
3	0.00	0.06	0.05	0.03	0.06	0.20	0.10	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=8sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.5	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.000%
0.75	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.000%
1	0.00	0.02	0.01	0.02	0.01	0.01	0.01	0.000%
1.25	0.00	0.02	0.02	0.02	0.01	0.01	0.01	0.000%
1.5	0.00	0.03	0.02	0.02	0.02	0.02	0.01	0.000%
1.75	0.00	0.03	0.02	0.03	0.02	0.02	0.01	0.000%
2	0.00	0.03	0.03	0.03	0.02	0.02	0.01	0.000%
2.25	0.00	0.04	0.03	0.03	0.03	0.02	0.02	0.000%
2.5	0.00	0.04	0.03	0.04	0.03	0.03	0.02	0.000%
2.75	0.00	0.05	0.04	0.04	0.03	0.03	0.02	0.000%
3	0.00	0.05	0.04	0.05	0.04	0.03	0.02	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=10sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.000%
0.5	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.000%
0.75	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.000%
1	0.03	0.02	0.02	0.02	0.02	0.01	0.01	0.000%
1.25	0.04	0.03	0.02	0.02	0.02	0.02	0.01	0.000%
1.5	0.04	0.04	0.03	0.02	0.02	0.02	0.02	0.000%
1.75	0.05	0.04	0.03	0.03	0.03	0.02	0.02	0.000%
2	0.06	0.05	0.04	0.03	0.03	0.03	0.02	0.000%
2.25	0.07	0.05	0.04	0.04	0.03	0.03	0.02	0.000%
2.5	0.07	0.06	0.04	0.04	0.04	0.03	0.03	0.000%
2.75	0.08	0.07	0.05	0.04	0.04	0.04	0.03	0.000%
3	0.09	0.07	0.05	0.05	0.05	0.04	0.03	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=12sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.000%
0.5	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.000%
0.75	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.000%
1	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.000%
1.25	0.04	0.03	0.03	0.03	0.03	0.02	0.02	0.000%
1.5	0.04	0.04	0.04	0.03	0.03	0.03	0.02	0.000%
1.75	0.05	0.05	0.04	0.04	0.04	0.03	0.03	0.000%
2	0.06	0.06	0.05	0.04	0.04	0.04	0.03	0.000%
2.25	0.07	0.06	0.05	0.05	0.05	0.04	0.03	0.000%
2.5	0.07	0.07	0.06	0.06	0.06	0.05	0.04	0.000%
2.75	0.08	0.08	0.07	0.06	0.06	0.05	0.04	0.000%
3	0.09	0.08	0.07	0.07	0.07	0.06	0.05	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=14sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.000%
0.5	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.000%
0.75	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.000%
1	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.000%
1.25	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.000%
1.5	0.05	0.04	0.04	0.03	0.03	0.03	0.03	0.000%
1.75	0.05	0.05	0.05	0.04	0.04	0.03	0.03	0.000%
2	0.06	0.06	0.05	0.04	0.04	0.04	0.03	0.000%
2.25	0.07	0.06	0.06	0.05	0.05	0.04	0.04	0.000%
2.5	0.08	0.07	0.07	0.06	0.05	0.04	0.04	0.000%
2.75	0.08	0.08	0.07	0.06	0.06	0.05	0.05	0.000%
3	0.09	0.09	0.08	0.07	0.06	0.05	0.05	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=16sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.000%
0.5	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.000%
0.75	0.03	0.03	0.03	0.02	0.02	0.02	0.01	0.000%
1	0.05	0.04	0.03	0.03	0.03	0.02	0.02	0.000%
1.25	0.06	0.05	0.04	0.04	0.03	0.03	0.02	0.000%
1.5	0.07	0.06	0.05	0.05	0.04	0.03	0.03	0.000%
1.75	0.08	0.07	0.06	0.05	0.05	0.04	0.03	0.000%
2	0.09	0.08	0.07	0.06	0.05	0.04	0.03	0.000%
2.25	0.10	0.09	0.08	0.07	0.06	0.05	0.04	0.000%
2.5	0.11	0.10	0.09	0.08	0.07	0.05	0.04	0.000%
2.75	0.12	0.11	0.09	0.08	0.08	0.06	0.05	0.000%
3	0.14	0.12	0.10	0.09	0.08	0.06	0.051	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=18sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.000%
0.5	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.000%
0.75	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.000%
1	0.04	0.04	0.03	0.03	0.02	0.02	0.02	0.000%
1.25	0.05	0.04	0.04	0.03	0.03	0.03	0.03	0.000%
1.5	0.06	0.05	0.04	0.04	0.04	0.03	0.03	0.000%
1.75	0.07	0.06	0.05	0.05	0.04	0.04	0.04	0.000%
2	0.08	0.07	0.06	0.05	0.05	0.04	0.04	0.000%
2.25	0.09	0.08	0.07	0.06	0.06	0.05	0.05	0.000%
2.5	0.10	0.09	0.07	0.06	0.06	0.05	0.05	0.000%
2.75	0.11	0.10	0.08	0.07	0.07	0.06	0.06	0.000%
3	0.12	0.11	0.09	0.08	0.07	0.06	0.06	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=20sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.000%
0.5	0.03	0.02	0.02	0.02	0.02	0.01	0.01	0.000%
0.75	0.04	0.03	0.03	0.03	0.02	0.02	0.02	0.000%
1	0.05	0.05	0.04	0.03	0.03	0.03	0.02	0.000%
1.25	0.06	0.06	0.05	0.04	0.04	0.03	0.03	0.000%
1.5	0.08	0.07	0.06	0.05	0.05	0.04	0.04	0.000%
1.75	0.09	0.08	0.07	0.06	0.05	0.05	0.04	0.000%
2	0.10	0.09	0.08	0.07	0.06	0.05	0.05	0.000%
2.25	0.12	0.10	0.09	0.08	0.07	0.06	0.05	0.000%
2.5	0.13	0.11	0.10	0.08	0.08	0.07	0.06	0.000%
2.75	0.14	0.12	0.11	0.09	0.08	0.07	0.07	0.000%
3	0.16	0.14	0.12	0.10	0.09	0.08	0.07	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

Table A.2.5.12 Wave Height and Total Percent Occurrence at Berth S2 in the case of Plan-A with a Breakwater (units : m)

[Peak Wave Period, Tp=6sec]

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.01	0.01	0.00	0.00	0.01	0.02	0.000%
0.5	0.00	0.02	0.02	0.01	0.01	0.01	0.04	0.000%
0.75	0.00	0.03	0.03	0.01	0.01	0.02	0.06	0.000%
1	0.00	0.04	0.04	0.02	0.02	0.02	0.08	0.000%
1.25	0.00	0.05	0.04	0.02	0.02	0.03	0.10	0.000%
1.5	0.00	0.06	0.05	0.02	0.03	0.04	0.12	0.000%
1.75	0.00	0.07	0.06	0.03	0.03	0.04	0.14	0.000%
2	0.00	0.08	0.07	0.03	0.04	0.05	0.16	0.000%
2.25	0.00	0.09	0.08	0.04	0.04	0.06	0.18	0.000%
2.5	0.00	0.10	0.09	0.04	0.05	0.06	0.20	0.000%
2.75	0.00	0.11	0.10	0.05	0.05	0.07	0.22	0.000%
3	0.00	0.12	0.11	0.05	0.06	0.07	0.24	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

[Peak Wave Period, Tp=8sec]

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.000%
0.5	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.000%
0.75	0.00	0.01	0.01	0.01	0.02	0.01	0.01	0.000%
1	0.00	0.02	0.01	0.02	0.02	0.02	0.01	0.000%
1.25	0.00	0.02	0.02	0.02	0.03	0.02	0.01	0.000%
1.5	0.00	0.03	0.02	0.03	0.03	0.03	0.02	0.000%
1.75	0.00	0.03	0.03	0.03	0.04	0.03	0.02	0.000%
2	0.00	0.04	0.03	0.04	0.04	0.04	0.02	0.000%
2.25	0.00	0.04	0.03	0.04	0.05	0.04	0.03	0.000%
2.5	0.00	0.04	0.04	0.05	0.06	0.05	0.03	0.000%
2.75	0.00	0.05	0.04	0.05	0.06	0.05	0.03	0.000%
3	0.00	0.05	0.04	0.06	0.07	0.06	0.03	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

[Peak Wave Period, Tp=10sec]

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.01	0.01	0.00	0.00	0.01	0.01	0.00	0.000%
0.5	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.000%
0.75	0.02	0.02	0.01	0.01	0.02	0.02	0.01	0.000%
1	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.000%
1.25	0.04	0.03	0.02	0.02	0.03	0.03	0.02	0.000%
1.5	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.000%
1.75	0.05	0.04	0.03	0.03	0.04	0.04	0.03	0.000%
2	0.06	0.04	0.04	0.04	0.04	0.04	0.03	0.000%
2.25	0.07	0.05	0.04	0.04	0.05	0.05	0.04	0.000%
2.5	0.07	0.05	0.05	0.05	0.05	0.05	0.04	0.000%
2.75	0.08	0.06	0.05	0.05	0.06	0.06	0.05	0.000%
3	0.09	0.06	0.06	0.06	0.06	0.06	0.05	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

[Peak Wave Period, Tp=12sec]

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.000%
0.5	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.000%
0.75	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.000%
1	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.000%
1.25	0.04	0.03	0.03	0.03	0.03	0.03	0.02	0.000%
1.5	0.05	0.04	0.04	0.03	0.03	0.03	0.03	0.000%
1.75	0.05	0.05	0.04	0.04	0.04	0.04	0.03	0.000%
2	0.06	0.06	0.05	0.05	0.05	0.04	0.04	0.000%
2.25	0.07	0.06	0.06	0.05	0.05	0.05	0.04	0.000%
2.5	0.08	0.07	0.06	0.06	0.06	0.05	0.05	0.000%
2.75	0.08	0.08	0.07	0.06	0.06	0.06	0.052	0.000%
3	0.09	0.08	0.07	0.07	0.07	0.06	0.06	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

[Peak Wave Period, Tp=14sec]

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.000%
0.5	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.000%
0.75	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.000%
1	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.000%
1.25	0.04	0.03	0.03	0.03	0.03	0.02	0.02	0.000%
1.5	0.05	0.04	0.04	0.03	0.03	0.03	0.03	0.000%
1.75	0.06	0.05	0.05	0.04	0.04	0.03	0.03	0.000%
2	0.06	0.06	0.05	0.05	0.04	0.04	0.04	0.000%
2.25	0.07	0.06	0.06	0.05	0.05	0.04	0.04	0.000%
2.5	0.08	0.07	0.06	0.06	0.05	0.05	0.04	0.000%
2.75	0.09	0.08	0.07	0.06	0.06	0.05	0.048	0.000%
3	0.09	0.08	0.08	0.07	0.06	0.06	0.05	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

[Peak Wave Period, Tp=16sec]

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.000%
0.5	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.000%
0.75	0.03	0.02	0.02	0.02	0.02	0.01	0.01	0.000%
1	0.04	0.03	0.03	0.02	0.02	0.02	0.02	0.000%
1.25	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.000%
1.5	0.05	0.05	0.04	0.04	0.03	0.03	0.02	0.000%
1.75	0.06	0.05	0.05	0.04	0.04	0.03	0.03	0.000%
2	0.07	0.06	0.05	0.05	0.04	0.04	0.03	0.000%
2.25	0.08	0.07	0.06	0.05	0.05	0.04	0.04	0.000%
2.5	0.09	0.08	0.06	0.06	0.06	0.05	0.04	0.000%
2.75	0.10	0.08	0.07	0.07	0.06	0.05	0.045	0.000%
3	0.11	0.09	0.08	0.07	0.07	0.06	0.05	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

[Peak Wave Period, Tp=18sec]

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.000%
0.5	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.000%
0.75	0.03	0.02	0.02	0.02	0.02	0.02	0.01	0.000%
1	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.000%
1.25	0.04	0.04	0.03	0.03	0.03	0.03	0.02	0.000%
1.5	0.05	0.05	0.04	0.04	0.04	0.03	0.03	0.000%
1.75	0.06	0.06	0.05	0.04	0.04	0.04	0.03	0.000%
2	0.07	0.06	0.05	0.05	0.05	0.04	0.04	0.000%
2.25	0.08	0.07	0.06	0.06	0.06	0.05	0.04	0.000%
2.5	0.09	0.08	0.07	0.06	0.06	0.06	0.05	0.000%
2.75	0.10	0.09	0.07	0.07	0.07	0.06	0.05	0.000%
3	0.10	0.10	0.08	0.08	0.08	0.07	0.06	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

[Peak Wave Period, Tp=20sec]

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.000%
0.5	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.000%
0.75	0.03	0.02	0.02	0.02	0.02	0.02	0.01	0.000%
1	0.04	0.03	0.03	0.03	0.03	0.02	0.02	0.000%
1.25	0.05	0.04	0.04	0.04	0.03	0.03	0.02	0.000%
1.5	0.05	0.05	0.05	0.04	0.04	0.03	0.03	0.000%
1.75	0.06	0.06	0.05	0.05	0.05	0.04	0.03	0.000%
2	0.07	0.07	0.06	0.06	0.05	0.05	0.04	0.000%
2.25	0.08	0.07	0.07	0.06	0.06	0.05	0.04	0.000%
2.5	0.09	0.08	0.08	0.07	0.07	0.06	0.05	0.000%
2.75	0.10	0.09	0.08	0.08	0.07	0.06	0.052	0.000%
3	0.11	0.10	0.09	0.09	0.08	0.07	0.06	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

Table A.2.5.13 Wave Height and Total Percent Occurrence at Berth E1 in the case of Plan-B (units : m)

【Peak Wave Period, Tp=6sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.07	0.07	0.06	0.06	0.05	0.05	0.000%
0.5	0.00	0.15	0.14	0.13	0.11	0.09	0.09	0.000%
0.75	0.00	0.22	0.20	0.19	0.17	0.14	0.14	0.000%
1	0.00	0.29	0.27	0.26	0.23	0.18	0.18	0.000%
1.25	0.00	0.36	0.34	0.32	0.28	0.23	0.23	0.000%
1.5	0.00	0.44	0.41	0.38	0.34	0.27	0.27	0.000%
1.75	0.00	0.51	0.48	0.45	0.39	0.32	0.32	0.000%
2	0.00	0.58	0.54	0.51	0.45	0.37	0.37	0.000%
2.25	0.00	0.66	0.61	0.57	0.51	0.41	0.41	0.000%
2.5	0.00	0.73	0.68	0.64	0.56	0.46	0.46	0.003%
2.75	0.00	0.80	0.75	0.702	0.62	0.50	0.50	0.000%
3	0.00	0.87	0.82	0.77	0.68	0.55	0.55	0.000%
Total Percent Occurrence	0.000%	0.003%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=8sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.07	0.06	0.05	0.04	0.06	0.04	0.000%
0.5	0.00	0.14	0.12	0.10	0.08	0.12	0.07	0.000%
0.75	0.00	0.22	0.18	0.16	0.13	0.18	0.11	0.000%
1	0.00	0.29	0.24	0.21	0.17	0.24	0.14	0.000%
1.25	0.00	0.36	0.30	0.26	0.21	0.29	0.18	0.000%
1.5	0.00	0.43	0.36	0.31	0.25	0.35	0.21	0.000%
1.75	0.00	0.50	0.42	0.36	0.30	0.41	0.25	0.000%
2	0.00	0.57	0.48	0.41	0.34	0.47	0.28	0.000%
2.25	0.00	0.65	0.54	0.47	0.38	0.53	0.32	0.000%
2.5	0.00	0.72	0.60	0.52	0.42	0.59	0.35	0.007%
2.75	0.00	0.79	0.66	0.57	0.47	0.65	0.39	0.006%
3	0.00	0.86	0.72	0.62	0.51	0.71	0.42	0.010%
Total Percent Occurrence	0.00%	0.02%	0.005%	0.000%	0.000%	0.002%	0.000%	0.02%

【Peak Wave Period, Tp=10sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.08	0.07	0.07	0.06	0.05	0.05	0.04	0.000%
0.5	0.17	0.14	0.13	0.12	0.10	0.09	0.07	0.000%
0.75	0.25	0.22	0.20	0.17	0.15	0.14	0.11	0.000%
1	0.33	0.29	0.26	0.23	0.20	0.18	0.15	0.000%
1.25	0.41	0.36	0.33	0.29	0.25	0.23	0.19	0.000%
1.5	0.50	0.43	0.39	0.35	0.30	0.28	0.22	0.000%
1.75	0.58	0.50	0.46	0.41	0.35	0.32	0.26	0.000%
2	0.66	0.58	0.53	0.47	0.40	0.37	0.30	0.000%
2.25	0.75	0.65	0.59	0.52	0.44	0.42	0.34	0.005%
2.5	0.83	0.72	0.66	0.58	0.49	0.46	0.37	0.000%
2.75	0.91	0.79	0.72	0.64	0.54	0.51	0.41	0.000%
3	0.99	0.86	0.79	0.700	0.59	0.55	0.45	0.000%
Total Percent Occurrence	0.005%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.01%

【Peak Wave Period, Tp=12sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.09	0.08	0.07	0.06	0.05	0.05	0.04	0.000%
0.5	0.18	0.16	0.14	0.12	0.11	0.09	0.09	0.000%
0.75	0.27	0.23	0.21	0.18	0.16	0.14	0.13	0.000%
1	0.36	0.31	0.28	0.24	0.21	0.18	0.17	0.000%
1.25	0.45	0.39	0.35	0.30	0.27	0.23	0.21	0.000%
1.5	0.54	0.47	0.42	0.36	0.32	0.27	0.26	0.000%
1.75	0.62	0.55	0.49	0.42	0.37	0.32	0.30	0.000%
2	0.71	0.62	0.56	0.48	0.43	0.36	0.34	0.067%
2.25	0.80	0.701	0.62	0.54	0.48	0.41	0.39	0.035%
2.5	0.89	0.78	0.69	0.60	0.53	0.46	0.43	0.009%
2.75	0.98	0.86	0.76	0.66	0.59	0.50	0.47	0.000%
3	1.07	0.93	0.83	0.73	0.64	0.55	0.51	0.000%
Total Percent Occurrence	0.080%	0.031%	0.000%	0.000%	0.000%	0.000%	0.000%	0.11%

【Peak Wave Period, Tp=14sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.09	0.08	0.08	0.07	0.06	0.05	0.05	0.000%
0.5	0.18	0.16	0.15	0.13	0.12	0.10	0.10	0.000%
0.75	0.27	0.24	0.23	0.20	0.18	0.16	0.15	0.000%
1	0.36	0.32	0.30	0.27	0.25	0.21	0.19	0.000%
1.25	0.45	0.41	0.38	0.33	0.31	0.26	0.24	0.000%
1.5	0.54	0.49	0.45	0.40	0.37	0.31	0.29	0.000%
1.75	0.63	0.57	0.53	0.47	0.43	0.37	0.34	0.000%
2	0.72	0.65	0.60	0.54	0.49	0.42	0.39	0.067%
2.25	0.81	0.73	0.68	0.60	0.55	0.47	0.44	0.061%
2.5	0.90	0.81	0.76	0.67	0.62	0.52	0.48	0.033%
2.75	0.99	0.89	0.83	0.74	0.68	0.57	0.53	0.013%
3	1.08	0.97	0.91	0.80	0.74	0.63	0.58	0.000%
Total Percent Occurrence	0.093%	0.074%	0.023%	0.005%	0.000%	0.000%	0.000%	0.19%

【Peak Wave Period, Tp=16sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.10	0.09	0.08	0.07	0.06	0.05	0.04	0.000%
0.5	0.19	0.17	0.15	0.14	0.12	0.10	0.09	0.000%
0.75	0.29	0.26	0.23	0.20	0.18	0.15	0.13	0.000%
1	0.38	0.34	0.30	0.27	0.24	0.20	0.18	0.000%
1.25	0.48	0.43	0.38	0.34	0.30	0.26	0.22	0.000%
1.5	0.57	0.51	0.45	0.41	0.36	0.31	0.27	0.000%
1.75	0.67	0.60	0.53	0.47	0.42	0.36	0.31	0.000%
2	0.76	0.69	0.60	0.54	0.49	0.41	0.36	0.052%
2.25	0.86	0.77	0.68	0.61	0.55	0.46	0.40	0.087%
2.5	0.95	0.86	0.75	0.68	0.61	0.51	0.45	0.062%
2.75	1.05	0.94	0.83	0.75	0.67	0.56	0.49	0.020%
3	1.14	1.03	0.90	0.81	0.73	0.61	0.54	0.009%
Total Percent Occurrence	0.078%	0.091%	0.048%	0.012%	0.002%	0.000%	0.000%	0.23%

【Peak Wave Period, Tp=18sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.09	0.09	0.08	0.07	0.06	0.06	0.05	0.000%
0.5	0.18	0.17	0.15	0.14	0.13	0.11	0.10	0.000%
0.75	0.28	0.26	0.23	0.21	0.19	0.17	0.15	0.000%
1	0.37	0.34	0.30	0.28	0.25	0.23	0.20	0.000%
1.25	0.46	0.43	0.38	0.35	0.32	0.28	0.25	0.000%
1.5	0.55	0.51	0.46	0.42	0.38	0.34	0.30	0.000%
1.75	0.64	0.60	0.53	0.49	0.44	0.40	0.35	0.000%
2	0.73	0.68	0.61	0.56	0.51	0.46	0.40	0.039%
2.25	0.83	0.77	0.68	0.63	0.57	0.51	0.45	0.062%
2.5	0.92	0.85	0.76	0.700	0.64	0.57	0.50	0.068%
2.75	1.01	0.94	0.84	0.77	0.699	0.63	0.55	0.020%
3	1.10	1.02	0.91	0.84	0.76	0.68	0.60	0.009%
Total Percent Occurrence	0.059%	0.065%	0.043%	0.049%	0.002%	0.000%	0.000%	0.22%

【Peak Wave Period, Tp=20sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.09	0.09	0.08	0.07	0.06	0.06	0.05	0.000%
0.5	0.19	0.17	0.16	0.14	0.13	0.11	0.10	0.000%
0.75	0.28	0.26	0.24	0.21	0.19	0.17	0.15	0.000%
1	0.38	0.35	0.32	0.28	0.25	0.23	0.20	0.000%
1.25	0.47	0.44	0.40	0.35	0.32	0.28	0.25	0.000%
1.5	0.56	0.52	0.48	0.42	0.38	0.34	0.30	0.000%
1.75	0.66	0.61	0.56	0.49	0.44	0.40	0.35	0.000%
2	0.75	0.696	0.64	0.56	0.51	0.45	0.40	0.010%
2.25	0.84	0.78	0.72	0.63	0.57	0.51	0.45	0.017%
2.5	0.94	0.87	0.80	0.698	0.63	0.57	0.50	0.015%
2.75	1.03	0.96	0.88	0.77	0.69	0.62	0.55	0.007%
3	1.13	1.04	0.96	0.84	0.76	0.68	0.60	0.000%
Total Percent Occurrence	0.014%	0.019%	0.012%	0.003%	0.000%	0.000%	0.000%	0.05%

Table A.2.5.14 Wave Height and Total Percent Occurrence at Berth E2 in the case of Plan-B (units : m)

【Peak Wave Period, Tp=6sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.08	0.07	0.07	0.06	0.05	0.04	0.000%
0.5	0.00	0.16	0.15	0.14	0.12	0.09	0.08	0.000%
0.75	0.00	0.24	0.22	0.20	0.17	0.14	0.12	0.000%
1	0.00	0.32	0.30	0.27	0.23	0.19	0.15	0.000%
1.25	0.00	0.41	0.37	0.34	0.29	0.23	0.19	0.000%
1.5	0.00	0.49	0.45	0.41	0.35	0.28	0.23	0.000%
1.75	0.00	0.57	0.52	0.47	0.41	0.33	0.27	0.000%
2	0.00	0.65	0.60	0.54	0.47	0.37	0.31	0.000%
2.25	0.00	0.73	0.67	0.61	0.52	0.42	0.35	0.011%
2.5	0.00	0.81	0.75	0.68	0.58	0.47	0.39	0.014%
2.75	0.00	0.89	0.82	0.74	0.64	0.51	0.43	0.000%
3	0.00	0.97	0.90	0.81	0.700	0.56	0.46	0.000%
Total Percent Occurrence	0.000%	0.014%	0.010%	0.000%	0.000%	0.000%	0.000%	0.02%

【Peak Wave Period, Tp=8sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.07	0.06	0.05	0.04	0.04	0.05	0.000%
0.5	0.00	0.15	0.12	0.10	0.09	0.08	0.09	0.000%
0.75	0.00	0.22	0.19	0.16	0.13	0.12	0.14	0.000%
1	0.00	0.29	0.25	0.21	0.17	0.16	0.18	0.000%
1.25	0.00	0.37	0.31	0.26	0.22	0.21	0.23	0.000%
1.5	0.00	0.44	0.37	0.31	0.26	0.25	0.28	0.000%
1.75	0.00	0.52	0.44	0.36	0.31	0.29	0.32	0.000%
2	0.00	0.59	0.50	0.42	0.35	0.33	0.37	0.000%
2.25	0.00	0.66	0.56	0.47	0.39	0.37	0.41	0.000%
2.5	0.00	0.74	0.62	0.52	0.44	0.41	0.46	0.007%
2.75	0.00	0.81	0.69	0.57	0.48	0.45	0.50	0.006%
3	0.00	0.88	0.75	0.63	0.52	0.49	0.55	0.007%
Total Percent Occurrence	0.00%	0.016%	0.005%	0.000%	0.000%	0.000%	0.000%	0.02%

【Peak Wave Period, Tp=10sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.08	0.07	0.07	0.06	0.05	0.04	0.04	0.000%
0.5	0.17	0.15	0.13	0.12	0.10	0.09	0.07	0.000%
0.75	0.25	0.22	0.20	0.17	0.14	0.13	0.11	0.000%
1	0.34	0.29	0.26	0.23	0.19	0.18	0.14	0.000%
1.25	0.42	0.37	0.33	0.29	0.24	0.22	0.18	0.000%
1.5	0.51	0.44	0.39	0.35	0.29	0.26	0.22	0.000%
1.75	0.59	0.51	0.46	0.40	0.33	0.31	0.25	0.000%
2	0.68	0.59	0.53	0.46	0.38	0.35	0.29	0.000%
2.25	0.76	0.66	0.59	0.52	0.43	0.39	0.32	0.005%
2.5	0.85	0.74	0.66	0.58	0.48	0.44	0.36	0.000%
2.75	0.93	0.81	0.72	0.64	0.52	0.48	0.40	0.000%
3	1.02	0.88	0.79	0.69	0.57	0.53	0.43	0.000%
Total Percent Occurrence	0.005%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.01%

【Peak Wave Period, Tp=12sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.08	0.07	0.07	0.06	0.06	0.05	0.04	0.000%
0.5	0.17	0.15	0.14	0.12	0.11	0.09	0.09	0.000%
0.75	0.25	0.22	0.21	0.18	0.17	0.14	0.13	0.000%
1	0.33	0.30	0.28	0.24	0.22	0.18	0.17	0.000%
1.25	0.42	0.37	0.35	0.30	0.28	0.23	0.21	0.000%
1.5	0.50	0.44	0.41	0.36	0.33	0.27	0.26	0.000%
1.75	0.58	0.52	0.48	0.43	0.39	0.32	0.30	0.000%
2	0.67	0.59	0.55	0.49	0.44	0.37	0.34	0.000%
2.25	0.75	0.66	0.62	0.55	0.50	0.41	0.38	0.011%
2.5	0.84	0.74	0.69	0.61	0.55	0.46	0.43	0.009%
2.75	0.92	0.81	0.76	0.67	0.61	0.50	0.47	0.000%
3	1.00	0.89	0.83	0.73	0.67	0.55	0.51	0.000%
Total Percent Occurrence	0.013%	0.008%	0.000%	0.000%	0.000%	0.000%	0.000%	0.02%

【Peak Wave Period, Tp=14sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.10	0.09	0.08	0.07	0.06	0.05	0.05	0.000%
0.5	0.20	0.18	0.16	0.14	0.13	0.11	0.10	0.000%
0.75	0.30	0.27	0.24	0.21	0.19	0.16	0.15	0.000%
1	0.40	0.35	0.33	0.28	0.26	0.22	0.20	0.000%
1.25	0.50	0.44	0.41	0.35	0.32	0.27	0.25	0.000%
1.5	0.59	0.53	0.49	0.43	0.39	0.32	0.30	0.000%
1.75	0.69	0.62	0.57	0.50	0.45	0.38	0.35	0.000%
2	0.79	0.71	0.65	0.57	0.51	0.43	0.40	0.262%
2.25	0.89	0.80	0.73	0.64	0.58	0.48	0.45	0.182%
2.5	0.99	0.89	0.82	0.71	0.64	0.54	0.50	0.053%
2.75	1.09	0.98	0.90	0.78	0.71	0.59	0.55	0.017%
3	1.19	1.06	0.98	0.85	0.77	0.65	0.60	0.000%
Total Percent Occurrence	0.093%	0.270%	0.123%	0.025%	0.004%	0.000%	0.000%	0.51%

【Peak Wave Period, Tp=16sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.10	0.09	0.08	0.07	0.06	0.05	0.05	0.000%
0.5	0.20	0.17	0.15	0.14	0.12	0.11	0.10	0.000%
0.75	0.29	0.26	0.23	0.21	0.19	0.16	0.14	0.000%
1	0.39	0.35	0.30	0.28	0.25	0.21	0.19	0.000%
1.25	0.49	0.43	0.38	0.35	0.31	0.26	0.24	0.000%
1.5	0.59	0.52	0.46	0.41	0.37	0.32	0.29	0.000%
1.75	0.69	0.61	0.53	0.48	0.44	0.37	0.33	0.000%
2	0.79	0.69	0.61	0.55	0.50	0.42	0.38	0.052%
2.25	0.88	0.78	0.69	0.62	0.56	0.46	0.43	0.087%
2.5	0.98	0.87	0.76	0.69	0.62	0.53	0.48	0.062%
2.75	1.08	0.96	0.84	0.76	0.68	0.58	0.52	0.020%
3	1.18	1.04	0.91	0.83	0.75	0.63	0.57	0.009%
Total Percent Occurrence	0.078%	0.091%	0.048%	0.012%	0.002%	0.000%	0.000%	0.23%

【Peak Wave Period, Tp=18sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.10	0.09	0.08	0.08	0.07	0.06	0.05	0.000%
0.5	0.20	0.19	0.17	0.15	0.14	0.12	0.11	0.000%
0.75	0.30	0.28	0.25	0.23	0.21	0.19	0.16	0.000%
1	0.40	0.38	0.34	0.31	0.28	0.25	0.22	0.000%
1.25	0.50	0.47	0.42	0.39	0.35	0.31	0.27	0.000%
1.5	0.61	0.56	0.50	0.46	0.42	0.37	0.33	0.000%
1.75	0.71	0.66	0.59	0.54	0.49	0.43	0.38	0.079%
2	0.81	0.75	0.67	0.62	0.56	0.50	0.44	0.165%
2.25	0.91	0.84	0.76	0.695	0.63	0.56	0.49	0.180%
2.5	1.01	0.94	0.84	0.77	0.696	0.62	0.55	0.086%
2.75	1.11	1.03	0.92	0.85	0.77	0.68	0.60	0.028%
3	1.21	1.13	1.01	0.93	0.84	0.75	0.66	0.010%
Total Percent Occurrence	0.138%	0.192%	0.161%	0.049%	0.008%	0.001%	0.000%	0.55%

【Peak Wave Period, Tp=20sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.10	0.09	0.09	0.08	0.07	0.06	0.06	0.000%
0.5	0.20	0.19	0.18	0.15	0.14	0.13	0.11	0.000%
0.75	0.31	0.28	0.26	0.23	0.21	0.19	0.17	0.000%
1	0.41	0.38	0.35	0.31	0.28	0.25	0.22	0.000%
1.25	0.51	0.47	0.44	0.39	0.35	0.32	0.28	0.000%
1.5	0.61	0.57	0.53	0.46	0.42	0.38	0.33	0.000%
1.75	0.72	0.66	0.61	0.54	0.49	0.44	0.39	0.022%
2	0.82	0.76	0.702	0.62	0.56	0.51	0.45	0.148%
2.25	0.92	0.85	0.79	0.697	0.64	0.57	0.50	0.052%
2.5	1.02	0.95	0.88	0.77	0.71	0.63	0.56	0.036%
2.75	1.13	1.04	0.96	0.85	0.78	0.695	0.61	0.010%
3	1.23	1.14	1.05	0.93	0.85	0.76	0.67	0.000%
Total Percent Occurrence	0.036%	0.058%	0.144%	0.018%	0.010%	0.000%	0.000%	0.26%

Table A.2.5.15 Wave Height and Total Percent Occurrence at Berth E3 in the case of Plan-B (units : m)

【Peak Wave Period, Tp=6sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.08	0.07	0.07	0.05	0.04	0.04	0.000%
0.5	0.00	0.16	0.15	0.13	0.11	0.09	0.08	0.000%
0.75	0.00	0.25	0.22	0.20	0.16	0.13	0.12	0.000%
1	0.00	0.33	0.30	0.26	0.22	0.17	0.16	0.000%
1.25	0.00	0.41	0.37	0.33	0.27	0.22	0.19	0.000%
1.5	0.00	0.49	0.45	0.39	0.33	0.26	0.23	0.000%
1.75	0.00	0.57	0.52	0.46	0.38	0.30	0.27	0.000%
2	0.00	0.66	0.60	0.53	0.43	0.35	0.31	0.000%
2.25	0.00	0.74	0.67	0.59	0.49	0.39	0.35	0.011%
2.5	0.00	0.82	0.75	0.66	0.54	0.44	0.39	0.014%
2.75	0.00	0.90	0.82	0.72	0.60	0.48	0.43	0.000%
3	0.00	0.98	0.90	0.79	0.65	0.52	0.47	0.000%
Total Percent Occurrence	0.00%	0.014%	0.010%	0.000%	0.000%	0.000%	0.000%	0.02%

【Peak Wave Period, Tp=8sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.07	0.06	0.05	0.04	0.04	0.03	0.000%
0.5	0.00	0.13	0.12	0.10	0.08	0.08	0.07	0.000%
0.75	0.00	0.20	0.17	0.16	0.13	0.11	0.10	0.000%
1	0.00	0.26	0.23	0.21	0.17	0.15	0.14	0.000%
1.25	0.00	0.33	0.29	0.26	0.21	0.19	0.17	0.000%
1.5	0.00	0.40	0.35	0.31	0.25	0.23	0.20	0.000%
1.75	0.00	0.46	0.40	0.36	0.30	0.27	0.24	0.000%
2	0.00	0.53	0.46	0.42	0.34	0.31	0.27	0.000%
2.25	0.00	0.59	0.52	0.47	0.38	0.34	0.31	0.000%
2.5	0.00	0.66	0.58	0.52	0.42	0.38	0.34	0.000%
2.75	0.00	0.73	0.63	0.57	0.46	0.42	0.37	0.006%
3	0.00	0.79	0.69	0.62	0.51	0.46	0.41	0.002%
Total Percent Occurrence	0.00%	0.009%	0.000%	0.000%	0.000%	0.000%	0.000%	0.01%

【Peak Wave Period, Tp=10sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.08	0.08	0.07	0.06	0.05	0.04	0.04	0.000%
0.5	0.17	0.15	0.13	0.12	0.10	0.09	0.07	0.000%
0.75	0.25	0.23	0.20	0.17	0.15	0.13	0.11	0.000%
1	0.33	0.30	0.27	0.23	0.20	0.18	0.15	0.000%
1.25	0.41	0.38	0.33	0.29	0.25	0.22	0.18	0.000%
1.5	0.50	0.45	0.40	0.35	0.30	0.27	0.22	0.000%
1.75	0.58	0.53	0.46	0.41	0.35	0.31	0.26	0.000%
2	0.66	0.60	0.53	0.46	0.39	0.36	0.29	0.000%
2.25	0.75	0.68	0.60	0.52	0.44	0.40	0.33	0.005%
2.5	0.83	0.75	0.66	0.58	0.49	0.44	0.37	0.000%
2.75	0.91	0.83	0.73	0.64	0.54	0.49	0.40	0.000%
3	1.00	0.90	0.80	0.69	0.59	0.53	0.44	0.000%
Total Percent Occurrence	0.005%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.01%

【Peak Wave Period, Tp=12sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.08	0.08	0.07	0.06	0.06	0.05	0.04	0.000%
0.5	0.17	0.15	0.15	0.12	0.11	0.09	0.09	0.000%
0.75	0.25	0.23	0.22	0.19	0.17	0.14	0.13	0.000%
1	0.34	0.31	0.29	0.25	0.22	0.18	0.18	0.000%
1.25	0.42	0.38	0.37	0.31	0.28	0.23	0.22	0.000%
1.5	0.51	0.46	0.44	0.37	0.33	0.28	0.26	0.000%
1.75	0.59	0.54	0.51	0.44	0.39	0.32	0.31	0.000%
2	0.68	0.61	0.59	0.50	0.45	0.37	0.35	0.000%
2.25	0.76	0.69	0.66	0.56	0.50	0.41	0.39	0.011%
2.5	0.85	0.77	0.73	0.62	0.56	0.46	0.44	0.016%
2.75	0.93	0.84	0.80	0.69	0.61	0.51	0.48	0.000%
3	1.02	0.92	0.86	0.75	0.67	0.55	0.53	0.000%
Total Percent Occurrence	0.013%	0.008%	0.007%	0.000%	0.000%	0.000%	0.000%	0.03%

【Peak Wave Period, Tp=14sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.10	0.09	0.08	0.07	0.06	0.05	0.05	0.000%
0.5	0.20	0.17	0.16	0.14	0.12	0.10	0.10	0.000%
0.75	0.29	0.26	0.24	0.21	0.19	0.16	0.14	0.000%
1	0.39	0.35	0.32	0.28	0.25	0.21	0.19	0.000%
1.25	0.49	0.43	0.40	0.35	0.31	0.26	0.24	0.000%
1.5	0.59	0.52	0.48	0.42	0.37	0.31	0.29	0.000%
1.75	0.69	0.61	0.56	0.49	0.43	0.36	0.34	0.000%
2	0.78	0.69	0.64	0.55	0.50	0.42	0.38	0.067%
2.25	0.88	0.78	0.72	0.62	0.56	0.47	0.43	0.182%
2.5	0.98	0.87	0.80	0.69	0.62	0.52	0.48	0.033%
2.75	1.08	0.95	0.88	0.76	0.68	0.57	0.53	0.013%
3	1.17	1.04	0.96	0.83	0.74	0.62	0.58	0.000%
Total Percent Occurrence	0.093%	0.074%	0.123%	0.005%	0.000%	0.000%	0.000%	0.29%

【Peak Wave Period, Tp=16sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.09	0.09	0.08	0.07	0.07	0.06	0.05	0.000%
0.5	0.19	0.17	0.16	0.14	0.13	0.11	0.10	0.000%
0.75	0.28	0.26	0.23	0.22	0.20	0.17	0.15	0.000%
1	0.38	0.35	0.31	0.29	0.27	0.23	0.20	0.000%
1.25	0.47	0.43	0.39	0.36	0.33	0.28	0.25	0.000%
1.5	0.57	0.52	0.47	0.43	0.40	0.34	0.30	0.000%
1.75	0.66	0.61	0.55	0.51	0.47	0.40	0.35	0.000%
2	0.76	0.69	0.63	0.58	0.53	0.45	0.40	0.000%
2.25	0.85	0.78	0.704	0.65	0.60	0.51	0.45	0.232%
2.5	0.95	0.87	0.78	0.72	0.67	0.57	0.50	0.109%
2.75	1.04	0.95	0.86	0.79	0.73	0.63	0.55	0.026%
3	1.13	1.04	0.94	0.87	0.80	0.68	0.60	0.009%
Total Percent Occurrence	0.078%	0.091%	0.193%	0.058%	0.008%	0.000%	0.000%	0.43%

【Peak Wave Period, Tp=18sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.10	0.09	0.08	0.07	0.06	0.06	0.05	0.000%
0.5	0.19	0.18	0.16	0.14	0.13	0.11	0.10	0.000%
0.75	0.29	0.27	0.24	0.21	0.19	0.17	0.15	0.000%
1	0.39	0.36	0.31	0.28	0.25	0.23	0.20	0.000%
1.25	0.49	0.45	0.39	0.36	0.32	0.28	0.25	0.000%
1.5	0.58	0.54	0.47	0.43	0.38	0.34	0.30	0.000%
1.75	0.68	0.63	0.55	0.50	0.44	0.39	0.35	0.000%
2	0.78	0.72	0.63	0.57	0.51	0.45	0.40	0.165%
2.25	0.88	0.80	0.71	0.64	0.57	0.51	0.45	0.180%
2.5	0.97	0.89	0.79	0.71	0.64	0.56	0.50	0.088%
2.75	1.07	0.98	0.88	0.78	0.699	0.62	0.55	0.020%
3	1.17	1.07	0.94	0.85	0.76	0.68	0.60	0.009%
Total Percent Occurrence	0.059%	0.192%	0.161%	0.049%	0.002%	0.000%	0.000%	0.46%

【Peak Wave Period, Tp=20sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.10	0.09	0.09	0.08	0.07	0.06	0.05	0.000%
0.5	0.20	0.18	0.17	0.15	0.14	0.12	0.11	0.000%
0.75	0.30	0.28	0.26	0.23	0.20	0.18	0.16	0.000%
1	0.40	0.37	0.34	0.30	0.27	0.24	0.22	0.000%
1.25	0.50	0.46	0.43	0.38	0.34	0.30	0.27	0.000%
1.5	0.60	0.55	0.51	0.45	0.41	0.36	0.32	0.000%
1.75	0.696	0.65	0.60	0.53	0.47	0.42	0.38	0.000%
2	0.80	0.74	0.69	0.60	0.54	0.48	0.43	0.049%
2.25	0.90	0.83	0.77	0.68	0.61	0.54	0.48	0.052%
2.5	0.99	0.92	0.86	0.76	0.68	0.60	0.54	0.028%
2.75	1.09	1.02	0.94	0.83	0.75	0.66	0.59	0.009%
3	1.19	1.11	1.03	0.91	0.81	0.73	0.65	0.000%
Total Percent Occurrence	0.014%	0.058%	0.047%	0.016%	0.002%	0.000%	0.000%	0.14%

Table A.2.5.16 Wave Height and Total Percent Occurrence at Berth E4 in the case of Plan-B (units : m)

【Peak Wave Period, Tp=6sec】

	Wave Direction(degrees)							
Significant Wave Height, Hs(m)	205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.08	0.07	0.07	0.06	0.05	0.05	0.000%
0.5	0.00	0.15	0.14	0.13	0.11	0.10	0.09	0.000%
0.75	0.00	0.23	0.20	0.20	0.17	0.16	0.14	0.000%
1	0.00	0.30	0.27	0.26	0.22	0.21	0.18	0.000%
1.25	0.00	0.38	0.34	0.33	0.28	0.26	0.23	0.000%
1.5	0.00	0.45	0.41	0.39	0.33	0.31	0.28	0.000%
1.75	0.00	0.53	0.47	0.46	0.39	0.36	0.32	0.000%
2	0.00	0.60	0.54	0.52	0.45	0.41	0.37	0.000%
2.25	0.00	0.68	0.61	0.59	0.50	0.47	0.41	0.000%
2.5	0.00	0.75	0.68	0.65	0.56	0.52	0.46	0.003%
2.75	0.00	0.83	0.75	0.72	0.61	0.57	0.51	0.000%
3	0.00	0.90	0.81	0.78	0.67	0.62	0.55	0.000%
Total Percent Occurrence	0.000%	0.003%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=8sec】

	Wave Direction(degrees)							
Significant Wave Height, Hs(m)	205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.07	0.06	0.06	0.05	0.05	0.04	0.000%
0.5	0.00	0.15	0.13	0.11	0.10	0.09	0.08	0.000%
0.75	0.00	0.22	0.19	0.17	0.15	0.14	0.12	0.000%
1	0.00	0.30	0.25	0.23	0.20	0.18	0.17	0.000%
1.25	0.00	0.37	0.32	0.29	0.25	0.23	0.21	0.000%
1.5	0.00	0.45	0.38	0.34	0.30	0.27	0.25	0.000%
1.75	0.00	0.52	0.45	0.40	0.35	0.32	0.29	0.000%
2	0.00	0.60	0.51	0.46	0.40	0.36	0.33	0.000%
2.25	0.00	0.67	0.57	0.52	0.45	0.41	0.37	0.000%
2.5	0.00	0.74	0.64	0.57	0.50	0.45	0.42	0.007%
2.75	0.00	0.82	0.701	0.63	0.55	0.50	0.46	0.018%
3	0.00	0.89	0.76	0.69	0.60	0.54	0.50	0.007%
Total Percent Occurrence	0.000%	0.016%	0.017%	0.000%	0.000%	0.000%	0.000%	0.03%

【Peak Wave Period, Tp=10sec】

	Wave Direction(degrees)							
Significant Wave Height, Hs(m)	205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.08	0.07	0.06	0.05	0.05	0.04	0.04	0.000%
0.5	0.15	0.14	0.13	0.11	0.09	0.09	0.07	0.000%
0.75	0.23	0.21	0.19	0.16	0.14	0.13	0.11	0.000%
1	0.31	0.28	0.26	0.22	0.18	0.18	0.15	0.000%
1.25	0.39	0.35	0.32	0.27	0.23	0.22	0.19	0.000%
1.5	0.46	0.43	0.39	0.33	0.28	0.26	0.22	0.000%
1.75	0.54	0.50	0.45	0.38	0.32	0.31	0.26	0.000%
2	0.62	0.57	0.52	0.44	0.37	0.35	0.30	0.000%
2.25	0.697	0.64	0.58	0.49	0.42	0.39	0.34	0.000%
2.5	0.77	0.71	0.64	0.55	0.46	0.44	0.37	0.000%
2.75	0.85	0.78	0.71	0.60	0.51	0.48	0.41	0.000%
3	0.93	0.85	0.77	0.66	0.55	0.53	0.45	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=12sec】

	Wave Direction(degrees)							
Significant Wave Height, Hs(m)	205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.08	0.08	0.07	0.06	0.05	0.04	0.04	0.000%
0.5	0.17	0.15	0.14	0.12	0.10	0.09	0.08	0.000%
0.75	0.25	0.23	0.21	0.18	0.16	0.13	0.12	0.000%
1	0.33	0.30	0.28	0.24	0.21	0.18	0.16	0.000%
1.25	0.42	0.38	0.34	0.30	0.26	0.22	0.20	0.000%
1.5	0.50	0.45	0.41	0.36	0.31	0.26	0.24	0.000%
1.75	0.58	0.53	0.48	0.42	0.37	0.31	0.28	0.000%
2	0.67	0.61	0.55	0.48	0.42	0.35	0.32	0.000%
2.25	0.75	0.68	0.62	0.54	0.47	0.40	0.37	0.011%
2.5	0.83	0.76	0.69	0.59	0.52	0.44	0.41	0.009%
2.75	0.91	0.83	0.76	0.65	0.58	0.48	0.45	0.000%
3	1.00	0.91	0.83	0.71	0.63	0.53	0.49	0.000%
Total Percent Occurrence	0.013%	0.006%	0.000%	0.000%	0.000%	0.000%	0.000%	0.02%

【Peak Wave Period, Tp=14sec】

	Wave Direction(degrees)							
Significant Wave Height, Hs(m)	205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.09	0.08	0.07	0.06	0.06	0.05	0.04	0.000%
0.5	0.19	0.17	0.15	0.13	0.11	0.09	0.09	0.000%
0.75	0.28	0.25	0.22	0.19	0.17	0.14	0.13	0.000%
1	0.38	0.33	0.30	0.26	0.23	0.19	0.17	0.000%
1.25	0.47	0.41	0.37	0.32	0.29	0.23	0.22	0.000%
1.5	0.57	0.50	0.45	0.39	0.34	0.28	0.26	0.000%
1.75	0.66	0.58	0.52	0.45	0.40	0.33	0.30	0.000%
2	0.75	0.66	0.60	0.51	0.46	0.37	0.35	0.067%
2.25	0.85	0.75	0.67	0.58	0.51	0.42	0.39	0.081%
2.5	0.94	0.83	0.75	0.64	0.57	0.47	0.43	0.033%
2.75	1.04	0.91	0.82	0.71	0.63	0.51	0.48	0.013%
3	1.13	1.00	0.90	0.77	0.68	0.56	0.52	0.000%
Total Percent Occurrence	0.093%	0.074%	0.023%	0.005%	0.000%	0.000%	0.000%	0.19%

【Peak Wave Period, Tp=16sec】

	Wave Direction(degrees)							
Significant Wave Height, Hs(m)	205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.09	0.09	0.08	0.07	0.07	0.06	0.05	0.000%
0.5	0.19	0.17	0.16	0.14	0.13	0.11	0.10	0.000%
0.75	0.28	0.26	0.23	0.21	0.20	0.17	0.15	0.000%
1	0.38	0.35	0.31	0.29	0.26	0.22	0.20	0.000%
1.25	0.47	0.43	0.39	0.36	0.33	0.28	0.25	0.000%
1.5	0.57	0.52	0.47	0.43	0.39	0.34	0.29	0.000%
1.75	0.66	0.61	0.54	0.50	0.46	0.39	0.34	0.000%
2	0.76	0.69	0.62	0.57	0.52	0.45	0.39	0.000%
2.25	0.85	0.78	0.698	0.64	0.59	0.50	0.44	0.087%
2.5	0.95	0.87	0.78	0.72	0.65	0.56	0.49	0.109%
2.75	1.04	0.95	0.85	0.79	0.72	0.62	0.54	0.026%
3	1.14	1.04	0.93	0.86	0.78	0.67	0.59	0.009%
Total Percent Occurrence	0.076%	0.091%	0.048%	0.058%	0.008%	0.000%	0.000%	0.28%

【Peak Wave Period, Tp=18sec】

	Wave Direction(degrees)							
Significant Wave Height, Hs(m)	205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.09	0.09	0.07	0.07	0.06	0.05	0.05	0.000%
0.5	0.19	0.17	0.15	0.13	0.12	0.11	0.10	0.000%
0.75	0.28	0.26	0.22	0.20	0.18	0.16	0.15	0.000%
1	0.37	0.34	0.30	0.27	0.24	0.22	0.19	0.000%
1.25	0.47	0.43	0.37	0.34	0.30	0.27	0.24	0.000%
1.5	0.56	0.51	0.45	0.40	0.36	0.33	0.29	0.000%
1.75	0.65	0.60	0.52	0.47	0.42	0.38	0.34	0.000%
2	0.75	0.69	0.60	0.54	0.48	0.43	0.39	0.039%
2.25	0.84	0.77	0.67	0.60	0.54	0.49	0.44	0.062%
2.5	0.93	0.86	0.75	0.67	0.60	0.54	0.48	0.051%
2.75	1.03	0.94	0.82	0.74	0.66	0.60	0.53	0.020%
3	1.12	1.03	0.90	0.80	0.72	0.650	0.58	0.009%
Total Percent Occurrence	0.059%	0.065%	0.043%	0.011%	0.002%	0.000%	0.000%	0.18%

【Peak Wave Period, Tp=20sec】

	Wave Direction(degrees)							
Significant Wave Height, Hs(m)	205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.10	0.09	0.08	0.07	0.07	0.06	0.05	0.000%
0.5	0.20	0.18	0.17	0.15	0.13	0.12	0.10	0.000%
0.75	0.29	0.27	0.25	0.22	0.20	0.18	0.15	0.000%
1	0.39	0.36	0.34	0.29	0.26	0.23	0.21	0.000%
1.25	0.49	0.45	0.42	0.37	0.33	0.29	0.26	0.000%
1.5	0.59	0.55	0.50	0.44	0.39	0.35	0.31	0.000%
1.75	0.68	0.64	0.59	0.51	0.46	0.41	0.36	0.000%
2	0.78	0.73	0.67	0.59	0.52	0.47	0.41	0.049%
2.25	0.88	0.82	0.76	0.66	0.59	0.53	0.46	0.052%
2.5	0.98	0.91	0.84	0.73	0.65	0.58	0.51	0.028%
2.75	1.08	1.00	0.92	0.81	0.72	0.64	0.57	0.009%
3	1.17	1.09	1.01	0.88	0.78	0.701	0.62	0.000%
Total Percent Occurrence	0.014%	0.058%	0.047%	0.016%	0.002%	0.000%	0.000%	0.14%

Table A.2.5.17 Wave Height and Total Percent Occurrence at Berth W1 in the case of Plan-B (units : m)

【Peak Wave Period, Tp=6sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.09	0.08	0.07	0.06	0.06	0.05	0.000%
0.5	0.00	0.18	0.16	0.15	0.13	0.12	0.10	0.000%
0.75	0.00	0.27	0.24	0.22	0.19	0.18	0.15	0.000%
1	0.00	0.36	0.32	0.30	0.26	0.25	0.19	0.000%
1.25	0.00	0.46	0.40	0.37	0.32	0.31	0.24	0.000%
1.5	0.00	0.55	0.48	0.44	0.38	0.37	0.29	0.000%
1.75	0.00	0.64	0.56	0.52	0.45	0.43	0.34	0.000%
2	0.00	0.73	0.64	0.59	0.51	0.49	0.39	0.028%
2.25	0.00	0.82	0.72	0.67	0.58	0.55	0.44	0.044%
2.5	0.00	0.91	0.80	0.74	0.64	0.62	0.49	0.038%
2.75	0.00	1.00	0.88	0.82	0.703	0.68	0.53	0.000%
3	0.00	1.09	0.96	0.89	0.77	0.74	0.58	0.000%
Total Percent Occurrence	0.000%	0.043%	0.043%	0.024%	0.000%	0.000%	0.000%	0.11%

【Peak Wave Period, Tp=8sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.08	0.08	0.06	0.06	0.05	0.04	0.000%
0.5	0.00	0.16	0.15	0.13	0.11	0.10	0.09	0.000%
0.75	0.00	0.24	0.23	0.19	0.17	0.15	0.13	0.000%
1	0.00	0.33	0.31	0.26	0.22	0.19	0.18	0.000%
1.25	0.00	0.41	0.38	0.32	0.28	0.24	0.22	0.000%
1.5	0.00	0.49	0.46	0.39	0.33	0.29	0.27	0.000%
1.75	0.00	0.57	0.54	0.45	0.39	0.34	0.31	0.000%
2	0.00	0.65	0.62	0.52	0.44	0.39	0.35	0.001%
2.25	0.00	0.73	0.69	0.58	0.50	0.44	0.40	0.001%
2.5	0.00	0.82	0.77	0.65	0.55	0.48	0.44	0.022%
2.75	0.00	0.90	0.85	0.71	0.61	0.53	0.49	0.030%
3	0.00	0.98	0.92	0.78	0.66	0.58	0.53	0.012%
Total Percent Occurrence	0.000%	0.017%	0.032%	0.017%	0.000%	0.000%	0.000%	0.07%

【Peak Wave Period, Tp=10sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.08	0.07	0.07	0.06	0.05	0.05	0.04	0.000%
0.5	0.16	0.14	0.14	0.12	0.11	0.10	0.08	0.000%
0.75	0.23	0.21	0.21	0.18	0.16	0.15	0.12	0.000%
1	0.31	0.28	0.28	0.24	0.21	0.20	0.16	0.000%
1.25	0.39	0.35	0.35	0.30	0.26	0.25	0.20	0.000%
1.5	0.47	0.43	0.42	0.36	0.32	0.30	0.24	0.000%
1.75	0.55	0.50	0.49	0.42	0.37	0.35	0.29	0.000%
2	0.63	0.57	0.56	0.48	0.42	0.40	0.33	0.000%
2.25	0.704	0.64	0.63	0.54	0.47	0.45	0.37	0.005%
2.5	0.78	0.71	0.700	0.60	0.53	0.50	0.41	0.000%
2.75	0.86	0.78	0.77	0.66	0.58	0.55	0.45	0.000%
3	0.94	0.85	0.84	0.72	0.63	0.60	0.49	0.000%
Total Percent Occurrence	0.005%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.01%

【Peak Wave Period, Tp=12sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.08	0.07	0.06	0.05	0.05	0.05	0.04	0.000%
0.5	0.15	0.14	0.13	0.11	0.10	0.09	0.09	0.000%
0.75	0.23	0.21	0.19	0.16	0.16	0.14	0.13	0.000%
1	0.31	0.28	0.25	0.22	0.21	0.18	0.18	0.000%
1.25	0.39	0.35	0.31	0.27	0.26	0.23	0.22	0.000%
1.5	0.46	0.42	0.38	0.33	0.31	0.27	0.27	0.000%
1.75	0.54	0.49	0.44	0.38	0.36	0.32	0.31	0.000%
2	0.62	0.56	0.50	0.44	0.42	0.36	0.36	0.000%
2.25	0.697	0.64	0.56	0.49	0.47	0.41	0.40	0.000%
2.5	0.77	0.71	0.63	0.55	0.52	0.46	0.45	0.003%
2.75	0.85	0.78	0.69	0.60	0.57	0.50	0.49	0.006%
3	0.93	0.85	0.75	0.66	0.62	0.55	0.54	0.000%
Total Percent Occurrence	0.003%	0.006%	0.000%	0.000%	0.000%	0.000%	0.000%	0.01%

【Peak Wave Period, Tp=14sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.07	0.06	0.06	0.06	0.05	0.04	0.04	0.000%
0.5	0.14	0.12	0.12	0.11	0.11	0.09	0.08	0.000%
0.75	0.21	0.19	0.18	0.17	0.16	0.13	0.12	0.000%
1	0.27	0.25	0.24	0.23	0.22	0.18	0.16	0.000%
1.25	0.34	0.31	0.30	0.28	0.27	0.22	0.20	0.000%
1.5	0.41	0.37	0.36	0.34	0.32	0.27	0.24	0.000%
1.75	0.48	0.44	0.42	0.39	0.38	0.31	0.28	0.000%
2	0.55	0.50	0.48	0.45	0.43	0.36	0.32	0.000%
2.25	0.62	0.56	0.54	0.51	0.49	0.40	0.36	0.000%
2.5	0.69	0.62	0.60	0.56	0.54	0.44	0.40	0.000%
2.75	0.76	0.69	0.66	0.62	0.59	0.49	0.44	0.001%
3	0.82	0.75	0.71	0.68	0.65	0.53	0.48	0.000%
Total Percent Occurrence	0.001%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=16sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.07	0.06	0.05	0.05	0.04	0.04	0.03	0.000%
0.5	0.13	0.12	0.11	0.10	0.09	0.08	0.07	0.000%
0.75	0.20	0.19	0.16	0.14	0.13	0.11	0.10	0.000%
1	0.27	0.25	0.22	0.19	0.17	0.15	0.14	0.000%
1.25	0.34	0.31	0.27	0.24	0.22	0.19	0.17	0.000%
1.5	0.40	0.37	0.33	0.29	0.26	0.23	0.21	0.000%
1.75	0.47	0.43	0.38	0.34	0.30	0.27	0.24	0.000%
2	0.54	0.49	0.44	0.39	0.35	0.31	0.28	0.000%
2.25	0.60	0.56	0.49	0.43	0.39	0.34	0.31	0.000%
2.5	0.67	0.62	0.55	0.48	0.43	0.38	0.35	0.000%
2.75	0.74	0.68	0.60	0.53	0.48	0.42	0.38	0.001%
3	0.81	0.74	0.66	0.58	0.52	0.46	0.41	0.001%
Total Percent Occurrence	0.001%	0.001%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=18sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.06	0.06	0.05	0.05	0.05	0.04	0.04	0.000%
0.5	0.12	0.12	0.11	0.10	0.09	0.08	0.07	0.000%
0.75	0.18	0.17	0.16	0.15	0.14	0.12	0.11	0.000%
1	0.24	0.23	0.21	0.20	0.19	0.16	0.15	0.000%
1.25	0.30	0.29	0.26	0.25	0.23	0.21	0.18	0.000%
1.5	0.36	0.35	0.32	0.30	0.28	0.25	0.22	0.000%
1.75	0.42	0.40	0.37	0.35	0.32	0.29	0.25	0.000%
2	0.48	0.46	0.42	0.40	0.37	0.33	0.29	0.000%
2.25	0.54	0.52	0.48	0.45	0.42	0.37	0.33	0.000%
2.5	0.60	0.58	0.53	0.50	0.46	0.41	0.36	0.000%
2.75	0.66	0.63	0.58	0.55	0.51	0.45	0.40	0.000%
3	0.72	0.69	0.63	0.60	0.56	0.49	0.44	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=20sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.06	0.06	0.06	0.05	0.04	0.04	0.03	0.000%
0.5	0.13	0.12	0.11	0.10	0.09	0.08	0.07	0.000%
0.75	0.19	0.18	0.17	0.15	0.13	0.11	0.10	0.000%
1	0.25	0.24	0.23	0.20	0.18	0.15	0.14	0.000%
1.25	0.31	0.30	0.28	0.25	0.22	0.19	0.17	0.000%
1.5	0.38	0.36	0.34	0.30	0.26	0.23	0.20	0.000%
1.75	0.44	0.42	0.40	0.35	0.31	0.27	0.24	0.000%
2	0.50	0.48	0.45	0.40	0.35	0.30	0.27	0.000%
2.25	0.57	0.54	0.51	0.45	0.39	0.34	0.30	0.000%
2.5	0.63	0.60	0.57	0.50	0.44	0.38	0.34	0.000%
2.75	0.69	0.66	0.62	0.54	0.48	0.42	0.37	0.000%
3	0.76	0.72	0.68	0.59	0.53	0.46	0.41	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

Table A.2.5.18 Wave Height and Total Percent Occurrence at Berth W2 in the case of Plan-B (units : m)

【Peak Wave Period, Tp=6sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.09	0.08	0.07	0.07	0.06	0.05	0.000%
0.5	0.00	0.18	0.16	0.14	0.13	0.12	0.10	0.000%
0.75	0.00	0.28	0.24	0.22	0.20	0.17	0.15	0.000%
1	0.00	0.37	0.32	0.29	0.27	0.23	0.19	0.000%
1.25	0.00	0.46	0.40	0.36	0.34	0.29	0.24	0.000%
1.5	0.00	0.55	0.49	0.43	0.40	0.35	0.29	0.000%
1.75	0.00	0.65	0.57	0.51	0.47	0.40	0.34	0.000%
2	0.00	0.74	0.65	0.58	0.54	0.46	0.39	0.026%
2.25	0.00	0.83	0.73	0.65	0.60	0.52	0.44	0.044%
2.5	0.00	0.92	0.81	0.72	0.67	0.58	0.49	0.038%
2.75	0.00	1.01	0.89	0.79	0.74	0.63	0.54	0.000%
3	0.00	1.11	0.97	0.87	0.81	0.69	0.56	0.000%
Total Percent Occurrence	0.000%	0.043%	0.043%	0.024%	0.000%	0.000%	0.000%	0.11%

【Peak Wave Period, Tp=8sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.07	0.07	0.06	0.05	0.05	0.04	0.000%
0.5	0.00	0.14	0.13	0.12	0.10	0.09	0.09	0.000%
0.75	0.00	0.22	0.20	0.18	0.16	0.14	0.13	0.000%
1	0.00	0.29	0.27	0.23	0.21	0.19	0.17	0.000%
1.25	0.00	0.36	0.33	0.29	0.26	0.24	0.22	0.000%
1.5	0.00	0.43	0.40	0.35	0.31	0.28	0.26	0.000%
1.75	0.00	0.51	0.47	0.41	0.36	0.33	0.30	0.000%
2	0.00	0.58	0.53	0.47	0.42	0.38	0.35	0.001%
2.25	0.00	0.65	0.60	0.53	0.47	0.42	0.39	0.000%
2.5	0.00	0.72	0.67	0.59	0.52	0.47	0.43	0.007%
2.75	0.00	0.80	0.73	0.64	0.57	0.52	0.477	0.018%
3	0.00	0.87	0.80	0.702	0.63	0.56	0.52	0.012%
Total Percent Occurrence	0.000%	0.016%	0.017%	0.005%	0.000%	0.000%	0.000%	0.04%

【Peak Wave Period, Tp=10sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.07	0.07	0.06	0.05	0.05	0.04	0.04	0.000%
0.5	0.15	0.14	0.13	0.11	0.10	0.09	0.07	0.000%
0.75	0.22	0.22	0.19	0.16	0.15	0.13	0.11	0.000%
1	0.29	0.29	0.26	0.22	0.19	0.17	0.15	0.000%
1.25	0.37	0.36	0.32	0.27	0.24	0.22	0.18	0.000%
1.5	0.44	0.43	0.39	0.33	0.29	0.26	0.22	0.000%
1.75	0.51	0.50	0.45	0.38	0.34	0.31	0.26	0.000%
2	0.59	0.57	0.52	0.44	0.39	0.35	0.29	0.000%
2.25	0.66	0.65	0.58	0.49	0.44	0.39	0.33	0.000%
2.5	0.73	0.72	0.65	0.55	0.48	0.44	0.37	0.000%
2.75	0.81	0.79	0.71	0.60	0.53	0.481	0.404	0.000%
3	0.88	0.86	0.77	0.66	0.58	0.52	0.44	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=12sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.08	0.07	0.06	0.06	0.05	0.04	0.04	0.000%
0.5	0.15	0.14	0.12	0.11	0.10	0.08	0.08	0.000%
0.75	0.23	0.21	0.19	0.17	0.15	0.13	0.12	0.000%
1	0.31	0.27	0.25	0.22	0.20	0.17	0.16	0.000%
1.25	0.39	0.34	0.31	0.28	0.25	0.21	0.21	0.000%
1.5	0.46	0.41	0.37	0.33	0.30	0.25	0.25	0.000%
1.75	0.54	0.48	0.43	0.39	0.35	0.29	0.29	0.000%
2	0.62	0.55	0.50	0.44	0.40	0.33	0.33	0.000%
2.25	0.69	0.62	0.56	0.50	0.45	0.38	0.37	0.000%
2.5	0.77	0.68	0.62	0.55	0.50	0.42	0.41	0.003%
2.75	0.85	0.75	0.68	0.61	0.55	0.46	0.45	0.000%
3	0.92	0.82	0.74	0.66	0.60	0.50	0.49	0.000%
Total Percent Occurrence	0.003%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=14sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.08	0.07	0.07	0.06	0.05	0.04	0.04	0.000%
0.5	0.16	0.14	0.13	0.11	0.10	0.09	0.08	0.000%
0.75	0.24	0.21	0.20	0.17	0.16	0.13	0.12	0.000%
1	0.32	0.29	0.26	0.23	0.21	0.17	0.16	0.000%
1.25	0.40	0.36	0.33	0.28	0.26	0.22	0.20	0.000%
1.5	0.48	0.43	0.40	0.34	0.31	0.26	0.24	0.000%
1.75	0.56	0.50	0.46	0.40	0.36	0.30	0.28	0.000%
2	0.64	0.57	0.53	0.45	0.42	0.35	0.32	0.000%
2.25	0.72	0.64	0.60	0.51	0.47	0.39	0.36	0.021%
2.5	0.80	0.71	0.66	0.56	0.52	0.43	0.40	0.015%
2.75	0.88	0.78	0.73	0.62	0.57	0.48	0.44	0.008%
3	0.96	0.86	0.79	0.68	0.62	0.52	0.48	0.000%
Total Percent Occurrence	0.026%	0.014%	0.005%	0.000%	0.000%	0.000%	0.000%	0.04%

【Peak Wave Period, Tp=16sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.08	0.07	0.06	0.06	0.05	0.04	0.04	0.000%
0.5	0.15	0.13	0.12	0.11	0.10	0.09	0.08	0.000%
0.75	0.23	0.20	0.18	0.17	0.15	0.13	0.12	0.000%
1	0.30	0.27	0.24	0.22	0.20	0.17	0.15	0.000%
1.25	0.38	0.34	0.30	0.28	0.25	0.22	0.19	0.000%
1.5	0.45	0.40	0.36	0.33	0.30	0.26	0.23	0.000%
1.75	0.53	0.47	0.42	0.39	0.35	0.31	0.27	0.000%
2	0.60	0.54	0.48	0.44	0.40	0.35	0.31	0.000%
2.25	0.68	0.61	0.54	0.50	0.45	0.39	0.35	0.000%
2.5	0.75	0.67	0.60	0.55	0.51	0.44	0.39	0.005%
2.75	0.83	0.74	0.66	0.61	0.56	0.48	0.43	0.004%
3	0.91	0.81	0.72	0.67	0.61	0.52	0.46	0.004%
Total Percent Occurrence	0.006%	0.005%	0.002%	0.000%	0.000%	0.000%	0.000%	0.01%

【Peak Wave Period, Tp=18sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.08	0.07	0.06	0.06	0.05	0.05	0.04	0.000%
0.5	0.15	0.14	0.13	0.12	0.10	0.09	0.08	0.000%
0.75	0.23	0.21	0.19	0.18	0.16	0.14	0.12	0.000%
1	0.31	0.28	0.25	0.23	0.21	0.18	0.16	0.000%
1.25	0.39	0.36	0.32	0.29	0.26	0.23	0.20	0.000%
1.5	0.46	0.43	0.38	0.35	0.31	0.28	0.25	0.000%
1.75	0.54	0.50	0.45	0.41	0.36	0.32	0.29	0.000%
2	0.62	0.57	0.51	0.47	0.42	0.37	0.33	0.000%
2.25	0.696	0.64	0.57	0.53	0.47	0.42	0.37	0.000%
2.5	0.77	0.71	0.64	0.59	0.52	0.46	0.41	0.018%
2.75	0.85	0.79	0.700	0.64	0.57	0.51	0.45	0.012%
3	0.93	0.86	0.76	0.703	0.63	0.55	0.49	0.007%
Total Percent Occurrence	0.005%	0.018%	0.010%	0.003%	0.000%	0.000%	0.000%	0.04%

【Peak Wave Period, Tp=20sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.08	0.07	0.07	0.06	0.05	0.05	0.04	0.000%
0.5	0.15	0.14	0.13	0.11	0.10	0.09	0.08	0.000%
0.75	0.23	0.22	0.20	0.17	0.15	0.14	0.13	0.000%
1	0.30	0.29	0.26	0.23	0.20	0.19	0.17	0.000%
1.25	0.38	0.36	0.33	0.29	0.26	0.23	0.21	0.000%
1.5	0.46	0.43	0.40	0.34	0.31	0.28	0.25	0.000%
1.75	0.53	0.50	0.46	0.40	0.36	0.33	0.30	0.000%
2	0.61	0.57	0.53	0.46	0.41	0.37	0.34	0.000%
2.25	0.69	0.65	0.60	0.51	0.46	0.42	0.38	0.000%
2.5	0.76	0.72	0.66	0.57	0.51	0.47	0.42	0.005%
2.75	0.84	0.79	0.73	0.63	0.56	0.52	0.47	0.004%
3	0.91	0.86	0.79	0.69	0.61	0.56	0.51	0.000%
Total Percent Occurrence	0.001%	0.005%	0.002%	0.000%	0.000%	0.000%	0.000%	0.01%

Table A.2.5.19 Wave Height and Total Percent Occurrence at Berth E1 in the case of Plan-C (units : m)

【Peak Wave Period, Tp=6sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.07	0.06	0.05	0.05	0.04	0.04	0.000%
0.5	0.00	0.14	0.12	0.11	0.10	0.09	0.08	0.000%
0.75	0.00	0.21	0.18	0.16	0.16	0.13	0.13	0.000%
1	0.00	0.28	0.24	0.22	0.21	0.18	0.17	0.000%
1.25	0.00	0.35	0.30	0.27	0.26	0.22	0.21	0.000%
1.5	0.00	0.41	0.36	0.33	0.31	0.27	0.25	0.000%
1.75	0.00	0.48	0.42	0.38	0.36	0.31	0.29	0.000%
2	0.00	0.55	0.49	0.44	0.41	0.36	0.33	0.000%
2.25	0.00	0.62	0.55	0.49	0.47	0.40	0.38	0.000%
2.5	0.00	0.69	0.61	0.55	0.52	0.45	0.42	0.000%
2.75	0.00	0.76	0.67	0.60	0.57	0.49	0.46	0.000%
3	0.00	0.83	0.73	0.66	0.62	0.54	0.50	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=8sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.07	0.06	0.05	0.04	0.05	0.03	0.000%
0.5	0.00	0.14	0.12	0.10	0.08	0.11	0.06	0.000%
0.75	0.00	0.21	0.18	0.15	0.13	0.16	0.09	0.000%
1	0.00	0.28	0.24	0.20	0.17	0.22	0.12	0.000%
1.25	0.00	0.35	0.30	0.25	0.21	0.27	0.16	0.000%
1.5	0.00	0.42	0.36	0.30	0.25	0.32	0.19	0.000%
1.75	0.00	0.49	0.42	0.35	0.29	0.38	0.22	0.000%
2	0.00	0.56	0.48	0.40	0.34	0.43	0.25	0.000%
2.25	0.00	0.63	0.54	0.44	0.38	0.49	0.28	0.000%
2.5	0.00	0.704	0.60	0.49	0.42	0.54	0.31	0.007%
2.75	0.00	0.77	0.66	0.54	0.46	0.59	0.34	0.006%
3	0.00	0.84	0.72	0.59	0.50	0.65	0.37	0.007%
Total Percent Occurrence	0.00%	0.02%	0.005%	0.000%	0.000%	0.000%	0.000%	0.02%

【Peak Wave Period, Tp=10sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.08	0.07	0.07	0.06	0.05	0.04	0.04	0.000%
0.5	0.16	0.15	0.13	0.11	0.09	0.09	0.07	0.000%
0.75	0.25	0.22	0.20	0.17	0.14	0.13	0.11	0.000%
1	0.33	0.30	0.26	0.23	0.19	0.18	0.15	0.000%
1.25	0.41	0.37	0.33	0.28	0.24	0.22	0.18	0.000%
1.5	0.49	0.45	0.39	0.34	0.28	0.26	0.22	0.000%
1.75	0.58	0.52	0.46	0.39	0.33	0.31	0.25	0.000%
2	0.66	0.59	0.52	0.45	0.38	0.35	0.29	0.000%
2.25	0.74	0.67	0.59	0.51	0.42	0.40	0.33	0.005%
2.5	0.82	0.74	0.66	0.56	0.47	0.44	0.36	0.000%
2.75	0.90	0.82	0.72	0.62	0.52	0.48	0.40	0.000%
3	0.99	0.89	0.79	0.68	0.56	0.53	0.44	0.000%
Total Percent Occurrence	0.005%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.01%

【Peak Wave Period, Tp=12sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.09	0.08	0.07	0.06	0.05	0.04	0.04	0.000%
0.5	0.18	0.16	0.14	0.12	0.11	0.09	0.08	0.000%
0.75	0.27	0.23	0.21	0.18	0.16	0.13	0.13	0.000%
1	0.36	0.31	0.28	0.24	0.21	0.18	0.17	0.000%
1.25	0.45	0.39	0.35	0.30	0.26	0.22	0.21	0.000%
1.5	0.54	0.47	0.42	0.36	0.32	0.27	0.25	0.000%
1.75	0.63	0.55	0.49	0.42	0.37	0.31	0.29	0.000%
2	0.72	0.62	0.56	0.48	0.42	0.36	0.33	0.067%
2.25	0.81	0.703	0.63	0.54	0.47	0.40	0.38	0.035%
2.5	0.89	0.78	0.698	0.60	0.53	0.45	0.42	0.009%
2.75	0.98	0.86	0.77	0.66	0.58	0.49	0.46	0.000%
3	1.07	0.94	0.84	0.72	0.63	0.53	0.50	0.000%
Total Percent Occurrence	0.080%	0.031%	0.000%	0.000%	0.000%	0.000%	0.000%	0.11%

【Peak Wave Period, Tp=14sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.09	0.08	0.07	0.06	0.06	0.05	0.05	0.000%
0.5	0.17	0.16	0.14	0.13	0.12	0.10	0.10	0.000%
0.75	0.26	0.23	0.22	0.19	0.18	0.15	0.14	0.000%
1	0.35	0.31	0.29	0.26	0.24	0.20	0.19	0.000%
1.25	0.43	0.39	0.36	0.32	0.30	0.25	0.24	0.000%
1.5	0.52	0.47	0.43	0.39	0.36	0.30	0.29	0.000%
1.75	0.61	0.54	0.50	0.45	0.42	0.36	0.33	0.000%
2	0.69	0.62	0.57	0.52	0.48	0.41	0.38	0.000%
2.25	0.78	0.698	0.65	0.58	0.54	0.46	0.43	0.021%
2.5	0.86	0.78	0.72	0.65	0.60	0.51	0.48	0.033%
2.75	0.95	0.85	0.79	0.71	0.66	0.56	0.52	0.013%
3	1.04	0.93	0.86	0.77	0.71	0.61	0.57	0.000%
Total Percent Occurrence	0.026%	0.014%	0.023%	0.005%	0.000%	0.000%	0.000%	0.07%

【Peak Wave Period, Tp=16sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.09	0.08	0.07	0.07	0.06	0.05	0.04	0.000%
0.5	0.19	0.17	0.15	0.13	0.12	0.10	0.09	0.000%
0.75	0.28	0.25	0.22	0.20	0.16	0.15	0.13	0.000%
1	0.37	0.33	0.29	0.26	0.24	0.20	0.17	0.000%
1.25	0.47	0.42	0.36	0.33	0.30	0.25	0.22	0.000%
1.5	0.56	0.50	0.44	0.40	0.36	0.30	0.26	0.000%
1.75	0.65	0.58	0.51	0.46	0.42	0.35	0.30	0.000%
2	0.75	0.67	0.58	0.53	0.48	0.40	0.35	0.052%
2.25	0.84	0.75	0.66	0.59	0.54	0.45	0.39	0.087%
2.5	0.94	0.83	0.73	0.66	0.59	0.50	0.44	0.062%
2.75	1.03	0.92	0.80	0.72	0.65	0.55	0.48	0.020%
3	1.12	1.00	0.88	0.79	0.71	0.60	0.52	0.009%
Total Percent Occurrence	0.078%	0.091%	0.048%	0.012%	0.002%	0.000%	0.000%	0.23%

【Peak Wave Period, Tp=18sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.09	0.08	0.08	0.07	0.06	0.06	0.05	0.000%
0.5	0.18	0.17	0.15	0.14	0.12	0.11	0.10	0.000%
0.75	0.27	0.25	0.23	0.21	0.19	0.17	0.15	0.000%
1	0.36	0.34	0.30	0.28	0.25	0.22	0.20	0.000%
1.25	0.45	0.42	0.38	0.34	0.31	0.28	0.25	0.000%
1.5	0.54	0.51	0.45	0.41	0.37	0.33	0.29	0.000%
1.75	0.63	0.59	0.53	0.48	0.43	0.39	0.34	0.000%
2	0.72	0.68	0.60	0.55	0.50	0.44	0.39	0.039%
2.25	0.81	0.76	0.68	0.62	0.56	0.50	0.44	0.062%
2.5	0.90	0.84	0.75	0.69	0.62	0.56	0.49	0.051%
2.75	0.99	0.93	0.83	0.76	0.68	0.61	0.54	0.020%
3	1.08	1.01	0.90	0.83	0.74	0.67	0.59	0.009%
Total Percent Occurrence	0.059%	0.065%	0.043%	0.011%	0.002%	0.000%	0.000%	0.18%

【Peak Wave Period, Tp=20sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.09	0.09	0.08	0.07	0.06	0.06	0.05	0.000%
0.5	0.19	0.18	0.16	0.14	0.13	0.11	0.10	0.000%
0.75	0.28	0.26	0.24	0.21	0.19	0.17	0.15	0.000%
1	0.38	0.35	0.32	0.28	0.25	0.22	0.20	0.000%
1.25	0.47	0.44	0.41	0.35	0.32	0.28	0.25	0.000%
1.5	0.57	0.53	0.49	0.42	0.38	0.34	0.30	0.000%
1.75	0.66	0.62	0.57	0.49	0.44	0.39	0.35	0.000%
2	0.76	0.704	0.65	0.56	0.51	0.45	0.40	0.049%
2.25	0.85	0.79	0.73	0.64	0.57	0.51	0.45	0.052%
2.5	0.94	0.88	0.81	0.71	0.63	0.56	0.50	0.028%
2.75	1.04	0.97	0.89	0.78	0.696	0.62	0.55	0.007%
3	1.13	1.06	0.97	0.85	0.76	0.67	0.60	0.000%
Total Percent Occurrence	0.014%	0.058%	0.012%	0.016%	0.000%	0.000%	0.000%	0.10%

Table A.2.5.20 Wave Height and Total Percent Occurrence at Berth E2 in the case of Plan-C (units : m)

【Peak Wave Period, Tp=6sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.07	0.07	0.06	0.05	0.05	0.04	0.000%
0.5	0.00	0.14	0.13	0.13	0.11	0.10	0.09	0.000%
0.75	0.00	0.21	0.20	0.19	0.16	0.16	0.13	0.000%
1	0.00	0.28	0.27	0.26	0.22	0.21	0.17	0.000%
1.25	0.00	0.35	0.33	0.32	0.27	0.26	0.21	0.000%
1.5	0.00	0.42	0.40	0.38	0.33	0.31	0.26	0.000%
1.75	0.00	0.49	0.47	0.45	0.38	0.37	0.30	0.000%
2	0.00	0.56	0.53	0.51	0.44	0.42	0.34	0.000%
2.25	0.00	0.63	0.60	0.58	0.49	0.47	0.38	0.000%
2.5	0.00	0.69	0.67	0.64	0.55	0.52	0.43	0.000%
2.75	0.00	0.76	0.73	0.705	0.60	0.58	0.47	0.000%
3	0.00	0.83	0.80	0.77	0.66	0.63	0.51	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=8sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.07	0.06	0.05	0.04	0.04	0.04	0.000%
0.5	0.00	0.14	0.12	0.11	0.09	0.09	0.08	0.000%
0.75	0.00	0.21	0.19	0.16	0.13	0.13	0.12	0.000%
1	0.00	0.29	0.25	0.21	0.18	0.17	0.17	0.000%
1.25	0.00	0.36	0.31	0.27	0.22	0.22	0.21	0.000%
1.5	0.00	0.43	0.37	0.32	0.27	0.26	0.25	0.000%
1.75	0.00	0.50	0.44	0.37	0.31	0.30	0.29	0.000%
2	0.00	0.57	0.50	0.42	0.36	0.35	0.33	0.000%
2.25	0.00	0.64	0.56	0.48	0.40	0.39	0.37	0.000%
2.5	0.00	0.72	0.62	0.53	0.44	0.43	0.42	0.007%
2.75	0.00	0.79	0.68	0.58	0.49	0.48	0.46	0.006%
3	0.00	0.86	0.75	0.64	0.53	0.52	0.50	0.007%
Total Percent Occurrence	0.00%	0.016%	0.005%	0.000%	0.000%	0.000%	0.000%	0.02%

【Peak Wave Period, Tp=10sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.08	0.07	0.06	0.06	0.05	0.04	0.04	0.000%
0.5	0.17	0.14	0.13	0.11	0.10	0.09	0.07	0.000%
0.75	0.25	0.22	0.19	0.17	0.14	0.13	0.11	0.000%
1	0.34	0.29	0.26	0.23	0.19	0.18	0.15	0.000%
1.25	0.42	0.36	0.32	0.28	0.24	0.22	0.19	0.000%
1.5	0.51	0.43	0.38	0.34	0.29	0.27	0.22	0.000%
1.75	0.59	0.50	0.45	0.39	0.33	0.31	0.26	0.000%
2	0.67	0.58	0.51	0.45	0.38	0.36	0.30	0.000%
2.25	0.76	0.65	0.57	0.51	0.43	0.40	0.34	0.005%
2.5	0.84	0.72	0.64	0.56	0.48	0.45	0.37	0.000%
2.75	0.93	0.79	0.702	0.62	0.53	0.49	0.41	0.000%
3	1.01	0.87	0.77	0.68	0.57	0.54	0.45	0.000%
Total Percent Occurrence	0.005%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.01%

【Peak Wave Period, Tp=12sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.09	0.07	0.07	0.06	0.06	0.05	0.04	0.000%
0.5	0.17	0.15	0.13	0.12	0.11	0.10	0.09	0.000%
0.75	0.26	0.22	0.20	0.18	0.17	0.14	0.13	0.000%
1	0.34	0.30	0.27	0.24	0.22	0.19	0.18	0.000%
1.25	0.43	0.37	0.34	0.30	0.28	0.24	0.22	0.000%
1.5	0.52	0.45	0.40	0.36	0.33	0.29	0.26	0.000%
1.75	0.60	0.52	0.47	0.42	0.39	0.34	0.31	0.000%
2	0.69	0.60	0.54	0.48	0.45	0.38	0.35	0.000%
2.25	0.78	0.67	0.61	0.54	0.50	0.43	0.40	0.011%
2.5	0.86	0.75	0.67	0.60	0.56	0.48	0.44	0.009%
2.75	0.95	0.82	0.74	0.66	0.61	0.53	0.48	0.000%
3	1.03	0.90	0.81	0.72	0.67	0.57	0.53	0.000%
Total Percent Occurrence	0.013%	0.006%	0.000%	0.000%	0.000%	0.000%	0.000%	0.02%

【Peak Wave Period, Tp=14sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.10	0.09	0.08	0.07	0.06	0.05	0.05	0.000%
0.5	0.19	0.18	0.16	0.14	0.13	0.11	0.10	0.000%
0.75	0.29	0.26	0.24	0.21	0.19	0.16	0.15	0.000%
1	0.39	0.35	0.33	0.28	0.26	0.21	0.20	0.000%
1.25	0.48	0.44	0.41	0.36	0.32	0.27	0.25	0.000%
1.5	0.58	0.53	0.49	0.43	0.38	0.32	0.30	0.000%
1.75	0.68	0.61	0.57	0.50	0.45	0.37	0.35	0.000%
2	0.77	0.701	0.65	0.57	0.51	0.43	0.40	0.262%
2.25	0.87	0.79	0.73	0.64	0.58	0.48	0.45	0.182%
2.5	0.97	0.88	0.81	0.71	0.64	0.53	0.50	0.053%
2.75	1.06	0.96	0.89	0.78	0.705	0.59	0.55	0.017%
3	1.16	1.05	0.98	0.85	0.77	0.64	0.60	0.000%
Total Percent Occurrence	0.093%	0.270%	0.123%	0.025%	0.004%	0.000%	0.000%	0.51%

【Peak Wave Period, Tp=16sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.10	0.09	0.08	0.07	0.06	0.05	0.05	0.000%
0.5	0.20	0.18	0.16	0.14	0.13	0.11	0.09	0.000%
0.75	0.30	0.27	0.23	0.21	0.19	0.16	0.14	0.000%
1	0.40	0.36	0.31	0.28	0.25	0.21	0.19	0.000%
1.25	0.50	0.45	0.39	0.35	0.31	0.26	0.23	0.000%
1.5	0.61	0.54	0.47	0.42	0.38	0.32	0.28	0.000%
1.75	0.71	0.63	0.55	0.49	0.44	0.37	0.33	0.123%
2	0.81	0.71	0.62	0.56	0.50	0.42	0.37	0.239%
2.25	0.91	0.80	0.703	0.63	0.57	0.48	0.42	0.232%
2.5	1.01	0.89	0.78	0.704	0.63	0.53	0.47	0.109%
2.75	1.11	0.98	0.86	0.77	0.69	0.58	0.51	0.020%
3	1.21	1.07	0.94	0.84	0.76	0.63	0.56	0.009%
Total Percent Occurrence	0.201%	0.278%	0.193%	0.058%	0.002%	0.000%	0.000%	0.73%

【Peak Wave Period, Tp=18sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.10	0.09	0.08	0.08	0.07	0.06	0.06	0.000%
0.5	0.20	0.19	0.17	0.15	0.14	0.12	0.11	0.000%
0.75	0.30	0.28	0.25	0.23	0.21	0.19	0.17	0.000%
1	0.40	0.37	0.33	0.30	0.27	0.25	0.22	0.000%
1.25	0.50	0.46	0.41	0.38	0.34	0.31	0.28	0.000%
1.5	0.60	0.56	0.50	0.45	0.41	0.37	0.33	0.000%
1.75	0.699	0.65	0.58	0.53	0.48	0.43	0.39	0.000%
2	0.80	0.74	0.66	0.60	0.55	0.50	0.44	0.165%
2.25	0.90	0.84	0.74	0.68	0.62	0.56	0.50	0.180%
2.5	1.00	0.93	0.83	0.76	0.68	0.62	0.56	0.068%
2.75	1.10	1.02	0.91	0.83	0.75	0.68	0.61	0.026%
3	1.20	1.11	0.99	0.91	0.82	0.75	0.67	0.010%
Total Percent Occurrence	0.059%	0.192%	0.161%	0.049%	0.008%	0.001%	0.000%	0.47%

【Peak Wave Period, Tp=20sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.10	0.10	0.09	0.08	0.07	0.06	0.06	0.000%
0.5	0.21	0.19	0.18	0.15	0.14	0.12	0.11	0.000%
0.75	0.31	0.29	0.26	0.23	0.21	0.18	0.17	0.000%
1	0.41	0.38	0.35	0.31	0.28	0.25	0.22	0.000%
1.25	0.51	0.48	0.44	0.39	0.35	0.31	0.28	0.000%
1.5	0.62	0.57	0.53	0.46	0.42	0.37	0.33	0.000%
1.75	0.72	0.67	0.61	0.54	0.49	0.44	0.39	0.022%
2	0.82	0.76	0.702	0.62	0.56	0.50	0.44	0.146%
2.25	0.93	0.86	0.79	0.69	0.63	0.56	0.50	0.052%
2.5	1.03	0.95	0.88	0.77	0.698	0.62	0.55	0.028%
2.75	1.13	1.05	0.97	0.85	0.77	0.69	0.61	0.009%
3	1.23	1.14	1.05	0.93	0.84	0.75	0.66	0.000%
Total Percent Occurrence	0.036%	0.058%	0.144%	0.016%	0.002%	0.000%	0.000%	0.26%

Table A.2.5.21 Wave Height and Total Percent Occurrence at Berth E3 in the case of Plan-C (units : m)

【Peak Wave Period, Tp=6sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.07	0.07	0.07	0.06	0.05	0.04	0.000%
0.5	0.00	0.15	0.14	0.14	0.12	0.10	0.09	0.000%
0.75	0.00	0.22	0.21	0.21	0.18	0.16	0.13	0.000%
1	0.00	0.29	0.27	0.28	0.24	0.21	0.17	0.000%
1.25	0.00	0.36	0.34	0.35	0.30	0.26	0.22	0.000%
1.5	0.00	0.44	0.41	0.42	0.36	0.31	0.26	0.000%
1.75	0.00	0.51	0.48	0.49	0.42	0.36	0.31	0.000%
2	0.00	0.58	0.55	0.56	0.48	0.41	0.35	0.000%
2.25	0.00	0.66	0.62	0.63	0.54	0.47	0.39	0.000%
2.5	0.00	0.73	0.69	0.69	0.60	0.52	0.44	0.003%
2.75	0.00	0.80	0.76	0.76	0.66	0.57	0.48	0.000%
3	0.00	0.87	0.82	0.83	0.72	0.62	0.52	0.000%
Total Percent Occurrence	0.00%	0.003%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=8sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.07	0.05	0.05	0.04	0.04	0.03	0.000%
0.5	0.00	0.13	0.11	0.09	0.07	0.07	0.06	0.000%
0.75	0.00	0.20	0.16	0.14	0.11	0.11	0.09	0.000%
1	0.00	0.26	0.22	0.18	0.15	0.14	0.13	0.000%
1.25	0.00	0.33	0.27	0.23	0.19	0.18	0.16	0.000%
1.5	0.00	0.39	0.33	0.28	0.22	0.21	0.19	0.000%
1.75	0.00	0.46	0.38	0.32	0.26	0.25	0.22	0.000%
2	0.00	0.53	0.44	0.37	0.30	0.28	0.25	0.000%
2.25	0.00	0.59	0.49	0.41	0.34	0.32	0.28	0.000%
2.5	0.00	0.66	0.55	0.46	0.37	0.36	0.32	0.000%
2.75	0.00	0.72	0.60	0.51	0.41	0.39	0.35	0.006%
3	0.00	0.79	0.66	0.55	0.45	0.43	0.38	0.002%
Total Percent Occurrence	0.00%	0.009%	0.000%	0.000%	0.000%	0.000%	0.000%	0.01%

【Peak Wave Period, Tp=10sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.08	0.07	0.06	0.05	0.05	0.04	0.03	0.000%
0.5	0.16	0.14	0.13	0.11	0.09	0.09	0.07	0.000%
0.75	0.24	0.21	0.19	0.16	0.14	0.13	0.10	0.000%
1	0.33	0.29	0.25	0.22	0.19	0.17	0.14	0.000%
1.25	0.41	0.36	0.32	0.27	0.23	0.22	0.17	0.000%
1.5	0.49	0.43	0.38	0.33	0.28	0.26	0.21	0.000%
1.75	0.57	0.50	0.44	0.38	0.33	0.30	0.24	0.000%
2	0.65	0.57	0.50	0.43	0.38	0.35	0.27	0.000%
2.25	0.73	0.64	0.57	0.49	0.42	0.39	0.31	0.005%
2.5	0.81	0.71	0.63	0.54	0.47	0.43	0.34	0.000%
2.75	0.89	0.78	0.69	0.60	0.52	0.48	0.38	0.000%
3	0.98	0.86	0.76	0.65	0.56	0.52	0.41	0.000%
Total Percent Occurrence	0.005%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.01%

【Peak Wave Period, Tp=12sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.08	0.07	0.07	0.06	0.06	0.05	0.04	0.000%
0.5	0.17	0.15	0.14	0.12	0.11	0.09	0.08	0.000%
0.75	0.25	0.22	0.21	0.19	0.17	0.14	0.13	0.000%
1	0.33	0.30	0.28	0.25	0.23	0.19	0.17	0.000%
1.25	0.42	0.37	0.35	0.31	0.28	0.24	0.22	0.000%
1.5	0.50	0.45	0.42	0.37	0.34	0.28	0.26	0.000%
1.75	0.58	0.52	0.49	0.43	0.40	0.33	0.30	0.000%
2	0.67	0.59	0.56	0.49	0.45	0.38	0.35	0.000%
2.25	0.75	0.67	0.63	0.56	0.51	0.43	0.39	0.011%
2.5	0.83	0.74	0.699	0.62	0.57	0.47	0.43	0.009%
2.75	0.92	0.82	0.77	0.68	0.62	0.52	0.48	0.000%
3	1.00	0.89	0.84	0.74	0.68	0.57	0.52	0.000%
Total Percent Occurrence	0.013%	0.006%	0.000%	0.000%	0.000%	0.000%	0.000%	0.02%

【Peak Wave Period, Tp=14sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.10	0.09	0.08	0.07	0.06	0.05	0.05	0.000%
0.5	0.20	0.17	0.16	0.14	0.13	0.11	0.10	0.000%
0.75	0.29	0.26	0.24	0.21	0.19	0.16	0.15	0.000%
1	0.39	0.35	0.32	0.28	0.25	0.21	0.19	0.000%
1.25	0.49	0.44	0.40	0.35	0.32	0.26	0.24	0.000%
1.5	0.59	0.52	0.48	0.42	0.38	0.32	0.29	0.000%
1.75	0.69	0.61	0.56	0.49	0.44	0.37	0.34	0.000%
2	0.78	0.699	0.64	0.56	0.50	0.42	0.39	0.067%
2.25	0.88	0.79	0.72	0.63	0.57	0.47	0.44	0.182%
2.5	0.98	0.87	0.80	0.700	0.63	0.53	0.49	0.053%
2.75	1.08	0.96	0.88	0.77	0.69	0.58	0.54	0.013%
3	1.18	1.05	0.96	0.84	0.76	0.63	0.58	0.000%
Total Percent Occurrence	0.093%	0.074%	0.123%	0.025%	0.000%	0.000%	0.000%	0.31%

【Peak Wave Period, Tp=16sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.09	0.08	0.07	0.07	0.06	0.05	0.05	0.000%
0.5	0.19	0.17	0.15	0.13	0.12	0.11	0.10	0.000%
0.75	0.28	0.25	0.22	0.20	0.19	0.16	0.14	0.000%
1	0.37	0.33	0.29	0.27	0.25	0.22	0.19	0.000%
1.25	0.47	0.42	0.36	0.33	0.31	0.27	0.24	0.000%
1.5	0.56	0.50	0.44	0.40	0.37	0.32	0.29	0.000%
1.75	0.65	0.58	0.51	0.47	0.43	0.38	0.34	0.000%
2	0.75	0.66	0.58	0.53	0.50	0.43	0.38	0.052%
2.25	0.84	0.75	0.66	0.60	0.56	0.49	0.43	0.087%
2.5	0.93	0.83	0.73	0.67	0.62	0.54	0.48	0.062%
2.75	1.03	0.91	0.80	0.73	0.68	0.59	0.53	0.020%
3	1.12	1.00	0.87	0.80	0.75	0.65	0.58	0.009%
Total Percent Occurrence	0.078%	0.091%	0.048%	0.012%	0.002%	0.000%	0.000%	0.23%

【Peak Wave Period, Tp=18sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.10	0.09	0.08	0.07	0.07	0.06	0.05	0.000%
0.5	0.19	0.18	0.16	0.15	0.13	0.12	0.10	0.000%
0.75	0.29	0.27	0.24	0.22	0.20	0.18	0.16	0.000%
1	0.39	0.36	0.32	0.29	0.26	0.24	0.21	0.000%
1.25	0.49	0.45	0.40	0.37	0.33	0.30	0.26	0.000%
1.5	0.58	0.54	0.48	0.44	0.40	0.35	0.31	0.000%
1.75	0.68	0.63	0.56	0.51	0.46	0.41	0.36	0.000%
2	0.78	0.72	0.64	0.59	0.53	0.47	0.42	0.165%
2.25	0.88	0.81	0.72	0.66	0.59	0.53	0.47	0.180%
2.5	0.97	0.90	0.80	0.73	0.66	0.59	0.52	0.088%
2.75	1.07	0.99	0.88	0.81	0.72	0.65	0.57	0.026%
3	1.17	1.08	0.96	0.88	0.79	0.71	0.62	0.010%
Total Percent Occurrence	0.059%	0.192%	0.161%	0.049%	0.008%	0.001%	0.000%	0.47%

【Peak Wave Period, Tp=20sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees) 205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.10	0.09	0.08	0.07	0.07	0.06	0.05	0.000%
0.5	0.19	0.18	0.17	0.15	0.13	0.12	0.11	0.000%
0.75	0.29	0.27	0.25	0.22	0.20	0.18	0.16	0.000%
1	0.38	0.36	0.33	0.29	0.27	0.24	0.21	0.000%
1.25	0.48	0.45	0.42	0.37	0.33	0.30	0.27	0.000%
1.5	0.58	0.54	0.50	0.44	0.40	0.36	0.32	0.000%
1.75	0.67	0.63	0.58	0.51	0.47	0.42	0.37	0.000%
2	0.77	0.72	0.67	0.59	0.53	0.48	0.43	0.049%
2.25	0.87	0.81	0.75	0.66	0.60	0.54	0.48	0.052%
2.5	0.96	0.90	0.83	0.73	0.67	0.60	0.53	0.028%
2.75	1.06	0.99	0.92	0.81	0.73	0.66	0.59	0.009%
3	1.15	1.08	1.00	0.88	0.80	0.72	0.64	0.000%
Total Percent Occurrence	0.014%	0.058%	0.047%	0.016%	0.002%	0.000%	0.000%	0.14%

Table A.2.5.22 Wave Height and Total Percent Occurrence at Berth E4 in the case of Plan-C (units : m)

【Peak Wave Period, Tp=6sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.07	0.08	0.08	0.06	0.05	0.04	0.000%
0.5	0.00	0.15	0.15	0.16	0.12	0.10	0.09	0.000%
0.75	0.00	0.22	0.23	0.23	0.18	0.15	0.13	0.000%
1	0.00	0.29	0.31	0.31	0.24	0.20	0.18	0.000%
1.25	0.00	0.37	0.39	0.39	0.31	0.25	0.22	0.000%
1.5	0.00	0.44	0.46	0.47	0.37	0.30	0.27	0.000%
1.75	0.00	0.51	0.54	0.54	0.43	0.35	0.31	0.000%
2	0.00	0.58	0.62	0.62	0.49	0.40	0.36	0.000%
2.25	0.00	0.66	0.696	0.698	0.55	0.45	0.40	0.000%
2.5	0.00	0.73	0.77	0.78	0.61	0.50	0.45	0.038%
2.75	0.00	0.80	0.85	0.85	0.67	0.55	0.49	0.000%
3	0.00	0.88	0.93	0.93	0.73	0.59	0.54	0.000%
Total Percent Occurrence	0.000%	0.003%	0.010%	0.024%	0.000%	0.000%	0.000%	0.04%

【Peak Wave Period, Tp=8sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.06	0.06	0.05	0.04	0.04	0.04	0.000%
0.5	0.00	0.13	0.11	0.09	0.08	0.08	0.07	0.000%
0.75	0.00	0.19	0.17	0.14	0.12	0.11	0.11	0.000%
1	0.00	0.25	0.23	0.19	0.16	0.15	0.14	0.000%
1.25	0.00	0.31	0.28	0.23	0.20	0.19	0.18	0.000%
1.5	0.00	0.38	0.34	0.28	0.24	0.23	0.21	0.000%
1.75	0.00	0.44	0.40	0.32	0.28	0.26	0.25	0.000%
2	0.00	0.50	0.45	0.37	0.32	0.30	0.28	0.000%
2.25	0.00	0.56	0.51	0.42	0.36	0.34	0.32	0.000%
2.5	0.00	0.63	0.56	0.46	0.40	0.38	0.35	0.000%
2.75	0.00	0.69	0.62	0.51	0.44	0.41	0.39	0.000%
3	0.00	0.75	0.68	0.56	0.48	0.45	0.42	0.000%
Total Percent Occurrence	0.000%	0.002%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=10sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.08	0.07	0.06	0.05	0.05	0.04	0.04	0.000%
0.5	0.15	0.15	0.13	0.11	0.09	0.09	0.07	0.000%
0.75	0.23	0.22	0.19	0.16	0.14	0.13	0.11	0.000%
1	0.31	0.29	0.26	0.22	0.18	0.17	0.15	0.000%
1.25	0.39	0.36	0.32	0.27	0.23	0.22	0.18	0.000%
1.5	0.46	0.44	0.38	0.33	0.27	0.26	0.22	0.000%
1.75	0.54	0.51	0.45	0.38	0.32	0.30	0.26	0.000%
2	0.62	0.58	0.51	0.44	0.36	0.34	0.29	0.000%
2.25	0.695	0.65	0.58	0.49	0.41	0.39	0.33	0.000%
2.5	0.77	0.73	0.64	0.55	0.45	0.43	0.37	0.000%
2.75	0.85	0.80	0.705	0.60	0.50	0.47	0.41	0.000%
3	0.93	0.87	0.77	0.66	0.54	0.52	0.44	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=12sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.08	0.07	0.07	0.06	0.05	0.04	0.04	0.000%
0.5	0.17	0.15	0.14	0.12	0.10	0.09	0.08	0.000%
0.75	0.25	0.22	0.21	0.18	0.16	0.13	0.12	0.000%
1	0.33	0.30	0.27	0.23	0.21	0.17	0.17	0.000%
1.25	0.41	0.37	0.34	0.29	0.26	0.22	0.21	0.000%
1.5	0.50	0.45	0.41	0.35	0.31	0.26	0.25	0.000%
1.75	0.58	0.52	0.48	0.41	0.36	0.30	0.29	0.000%
2	0.66	0.59	0.55	0.47	0.42	0.35	0.33	0.000%
2.25	0.74	0.67	0.62	0.53	0.47	0.39	0.37	0.011%
2.5	0.83	0.74	0.68	0.58	0.52	0.43	0.41	0.009%
2.75	0.91	0.82	0.75	0.64	0.57	0.48	0.45	0.000%
3	0.99	0.89	0.82	0.702	0.62	0.52	0.50	0.000%
Total Percent Occurrence	0.013%	0.006%	0.000%	0.000%	0.000%	0.000%	0.000%	0.02%

【Peak Wave Period, Tp=14sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.10	0.09	0.08	0.07	0.06	0.05	0.05	0.000%
0.5	0.20	0.17	0.16	0.14	0.12	0.10	0.09	0.000%
0.75	0.29	0.26	0.24	0.20	0.18	0.15	0.14	0.000%
1	0.39	0.35	0.32	0.27	0.25	0.20	0.18	0.000%
1.25	0.49	0.43	0.39	0.34	0.31	0.25	0.23	0.000%
1.5	0.59	0.52	0.47	0.41	0.37	0.30	0.28	0.000%
1.75	0.68	0.61	0.55	0.48	0.43	0.35	0.32	0.000%
2	0.78	0.69	0.63	0.54	0.49	0.41	0.37	0.067%
2.25	0.88	0.78	0.71	0.61	0.55	0.46	0.41	0.182%
2.5	0.98	0.87	0.79	0.68	0.61	0.51	0.46	0.033%
2.75	1.07	0.95	0.87	0.75	0.67	0.56	0.51	0.013%
3	1.17	1.04	0.95	0.82	0.74	0.61	0.55	0.000%
Total Percent Occurrence	0.093%	0.074%	0.123%	0.005%	0.000%	0.000%	0.000%	0.29%

【Peak Wave Period, Tp=16sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.10	0.09	0.08	0.07	0.07	0.06	0.05	0.000%
0.5	0.20	0.18	0.16	0.15	0.13	0.11	0.10	0.000%
0.75	0.29	0.26	0.24	0.22	0.20	0.17	0.15	0.000%
1	0.39	0.35	0.32	0.29	0.27	0.23	0.20	0.000%
1.25	0.49	0.44	0.39	0.36	0.33	0.28	0.25	0.000%
1.5	0.59	0.53	0.47	0.44	0.40	0.34	0.30	0.000%
1.75	0.69	0.62	0.55	0.51	0.47	0.40	0.35	0.000%
2	0.78	0.71	0.63	0.58	0.53	0.46	0.40	0.239%
2.25	0.88	0.79	0.71	0.66	0.60	0.51	0.45	0.232%
2.5	0.98	0.88	0.79	0.73	0.67	0.57	0.50	0.109%
2.75	1.08	0.97	0.87	0.80	0.73	0.63	0.54	0.028%
3	1.18	1.06	0.95	0.88	0.80	0.68	0.59	0.009%
Total Percent Occurrence	0.078%	0.278%	0.193%	0.058%	0.008%	0.000%	0.000%	0.62%

【Peak Wave Period, Tp=18sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.10	0.09	0.08	0.07	0.06	0.06	0.05	0.000%
0.5	0.20	0.18	0.16	0.14	0.13	0.12	0.10	0.000%
0.75	0.30	0.27	0.24	0.21	0.19	0.17	0.15	0.000%
1	0.40	0.36	0.32	0.29	0.26	0.23	0.21	0.000%
1.25	0.50	0.46	0.40	0.36	0.32	0.29	0.26	0.000%
1.5	0.60	0.55	0.48	0.43	0.39	0.35	0.31	0.000%
1.75	0.698	0.64	0.56	0.50	0.45	0.41	0.36	0.000%
2	0.80	0.73	0.64	0.57	0.52	0.46	0.41	0.165%
2.25	0.89	0.82	0.72	0.64	0.58	0.52	0.46	0.160%
2.5	0.99	0.91	0.80	0.72	0.65	0.58	0.52	0.088%
2.75	1.09	1.00	0.88	0.79	0.71	0.64	0.57	0.026%
3	1.19	1.09	0.95	0.86	0.78	0.697	0.62	0.009%
Total Percent Occurrence	0.059%	0.192%	0.161%	0.049%	0.008%	0.000%	0.000%	0.47%

【Peak Wave Period, Tp=20sec】

Significant Wave Height, Hs(m)	Wave Direction(degrees)							Total Percent Occurrence
	205	210	215	220	225	230	235	
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.10	0.10	0.09	0.08	0.07	0.06	0.05	0.000%
0.5	0.21	0.19	0.18	0.16	0.14	0.12	0.11	0.000%
0.75	0.31	0.29	0.27	0.23	0.21	0.19	0.16	0.000%
1	0.41	0.38	0.35	0.31	0.28	0.25	0.22	0.000%
1.25	0.52	0.48	0.44	0.39	0.35	0.31	0.27	0.000%
1.5	0.62	0.58	0.53	0.47	0.42	0.37	0.33	0.000%
1.75	0.72	0.67	0.62	0.54	0.49	0.43	0.38	0.022%
2	0.83	0.77	0.71	0.62	0.56	0.50	0.44	0.146%
2.25	0.93	0.86	0.80	0.699	0.63	0.56	0.49	0.052%
2.5	1.03	0.96	0.89	0.78	0.699	0.62	0.55	0.028%
2.75	1.14	1.05	0.98	0.85	0.77	0.68	0.60	0.009%
3	1.24	1.15	1.06	0.93	0.84	0.75	0.66	0.000%
Total Percent Occurrence	0.036%	0.058%	0.144%	0.016%	0.002%	0.000%	0.000%	0.26%

Table A.2.5.23 Wave Height and Total Percent Occurrence at Berth E5 in the case of Plan-C (units : m)

【Peak Wave Period, Tp=6sec】

	Wave Direction(degrees)							
Significant Wave Height, Hs(m)	205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.08	0.10	0.08	0.06	0.05	0.05	0.000%
0.5	0.00	0.16	0.19	0.16	0.13	0.10	0.10	0.000%
0.75	0.00	0.25	0.29	0.23	0.19	0.15	0.14	0.000%
1	0.00	0.33	0.39	0.31	0.26	0.20	0.19	0.000%
1.25	0.00	0.41	0.49	0.39	0.32	0.25	0.24	0.000%
1.5	0.00	0.49	0.58	0.47	0.39	0.30	0.29	0.000%
1.75	0.00	0.57	0.68	0.54	0.45	0.35	0.33	0.000%
2	0.00	0.65	0.78	0.62	0.52	0.40	0.38	0.085%
2.25	0.00	0.74	0.88	0.698	0.58	0.45	0.43	0.044%
2.5	0.00	0.82	0.97	0.78	0.65	0.50	0.48	0.038%
2.75	0.00	0.90	1.07	0.85	0.71	0.54	0.52	0.000%
3	0.00	0.98	1.17	0.93	0.78	0.59	0.57	0.000%
Total Percent Occurrence	0.000%	0.014%	0.128%	0.024%	0.000%	0.000%	0.000%	0.17%

【Peak Wave Period, Tp=8sec】

	Wave Direction(degrees)							
Significant Wave Height, Hs(m)	205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.07	0.06	0.05	0.04	0.04	0.04	0.000%
0.5	0.00	0.13	0.11	0.10	0.09	0.08	0.08	0.000%
0.75	0.00	0.20	0.17	0.15	0.13	0.12	0.11	0.000%
1	0.00	0.27	0.23	0.20	0.18	0.16	0.15	0.000%
1.25	0.00	0.34	0.29	0.25	0.22	0.20	0.19	0.000%
1.5	0.00	0.40	0.34	0.30	0.27	0.25	0.23	0.000%
1.75	0.00	0.47	0.40	0.35	0.31	0.29	0.27	0.000%
2	0.00	0.54	0.46	0.40	0.35	0.33	0.30	0.001%
2.25	0.00	0.60	0.52	0.45	0.40	0.37	0.34	0.001%
2.5	0.00	0.67	0.57	0.50	0.44	0.41	0.38	0.007%
2.75	0.00	0.74	0.63	0.55	0.49	0.45	0.42	0.006%
3	0.00	0.81	0.69	0.60	0.53	0.49	0.45	0.002%
Total Percent Occurrence	0.000%	0.009%	0.000%	0.000%	0.000%	0.000%	0.000%	0.01%

【Peak Wave Period, Tp=10sec】

	Wave Direction(degrees)							
Significant Wave Height, Hs(m)	205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.08	0.07	0.06	0.05	0.05	0.04	0.04	0.000%
0.5	0.16	0.14	0.13	0.11	0.09	0.09	0.07	0.000%
0.75	0.23	0.21	0.19	0.16	0.14	0.13	0.11	0.000%
1	0.31	0.28	0.25	0.21	0.19	0.18	0.14	0.000%
1.25	0.39	0.35	0.31	0.27	0.24	0.22	0.18	0.000%
1.5	0.47	0.42	0.38	0.32	0.28	0.26	0.22	0.000%
1.75	0.55	0.49	0.44	0.38	0.33	0.31	0.25	0.000%
2	0.63	0.56	0.50	0.43	0.38	0.35	0.29	0.000%
2.25	0.704	0.64	0.57	0.48	0.43	0.39	0.33	0.005%
2.5	0.78	0.71	0.63	0.54	0.47	0.44	0.36	0.000%
2.75	0.86	0.78	0.69	0.59	0.52	0.48	0.40	0.000%
3	0.94	0.85	0.75	0.64	0.57	0.53	0.43	0.000%
Total Percent Occurrence	0.005%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.01%

【Peak Wave Period, Tp=12sec】

	Wave Direction(degrees)							
Significant Wave Height, Hs(m)	205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.08	0.07	0.07	0.06	0.05	0.04	0.04	0.000%
0.5	0.17	0.15	0.14	0.12	0.11	0.09	0.08	0.000%
0.75	0.25	0.22	0.21	0.18	0.16	0.13	0.12	0.000%
1	0.34	0.30	0.27	0.24	0.21	0.18	0.17	0.000%
1.25	0.42	0.37	0.34	0.30	0.27	0.22	0.21	0.000%
1.5	0.51	0.45	0.41	0.36	0.32	0.27	0.25	0.000%
1.75	0.59	0.52	0.48	0.42	0.38	0.31	0.29	0.000%
2	0.68	0.60	0.55	0.48	0.43	0.36	0.33	0.000%
2.25	0.76	0.67	0.62	0.54	0.48	0.40	0.37	0.011%
2.5	0.85	0.75	0.69	0.60	0.54	0.45	0.41	0.009%
2.75	0.93	0.82	0.75	0.66	0.59	0.49	0.45	0.000%
3	1.01	0.90	0.82	0.72	0.64	0.54	0.50	0.000%
Total Percent Occurrence	0.013%	0.006%	0.000%	0.000%	0.000%	0.000%	0.000%	0.02%

【Peak Wave Period, Tp=14sec】

	Wave Direction(degrees)							
Significant Wave Height, Hs(m)	205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.09	0.08	0.07	0.06	0.06	0.05	0.04	0.000%
0.5	0.19	0.16	0.15	0.13	0.12	0.10	0.09	0.000%
0.75	0.28	0.25	0.22	0.19	0.17	0.14	0.13	0.000%
1	0.37	0.33	0.30	0.26	0.23	0.19	0.17	0.000%
1.25	0.46	0.41	0.37	0.32	0.29	0.24	0.22	0.000%
1.5	0.56	0.49	0.45	0.38	0.35	0.29	0.26	0.000%
1.75	0.65	0.58	0.52	0.45	0.40	0.33	0.30	0.000%
2	0.74	0.66	0.59	0.51	0.46	0.38	0.34	0.067%
2.25	0.84	0.74	0.67	0.58	0.52	0.43	0.39	0.081%
2.5	0.93	0.82	0.74	0.64	0.58	0.48	0.43	0.033%
2.75	1.02	0.90	0.82	0.705	0.64	0.53	0.47	0.013%
3	1.12	0.99	0.89	0.77	0.69	0.57	0.52	0.000%
Total Percent Occurrence	0.093%	0.074%	0.023%	0.005%	0.000%	0.000%	0.000%	0.19%

【Peak Wave Period, Tp=16sec】

	Wave Direction(degrees)							
Significant Wave Height, Hs(m)	205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.10	0.09	0.08	0.07	0.07	0.06	0.05	0.000%
0.5	0.20	0.18	0.16	0.14	0.13	0.11	0.10	0.000%
0.75	0.30	0.27	0.24	0.22	0.20	0.17	0.14	0.000%
1	0.40	0.36	0.32	0.29	0.26	0.22	0.19	0.000%
1.25	0.50	0.45	0.40	0.36	0.33	0.28	0.24	0.000%
1.5	0.60	0.54	0.47	0.43	0.39	0.33	0.29	0.000%
1.75	0.69	0.63	0.55	0.51	0.46	0.39	0.34	0.000%
2	0.79	0.72	0.63	0.58	0.52	0.44	0.38	0.239%
2.25	0.89	0.81	0.71	0.65	0.59	0.50	0.43	0.232%
2.5	0.99	0.90	0.79	0.72	0.66	0.55	0.48	0.109%
2.75	1.09	0.99	0.87	0.80	0.72	0.61	0.53	0.026%
3	1.19	1.08	0.95	0.87	0.79	0.66	0.58	0.009%
Total Percent Occurrence	0.078%	0.278%	0.193%	0.058%	0.008%	0.000%	0.000%	0.62%

【Peak Wave Period, Tp=18sec】

	Wave Direction(degrees)							
Significant Wave Height, Hs(m)	205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.09	0.09	0.08	0.07	0.06	0.06	0.05	0.000%
0.5	0.19	0.17	0.15	0.14	0.13	0.12	0.10	0.000%
0.75	0.28	0.26	0.23	0.21	0.19	0.17	0.15	0.000%
1	0.38	0.35	0.31	0.28	0.25	0.23	0.21	0.000%
1.25	0.47	0.44	0.38	0.35	0.32	0.29	0.26	0.000%
1.5	0.57	0.52	0.46	0.42	0.38	0.35	0.31	0.000%
1.75	0.66	0.61	0.54	0.49	0.45	0.40	0.36	0.000%
2	0.76	0.697	0.61	0.56	0.51	0.46	0.41	0.039%
2.25	0.85	0.78	0.69	0.63	0.57	0.52	0.46	0.062%
2.5	0.95	0.87	0.76	0.701	0.64	0.58	0.52	0.088%
2.75	1.04	0.96	0.84	0.77	0.700	0.63	0.57	0.020%
3	1.14	1.05	0.92	0.84	0.76	0.69	0.62	0.009%
Total Percent Occurrence	0.059%	0.065%	0.043%	0.049%	0.008%	0.000%	0.000%	0.22%

【Peak Wave Period, Tp=20sec】

	Wave Direction(degrees)							
Significant Wave Height, Hs(m)	205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.10	0.09	0.08	0.07	0.07	0.06	0.05	0.000%
0.5	0.20	0.18	0.17	0.15	0.13	0.12	0.10	0.000%
0.75	0.30	0.28	0.25	0.22	0.20	0.18	0.16	0.000%
1	0.40	0.37	0.34	0.29	0.27	0.24	0.21	0.000%
1.25	0.50	0.46	0.42	0.37	0.33	0.30	0.26	0.000%
1.5	0.60	0.55	0.50	0.44	0.40	0.36	0.31	0.000%
1.75	0.700	0.64	0.59	0.51	0.47	0.42	0.37	0.022%
2	0.80	0.74	0.67	0.59	0.53	0.48	0.42	0.049%
2.25	0.90	0.83	0.76	0.66	0.60	0.54	0.47	0.052%
2.5	1.00	0.92	0.84	0.74	0.67	0.59	0.52	0.028%
2.75	1.10	1.01	0.92	0.81	0.73	0.65	0.58	0.009%
3	1.20	1.10	1.01	0.88	0.80	0.71	0.63	0.000%
Total Percent Occurrence	0.036%	0.058%	0.047%	0.016%	0.002%	0.000%	0.000%	0.16%

Table A.2.5.24 Wave Height and Total Percent Occurrence at Berth E6 in the case of Plan-C (units : m)

【Peak Wave Period, Tp=6sec】

	Wave Direction(degrees)							
Significant Wave Height, Hs(m)	205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.08	0.08	0.07	0.06	0.05	0.05	0.000%
0.5	0.00	0.17	0.15	0.13	0.11	0.10	0.09	0.000%
0.75	0.00	0.25	0.23	0.20	0.17	0.15	0.14	0.000%
1	0.00	0.34	0.30	0.27	0.23	0.21	0.18	0.000%
1.25	0.00	0.42	0.38	0.33	0.28	0.26	0.23	0.000%
1.5	0.00	0.50	0.46	0.40	0.34	0.31	0.27	0.000%
1.75	0.00	0.59	0.53	0.46	0.39	0.36	0.32	0.000%
2	0.00	0.67	0.61	0.53	0.45	0.41	0.36	0.000%
2.25	0.00	0.75	0.68	0.60	0.51	0.46	0.41	0.011%
2.5	0.00	0.84	0.76	0.66	0.56	0.52	0.46	0.014%
2.75	0.00	0.92	0.83	0.73	0.62	0.57	0.50	0.000%
3	0.00	1.01	0.91	0.80	0.68	0.62	0.55	0.000%
Total Percent Occurrence	0.000%	0.014%	0.010%	0.000%	0.000%	0.000%	0.000%	0.02%

【Peak Wave Period, Tp=8sec】

	Wave Direction(degrees)							
Significant Wave Height, Hs(m)	205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.00	0.07	0.06	0.06	0.05	0.05	0.04	0.000%
0.5	0.00	0.14	0.12	0.12	0.10	0.09	0.08	0.000%
0.75	0.00	0.21	0.18	0.18	0.15	0.14	0.12	0.000%
1	0.00	0.28	0.24	0.24	0.20	0.18	0.16	0.000%
1.25	0.00	0.35	0.30	0.30	0.25	0.23	0.20	0.000%
1.5	0.00	0.43	0.36	0.36	0.30	0.27	0.24	0.000%
1.75	0.00	0.50	0.42	0.42	0.35	0.32	0.28	0.000%
2	0.00	0.57	0.48	0.48	0.40	0.36	0.32	0.001%
2.25	0.00	0.64	0.54	0.54	0.45	0.41	0.36	0.000%
2.5	0.00	0.71	0.60	0.60	0.50	0.46	0.40	0.007%
2.75	0.00	0.78	0.66	0.66	0.55	0.50	0.44	0.006%
3	0.00	0.85	0.72	0.72	0.60	0.55	0.49	0.012%
Total Percent Occurrence	0.000%	0.016%	0.005%	0.005%	0.000%	0.000%	0.000%	0.03%

【Peak Wave Period, Tp=10sec】

	Wave Direction(degrees)							
Significant Wave Height, Hs(m)	205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.08	0.07	0.06	0.05	0.05	0.04	0.04	0.000%
0.5	0.15	0.13	0.12	0.11	0.09	0.08	0.07	0.000%
0.75	0.23	0.20	0.18	0.16	0.14	0.13	0.11	0.000%
1	0.30	0.27	0.24	0.21	0.19	0.17	0.14	0.000%
1.25	0.38	0.34	0.30	0.26	0.23	0.21	0.18	0.000%
1.5	0.45	0.40	0.36	0.32	0.28	0.25	0.21	0.000%
1.75	0.53	0.47	0.42	0.37	0.33	0.29	0.25	0.000%
2	0.60	0.54	0.48	0.42	0.37	0.34	0.29	0.000%
2.25	0.68	0.60	0.54	0.47	0.42	0.38	0.32	0.000%
2.5	0.76	0.67	0.60	0.53	0.47	0.42	0.36	0.000%
2.75	0.83	0.74	0.66	0.58	0.51	0.46	0.39	0.000%
3	0.91	0.81	0.73	0.63	0.56	0.50	0.43	0.000%
Total Percent Occurrence	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.00%

【Peak Wave Period, Tp=12sec】

	Wave Direction(degrees)							
Significant Wave Height, Hs(m)	205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.08	0.08	0.07	0.06	0.05	0.04	0.04	0.000%
0.5	0.17	0.15	0.14	0.12	0.10	0.08	0.08	0.000%
0.75	0.25	0.23	0.21	0.18	0.15	0.13	0.12	0.000%
1	0.34	0.30	0.28	0.24	0.21	0.17	0.16	0.000%
1.25	0.42	0.38	0.35	0.30	0.26	0.21	0.20	0.000%
1.5	0.51	0.45	0.42	0.35	0.31	0.25	0.23	0.000%
1.75	0.59	0.53	0.48	0.41	0.36	0.30	0.27	0.000%
2	0.68	0.60	0.55	0.47	0.41	0.34	0.31	0.000%
2.25	0.76	0.68	0.62	0.53	0.46	0.38	0.35	0.011%
2.5	0.85	0.75	0.69	0.59	0.51	0.42	0.39	0.009%
2.75	0.93	0.83	0.76	0.65	0.57	0.47	0.429	0.000%
3	1.01	0.90	0.83	0.71	0.62	0.51	0.47	0.000%
Total Percent Occurrence	0.013%	0.006%	0.000%	0.000%	0.000%	0.000%	0.000%	0.02%

【Peak Wave Period, Tp=14sec】

	Wave Direction(degrees)							
Significant Wave Height, Hs(m)	205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.08	0.07	0.07	0.06	0.05	0.05	0.04	0.000%
0.5	0.17	0.15	0.13	0.12	0.10	0.09	0.09	0.000%
0.75	0.25	0.22	0.20	0.17	0.16	0.14	0.13	0.000%
1	0.33	0.29	0.27	0.23	0.21	0.18	0.17	0.000%
1.25	0.41	0.36	0.34	0.29	0.26	0.23	0.22	0.000%
1.5	0.50	0.44	0.40	0.35	0.31	0.27	0.26	0.000%
1.75	0.58	0.51	0.47	0.41	0.37	0.32	0.30	0.000%
2	0.66	0.58	0.54	0.46	0.42	0.36	0.35	0.000%
2.25	0.74	0.65	0.60	0.52	0.47	0.41	0.39	0.021%
2.5	0.83	0.73	0.67	0.58	0.52	0.45	0.43	0.015%
2.75	0.91	0.80	0.74	0.64	0.57	0.50	0.48	0.008%
3	0.99	0.87	0.80	0.69	0.63	0.54	0.52	0.000%
Total Percent Occurrence	0.026%	0.014%	0.005%	0.000%	0.000%	0.000%	0.000%	0.04%

【Peak Wave Period, Tp=16sec】

	Wave Direction(degrees)							
Significant Wave Height, Hs(m)	205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.09	0.08	0.07	0.07	0.06	0.05	0.04	0.000%
0.5	0.19	0.17	0.15	0.13	0.12	0.10	0.09	0.000%
0.75	0.28	0.25	0.22	0.20	0.18	0.15	0.13	0.000%
1	0.38	0.34	0.30	0.27	0.24	0.20	0.17	0.000%
1.25	0.47	0.42	0.37	0.34	0.30	0.25	0.22	0.000%
1.5	0.57	0.51	0.44	0.40	0.36	0.30	0.26	0.000%
1.75	0.66	0.59	0.52	0.47	0.42	0.35	0.30	0.000%
2	0.76	0.67	0.59	0.54	0.48	0.40	0.35	0.052%
2.25	0.85	0.76	0.67	0.61	0.54	0.45	0.39	0.087%
2.5	0.95	0.84	0.74	0.67	0.60	0.50	0.43	0.062%
2.75	1.04	0.93	0.81	0.74	0.66	0.55	0.47	0.020%
3	1.14	1.01	0.89	0.81	0.72	0.60	0.52	0.009%
Total Percent Occurrence	0.078%	0.091%	0.048%	0.012%	0.002%	0.000%	0.000%	0.23%

【Peak Wave Period, Tp=18sec】

	Wave Direction(degrees)							
Significant Wave Height, Hs(m)	205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.09	0.08	0.07	0.07	0.06	0.06	0.05	0.000%
0.5	0.17	0.16	0.14	0.13	0.12	0.11	0.10	0.000%
0.75	0.26	0.24	0.22	0.20	0.19	0.17	0.15	0.000%
1	0.35	0.32	0.29	0.27	0.25	0.22	0.20	0.000%
1.25	0.43	0.41	0.36	0.34	0.31	0.28	0.25	0.000%
1.5	0.52	0.49	0.43	0.40	0.37	0.34	0.30	0.000%
1.75	0.61	0.57	0.51	0.47	0.43	0.39	0.35	0.000%
2	0.69	0.65	0.58	0.54	0.50	0.45	0.40	0.000%
2.25	0.78	0.73	0.65	0.60	0.56	0.51	0.45	0.062%
2.5	0.87	0.81	0.72	0.67	0.62	0.56	0.49	0.051%
2.75	0.95	0.89	0.80	0.74	0.68	0.62	0.54	0.020%
3	1.04	0.97	0.87	0.80	0.74	0.67	0.59	0.009%
Total Percent Occurrence	0.020%	0.065%	0.043%	0.011%	0.002%	0.000%	0.000%	0.14%

【Peak Wave Period, Tp=20sec】

	Wave Direction(degrees)							
Significant Wave Height, Hs(m)	205	210	215	220	225	230	235	Total Percent Occurrence
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000%
0.25	0.09	0.08	0.08	0.07	0.06	0.05	0.05	0.000%
0.5	0.18	0.17	0.16	0.14	0.12	0.11	0.09	0.000%
0.75	0.27	0.25	0.23	0.20	0.18	0.16	0.14	0.000%
1	0.37	0.34	0.31	0.27	0.24	0.22	0.19	0.000%
1.25	0.46	0.42	0.39	0.34	0.31	0.27	0.24	0.000%
1.5	0.55	0.51	0.47	0.41	0.37	0.32	0.28	0.000%
1.75	0.64	0.59	0.55	0.48	0.43	0.38	0.33	0.000%
2	0.73	0.68	0.62	0.54	0.49	0.43	0.38	0.010%
2.25	0.82	0.76	0.701	0.61	0.55	0.48	0.43	0.052%
2.5	0.91	0.85	0.78	0.68	0.61	0.54	0.47	0.015%
2.75	1.01	0.93	0.86	0.75	0.67	0.59	0.52	0.007%
3	1.10	1.01	0.93	0.82	0.73	0.65	0.57	0.000%
Total Percent Occurrence	0.014%	0.019%	0.047%	0.003%	0.000%	0.000%	0.000%	0.08%

APPENDIX 3 CURRENT ANALYSIS

Prediction of the Tidal Current Variations Resulting from the Construction of an Artificial Island in the Gulf of Panama

Report

March 2004

JETRO STUDY TEAM

CONTENTS

1 Introduction

The current simulation was generated as per the available data to determine and confirm the potential impacts of the construction of the artificial island and the access way.

The data herein presented is at the same level of accuracy of the Pre Feasibility Study, more detail and precise results would require collection of additional information and the development of a new model.

2 Numerical Model

2.1 Modeling Approach

2.1.1 Basic Equations

In the coastal sea area, tidal current is basically supposed to be barotropic, which means water density is uniform in the vertical direction. Because horizontal velocity of tide and tidal current are usually very large compared with vertical velocity, a numerical model for tidal current generally deal with horizontal 2-D simulation.

The basic equations of the model are Navier-Stokes equations for an incompressible fluid, under the shallow water and the Bussinesq assumption and continuity equation. Those are described as

$$\frac{\partial u}{\partial t}+u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}-fv=-g\frac{\partial \eta}{\partial x}+A_h\frac{\partial^2 u}{\partial x^2}+A_h\frac{\partial^2 u}{\partial y^2}+\frac{\tau_x}{h}$$

$$\frac{\partial v}{\partial t}+u\frac{\partial v}{\partial x}+v\frac{\partial v}{\partial y}+fu=-g\frac{\partial \eta}{\partial y}+A_h\frac{\partial^2 v}{\partial x^2}+A_h\frac{\partial^2 v}{\partial y^2}+\frac{\tau_y}{h}$$

$$\frac{\partial \eta}{\partial t} + \frac{\partial (hu)}{\partial x} + \frac{\partial (hv)}{\partial y} = 0$$

where, the parameters u and v stand for the horizontal velocity, the parameter η and h stand for surface elevation and water depth. Similarly, the parameter f stands for Coriolis parameter and parameter g represents the acceleration of gravity. The parameter A_h represents Eddy viscosity and the parameter τ_x and τ_y are bottom friction.

Because of the difficulty of solving those basic equations exactly, the difference method, which is one of the approximate method, is applied to this numerical simulation.

2.1.2 Boundary Conditions

The bottom friction is considered on the bottom of the sea and that model is described as

$$\tau_x = -\gamma_b^2 \left(u^2 + v^2\right)^{1/2} u$$

$$\tau_y = -\gamma_b^2 \left(u^2 + v^2\right)^{1/2} v$$

where, the parameter γ_b stands for the coefficient of bottom friction.

The boundary between sea and land has been defined by slip condition that the horizontal friction is equal to zero. And the open boundary has been defined by the amplitude of M2 tide and Oceanic Current.

2.2 Modeling Region

The domain for numerical simulation of tidal current is shown in **Figure A.3.1**. The area is 70 kilometers distance in the east and west direction and 60 kilometers distance in the south and north direction. The depth is over 60 meters in the offshore.

Strictly, the case of the whole area of the Gulf of Panama should be simulated at first and then the case of local area simulation (shown in **Figure A.3.1**) should be carried out by using the results of the case of whole area for the open boundary conditions. But in this analysis, the local area is directly simulated because this analysis aimed at the understanding of the outline of influence due to the construction.

In this simulation, water depth is defined in the grid spacing of 100 meters. And the depth over 60 meters in offshore and under 2.0 meters in nearshore are approximated 60 meters and 2.0 meters respectively for the stability of the numerical simulation.

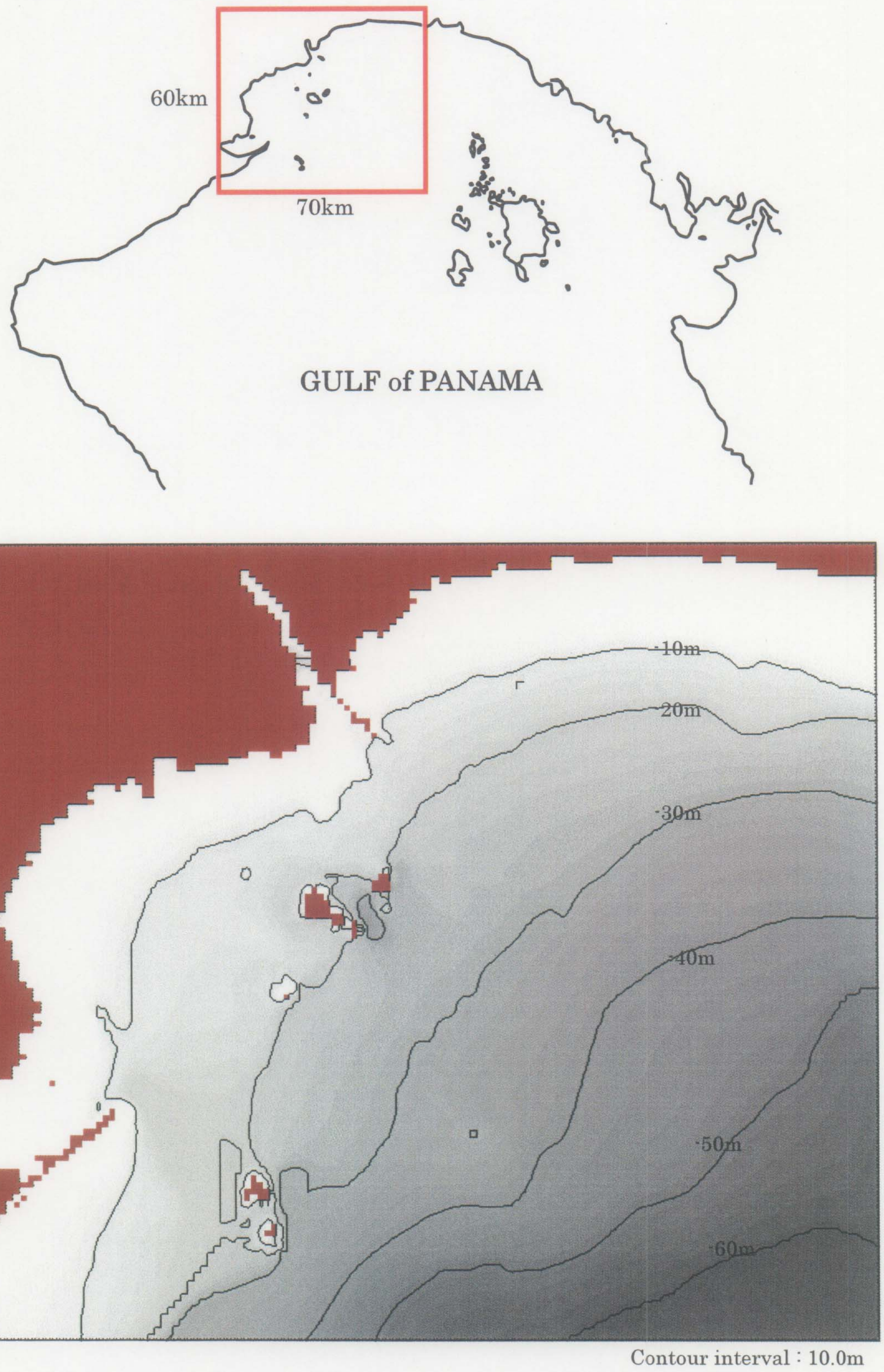


Figure A.3.1 The domain for numerical simulation

2.3 Conditions of the Simulation

2.3.1 Conditions of the Simulation

This analysis aimed at understanding of the outline of influence due to the construction of an artificial island. So only tidal currents and oceanic current has been considered as the driving forces in the numerical simulations. Here, wind forcing has not been considered. And water density has been set uniformly in the whole domain.

The numerical simulation has been carried out for 5 periods of a tidal wave by using the same tide and the result obtained in the last one period is applied to the analysis of the influences. Besides the steady state of the tidal currents after successive simulation of 5 tidal periods is confirmed.

2.3.2 Model Parameters

The following parameters presented in **Table A.3.1** have been applied in the model. Eddy viscosity A_h is based on Richardson's 4/3 law. Coriolis parameter f is calculated by using following equation.

$$f = 2\Omega \sin\varphi$$

where the parameter Ω stands for angular velocity (=7.92 × 10^{-5} (s^{-1})). The parameter φ represents the latitude of the Gulf of Panama (=9.0°).

Table A.3.1 Model Parameters

Horizontal Grid Size	100 (m)
Time Step : dt	15 (s)
Times of simulation	62hours (about 5 periods of M2 tide)
Water Density : ρ_0	1,020 (kg/ m^3)
Acceleration of gravity : g	9.78 (m/s^2)
Eddy Viscosity : A_h	10.0(m^2/s)
Coriolis parameter : f	2.28 × 10^{-5}(s^{-1})

2.4 Simulated Cases

The cases of numerical simulation of tidal current are shown in **Table A.3.2**.

Table A.3.2 Cases of Numerical Simulation of Tidal Current

Island Type	Accessway					Breakwater
	Nothing	Causeway	Causeway + Trestle	Causeway + Bridge	Bridge	
Nothing	○	/	/	/	/	/
Plan A	○	*1)	*1)	*1)	*1)	○
Plan B	○	○	○	○	○	/
Plan C	○	○	○	○	○	/

*1) : Nearly equal to Plan B

*2) : Each case has 4 tidal conditions; High water level, Peak ebb, Low water level, and Peak flood

3 Simulation Results and Issues

3.1 Present State

The typical current of the Gulf of Panama originated in Oceanic Current forms a cyclonic (counter clockwise) circulation known as Gulf of Panama Current or Colombia current (Bennett; 1965).

The following figures show the existing natural conditions in high water, low water, peak ebb and peak flood. As can be appreciated, with the exception of the ebbing tide, all the other times the tide direction is parallel to the coast.

As can be observed in the case of the Peak Flood, which generates high velocity currents in the east-west direction.

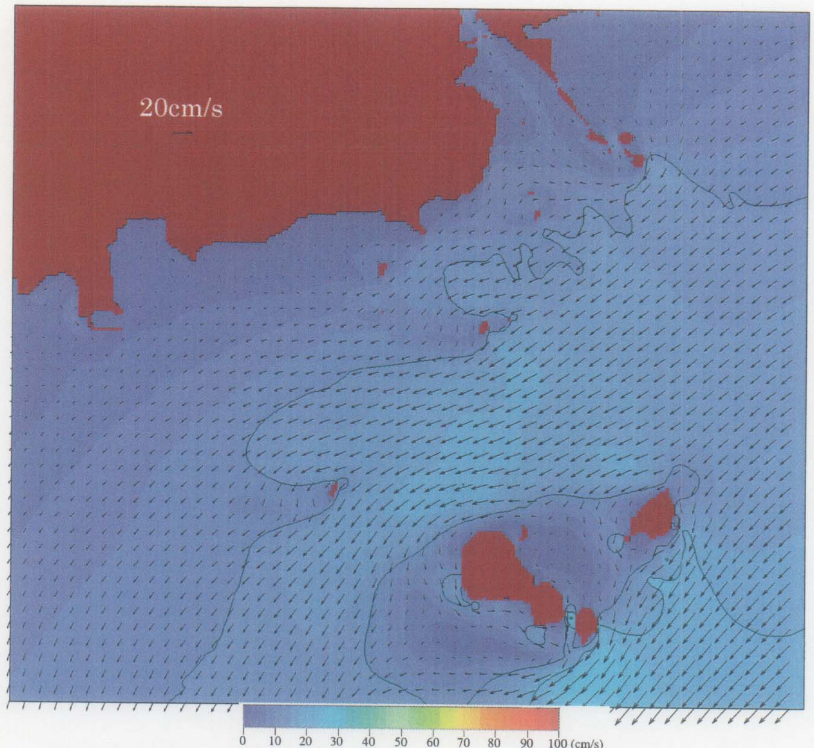


Figure A.3.2 Present current velocity (High Water Level)

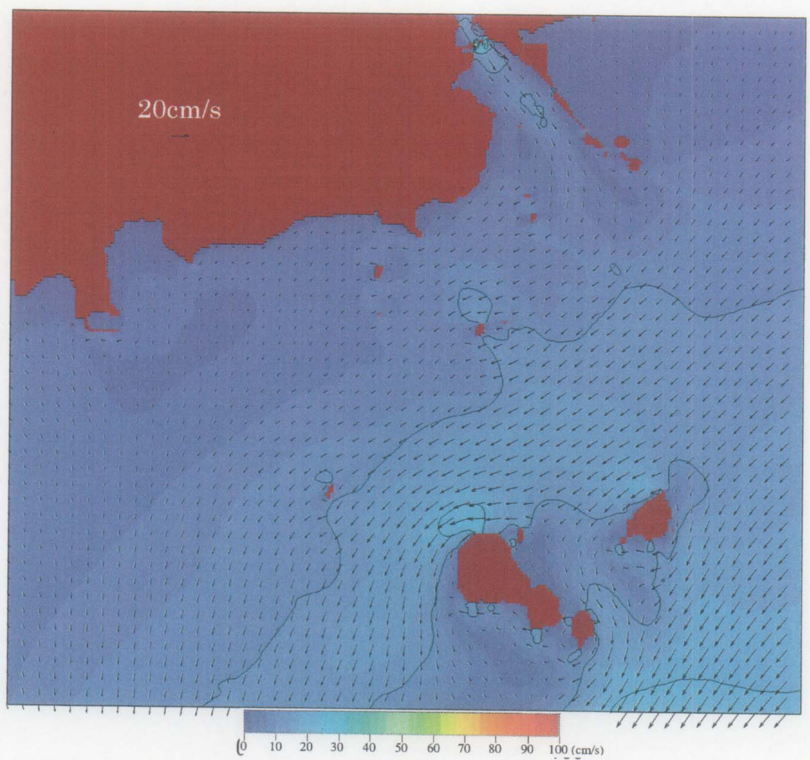


Figure A.3.3 Present current velocity (Low Water Level)

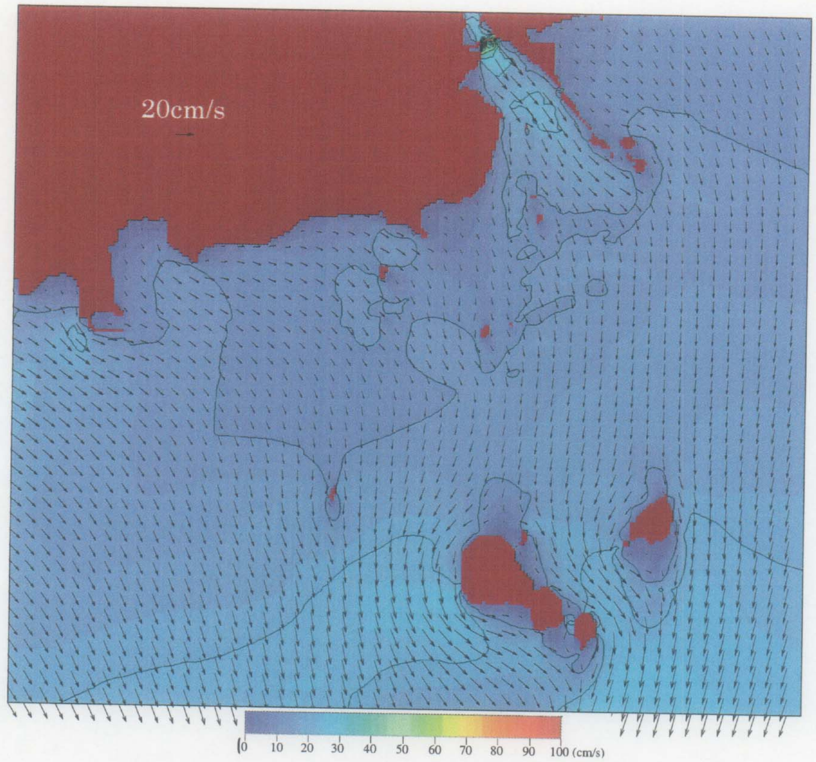


Figure A.3.4 Present current velocity (Peak ebb)

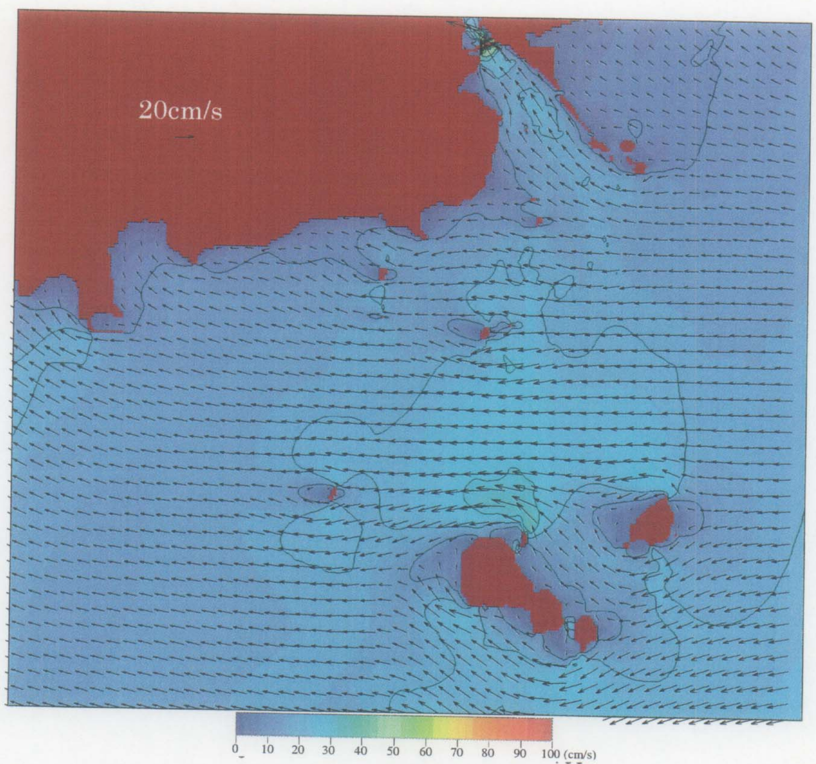


Figure A.3.5 Present current velocity (Peak flood)

3.2 Construction of Artificial Island and Accessway

As a result of the current simulation analysis, Bridge type and Causeway + Trestle type proved to be the most favourable to avoid significant alteration of the existing currents. The following figures show the simulation results for Plan B during the flood tide for four (4) structural types.

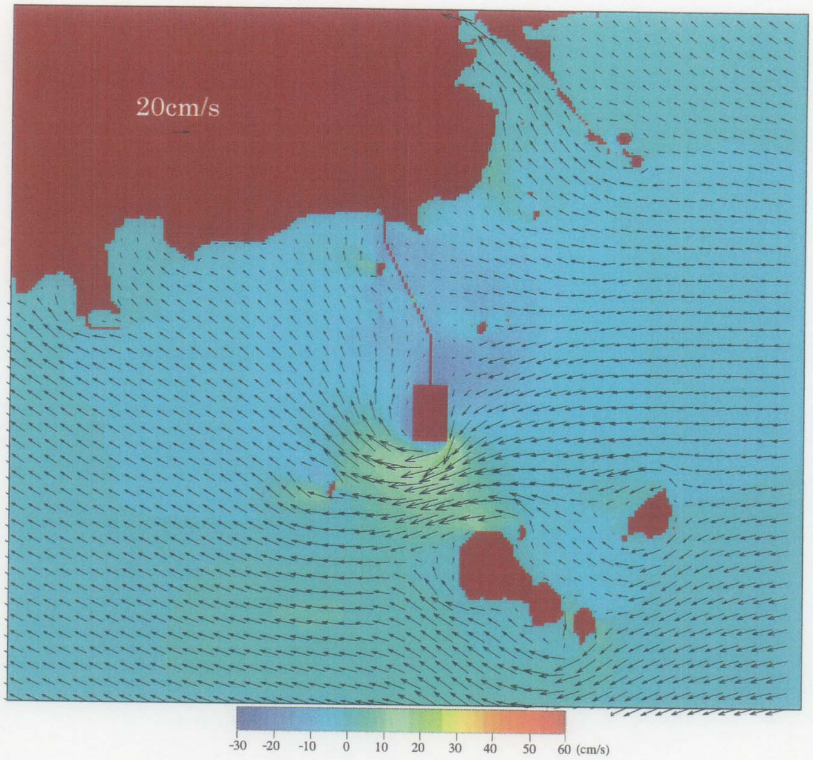


Figure A.3.6 Comparison of Current Velocity : Plan B (Causeway, Peak Flood)

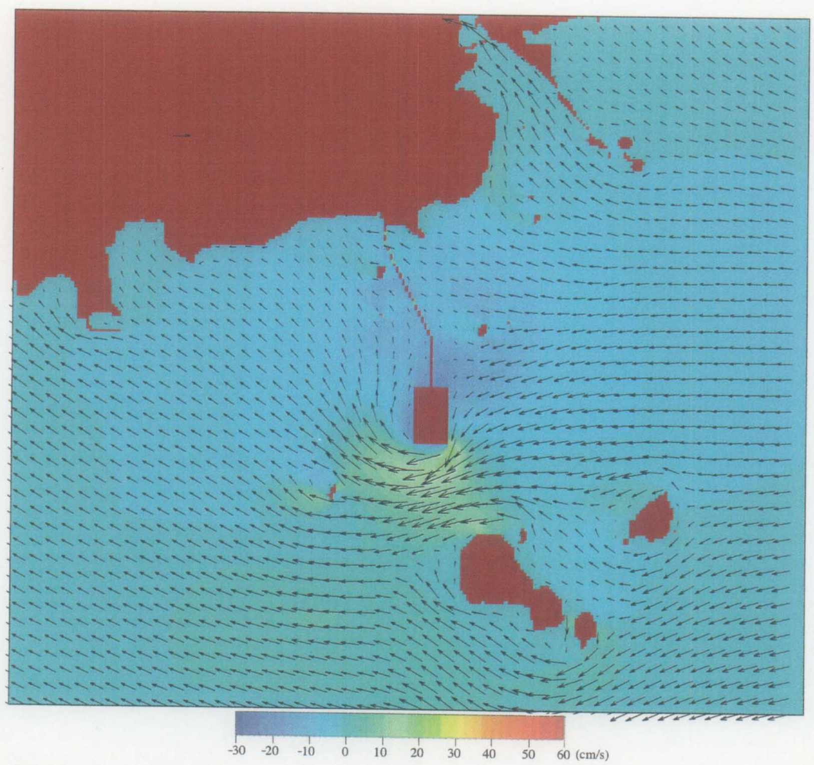


Figure A.3.7 Comparison of Current Velocity : Plan B (Causeway + Trestle, Peak Flood)

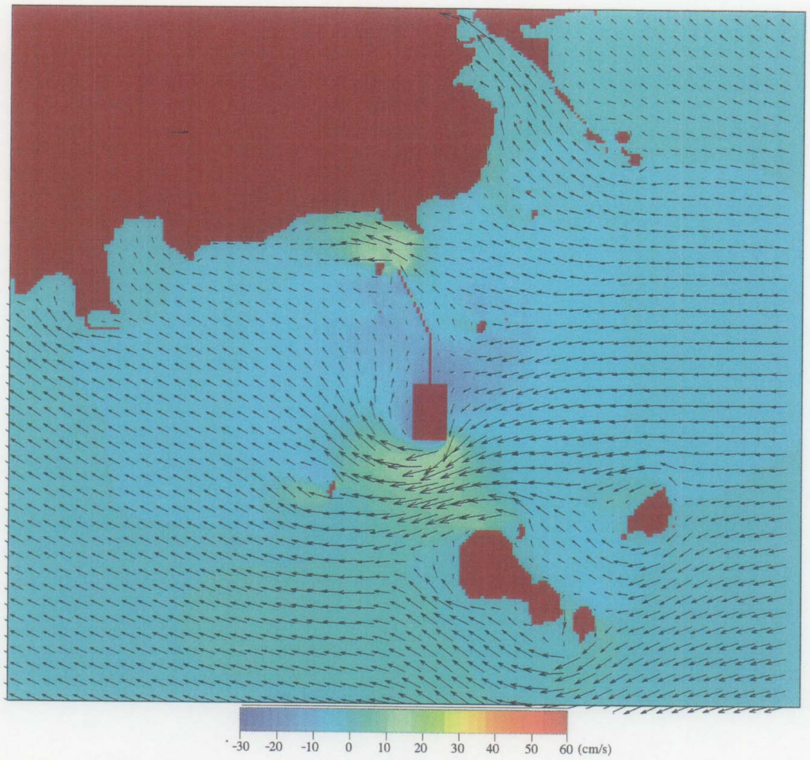


Figure A.3.8 Comparison of Current Velocity : Plan B (Causeway + Bridge, Peak Flood)

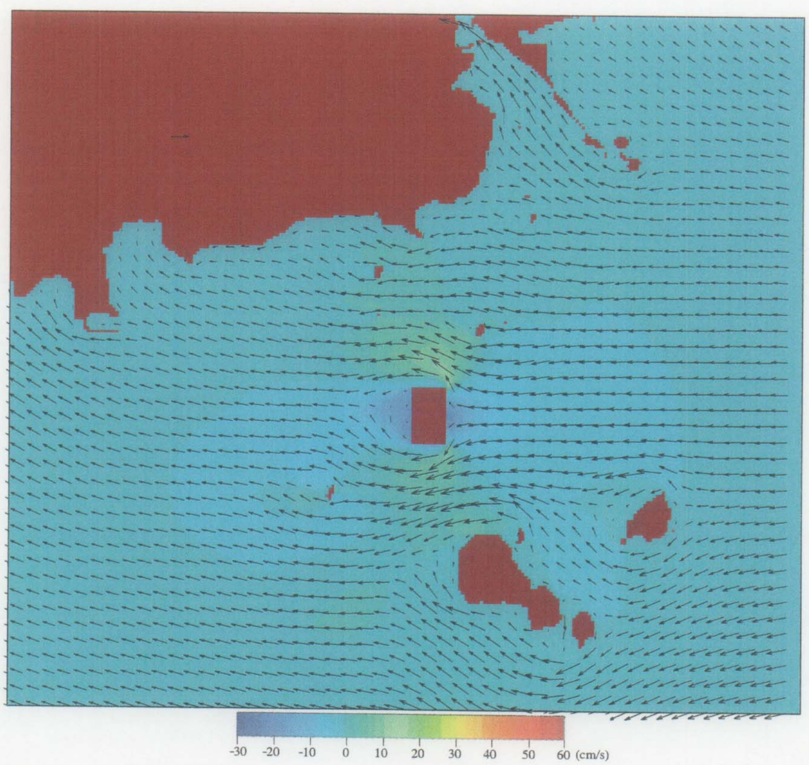


Figure A.3.9 Comparison of Current Velocity : Plan B (Bridge, Peak Flood)

4 Coastal Condition

The Coastal area around the project site was surveyed to learn about its natural condition. The visual survey was carried out from Punta Bruja to the West towards Bique Bay. It was observed, as can be seen in the following Figure A.3.10, that two types of beach conditions are predominant; sandy beach and pebble beach.

Sandy beach was found from the proposed access point to the west until approximately the beginning of the Veracruz town. The sand is mostly light brown with high contents of shells. The areas near the access point are predominately used as a tourist area with the existence of well developed food services which cater to the tourist who visit this area specially during the weekends.

Pebble beach and rocky formations were found further west from this point towards Bique Bay. Some Mangrove trees and were also found in this area. This area is predominant throughout the entire length of coast in front of Veracruz Town.

Historical aerial photo analysis was carried out to investigate the natural effects of the waves and currents on the shore; the main purpose of such comparison was to learn if beach erosion conditions were naturally present near the project proposed access point. Two images were compared for such purpose, see Figure A.3.10; 1984 and 2002, thus providing a 20 year lapse. A blue line was drawn in the shore area in 1984 and the same line was copied and transposed on top of the image from 2002 and it was concluded that beach erosion is not a problem in this area.

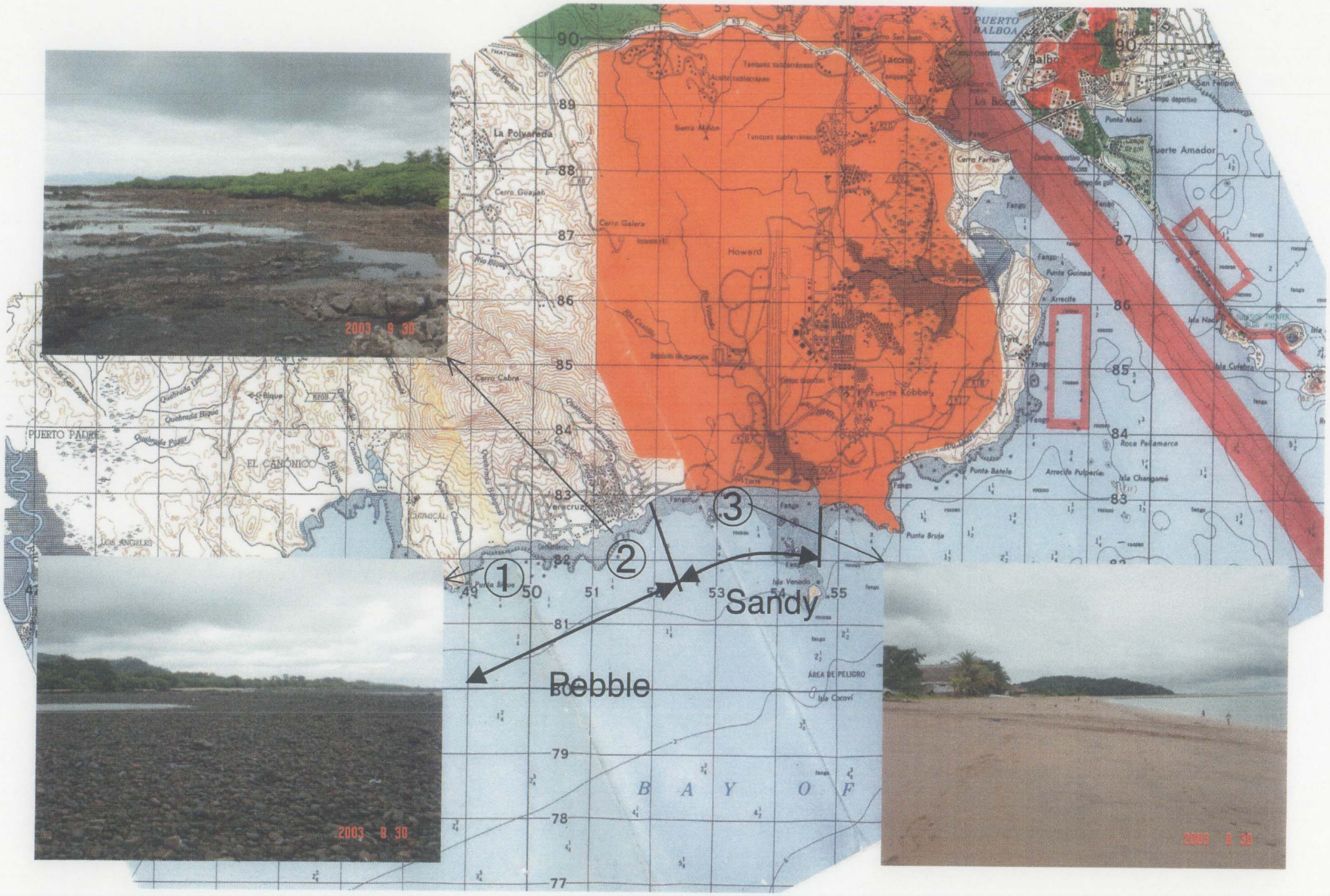


Figure A.3.10 Existing Condition of Coast

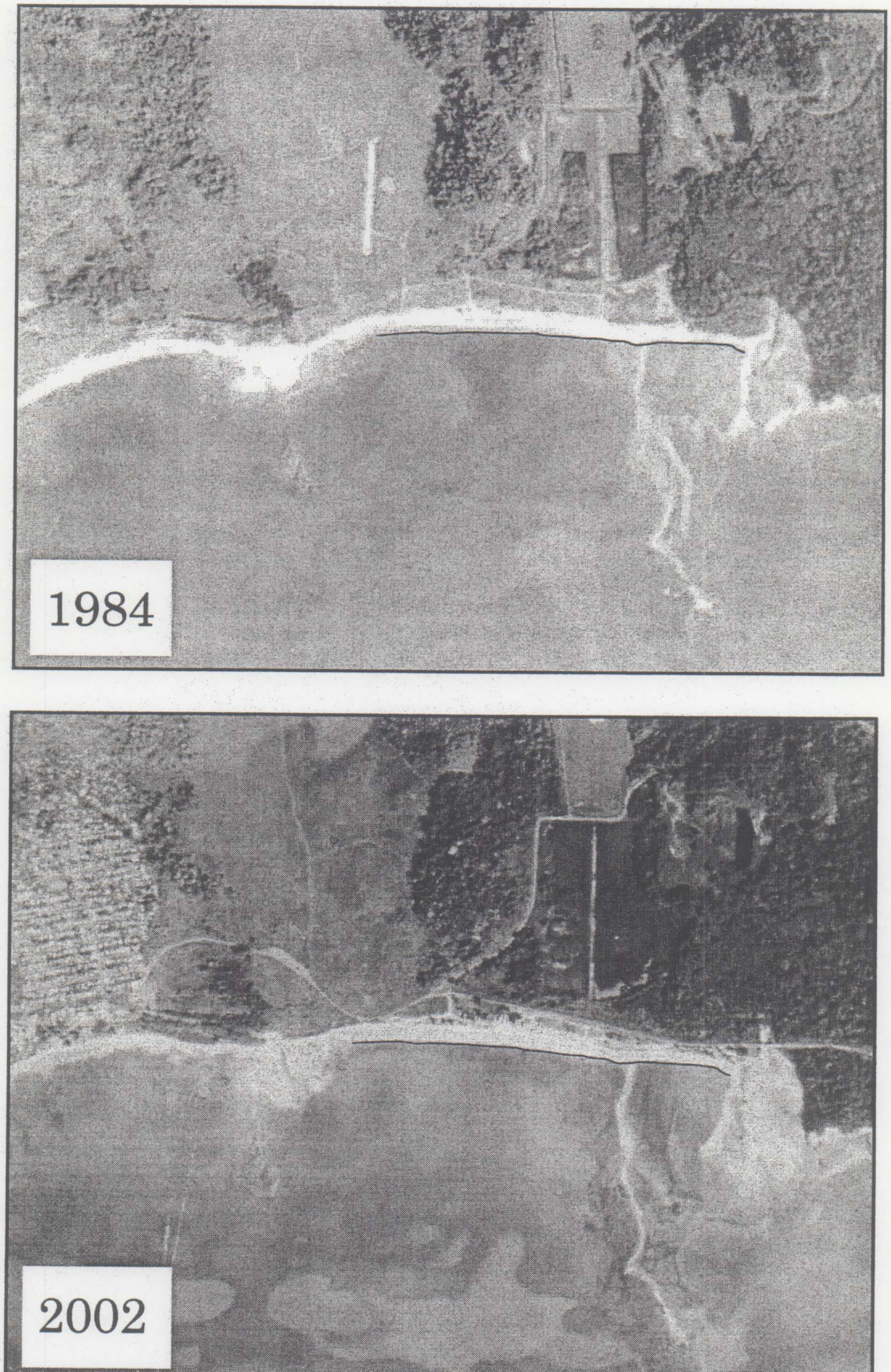


Figure A.3.11 Comparison of Coastalline in 1984 and 2002

5 Conclusion and Recommendation

The following are concluded based on the mathematical modelling of the effects of the construction of the artificial island and the proposed Accessway:

The construction of the island will change current directions and speeds in some degrees, However such change does not significantly affect the natural current conditions of the bay as a whole. Utmost change in current speeds would occur during the peak flood in the spring tide and it would continue for 30 minutes at most for one time. In other words, it would occur one hour in a day and five (5) hours in total in the month.

The recommended Accessway design shall incorporate a bridge or intermittent box culvert sections to avoid any impact on the shore area and to prevent negative effects especially due to the social and environmental value of Veracruz Beach.

The detail design of the location of the opening in the causeway (water passages) shall be subject of further design in a detail design phase; this would require collection of additional data and modelling.

The greater increases in current velocities are reported in the south east corner or the proposed island.

The impact of the increases in the currents velocities from natural condition is more significant in the north part of Taboga Island, however, the increase remains within around 10cm/s from natural condition.

The north part of Taboga island is naturally subject to currents with higher velocities than the rest of the bay area, thus implying that the natural environment in such zone shall already be adapted to such fast current conditions, the increases in this zone are also limited to approximately 10 cm/s.

Table A3.3 Cases of Current Simulation (Current Velocity)

Case	Artificial Island	Accessway	Tide	Breakwater	Remark
1-1-1	Nothing	Nothing	High Water Level	Nothing	Existing
1-1-2			Peak Ebb	Nothing	Existing
1-1-3			Low Water Level	Nothing	Existing
1-1-4			Peak Flood	Nothing	Existing
1-2-1	Plan A	Nothing	High Water Level	Nothing	
1-2-2			Peak Ebb	Nothing	
1-2-3			Low Water Level	Nothing	
1-2-4			Peak Flood	Nothing	
1-2-5	Plan A	Nothing	High Water Level	Breakwater	
1-2-6			Peak Ebb	Breakwater	
1-2-7			Low Water Level	Breakwater	
1-2-8			Peak Flood	Breakwater	
1-3-1	Plan B	Nothing	High Water Level	Nothing	
1-3-2			Peak Ebb	Nothing	
1-3-3			Low Water Level	Nothing	
1-3-4			Peak Flood	Nothing	
1-3-5	Plan B	Causeway	High Water Level	Nothing	
1-3-6			Peak Ebb	Nothing	
1-3-7			Low Water Level	Nothing	
1-3-8			Peak Flood	Nothing	
1-3-9	Plan B	Causeway + Trestle	High Water Level	Nothing	
1-3-10			Peak Ebb	Nothing	
1-3-11			Low Water Level	Nothing	
1-3-12			Peak Flood	Nothing	
1-3-13	Plan B	Causeway + Bridge	High Water Level	Nothing	
1-3-14			Peak Ebb	Nothing	
1-3-15			Low Water Level	Nothing	
1-3-16			Peak Flood	Nothing	
1-3-17	Plan B	Bridge	High Water Level	Nothing	
1-3-18			Peak Ebb	Nothing	
1-3-19			Low Water Level	Nothing	
1-3-20			Peak Flood	Nothing	
1-4-1	Plan C	Nothing	High Water Level	Nothing	
1-4-2			Peak Ebb	Nothing	
1-4-3			Low Water Level	Nothing	
1-4-4			Peak Flood	Nothing	
1-4-5	Plan C	Causeway	High Water Level	Nothing	
1-4-6			Peak Ebb	Nothing	
1-4-7			Low Water Level	Nothing	
1-4-8			Peak Flood	Nothing	
1-4-9	Plan C	Causeway + Trestle	High Water Level	Nothing	
1-4-10			Peak Ebb	Nothing	
1-4-11			Low Water Level	Nothing	
1-4-12			Peak Flood	Nothing	
1-4-13	Plan C	Causeway + Bridge	High Water Level	Nothing	
1-4-14			Peak Ebb	Nothing	
1-4-15			Low Water Level	Nothing	
1-4-16			Peak Flood	Nothing	
1-4-17	Plan C	Bridge	High Water Level	Nothing	
1-4-18			Peak Ebb	Nothing	
1-4-19			Low Water Level	Nothing	
1-4-20			Peak Flood	Nothing	

Table A.3.4 Cases of Current Simulation (Comparison of Current Velocity)

Case	Artificial Island	Accessway	Tide	Breakwater	Remark
2-1-1	Nothing	Nothing	High Water Level	Nothing	Existing
2-1-2			Peak Ebb	Nothing	Existing
2-1-3			Low Water Level	Nothing	Existing
2-1-4			Peak Flood	Nothing	Existing
2-2-1	Plan A	Nothing	High Water Level	Nothing	
2-2-2			Peak Ebb	Nothing	
2-2-3			Low Water Level	Nothing	
2-2-4			Peak Flood	Nothing	
2-2-5	Plan A	Nothing	High Water Level	Breakwater	
2-2-6			Peak Ebb	Breakwater	
2-2-7			Low Water Level	Breakwater	
2-2-8			Peak Flood	Breakwater	
2-3-1	Plan B	Nothing	High Water Level	Nothing	
2-3-2			Peak Ebb	Nothing	
2-3-3			Low Water Level	Nothing	
2-3-4			Peak Flood	Nothing	
2-3-5	Plan B	Causeway	High Water Level	Nothing	
2-3-6			Peak Ebb	Nothing	
2-3-7			Low Water Level	Nothing	
2-3-8			Peak Flood	Nothing	
2-3-9	Plan B	Causeway + Trestle	High Water Level	Nothing	
2-3-10			Peak Ebb	Nothing	
2-3-11			Low Water Level	Nothing	
2-3-12			Peak Flood	Nothing	
2-3-13	Plan B	Causeway + Bridge	High Water Level	Nothing	
2-3-14			Peak Ebb	Nothing	
2-3-15			Low Water Level	Nothing	
2-3-16			Peak Flood	Nothing	
2-3-17	Plan B	Bridge	High Water Level	Nothing	
2-3-18			Peak Ebb	Nothing	
2-3-19			Low Water Level	Nothing	
2-3-20			Peak Flood	Nothing	
2-4-1	Plan C	Nothing	High Water Level	Nothing	
2-4-2			Peak Ebb	Nothing	
2-4-3			Low Water Level	Nothing	
2-4-4			Peak Flood	Nothing	
2-4-5	Plan C	Causeway	High Water Level	Nothing	
2-4-6			Peak Ebb	Nothing	
2-4-7			Low Water Level	Nothing	
2-4-8			Peak Flood	Nothing	
2-4-9	Plan C	Causeway + Trestle	High Water Level	Nothing	
2-4-10			Peak Ebb	Nothing	
2-4-11			Low Water Level	Nothing	
2-4-12			Peak Flood	Nothing	
2-4-13	Plan C	Causeway + Bridge	High Water Level	Nothing	
2-4-14			Peak Ebb	Nothing	
2-4-15			Low Water Level	Nothing	
2-4-16			Peak Flood	Nothing	
2-4-17	Plan C	Bridge	High Water Level	Nothing	
2-4-18			Peak Ebb	Nothing	
2-4-19			Low Water Level	Nothing	
2-4-20			Peak Flood	Nothing	

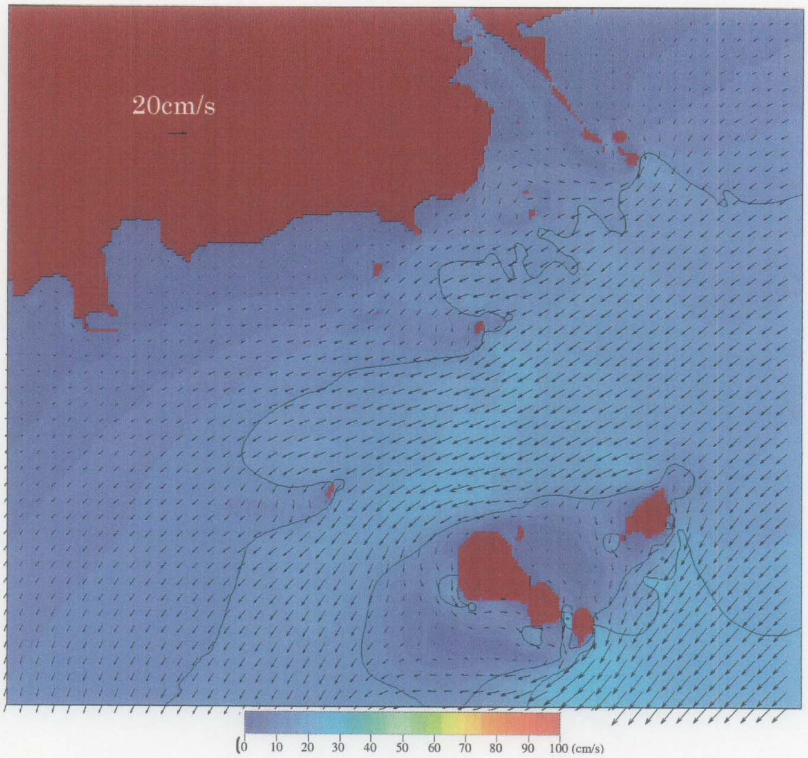


Figure A.3.12-1-1-1 Current Velocity : Existing Condition (High Water)

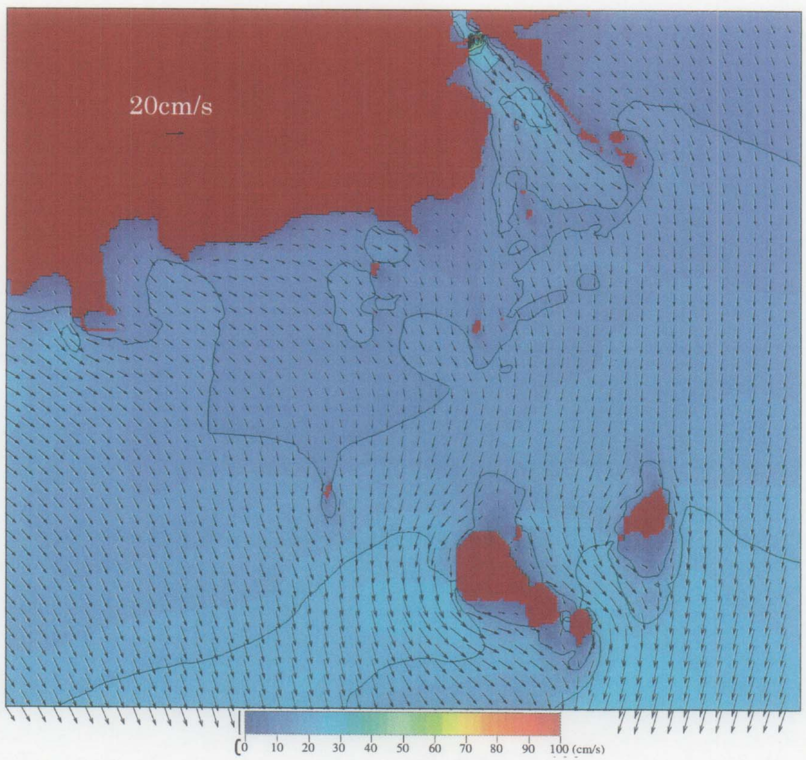


Figure A.3.12-1-1-2 Current Velocity : Existing Condition (Peak Ebb)

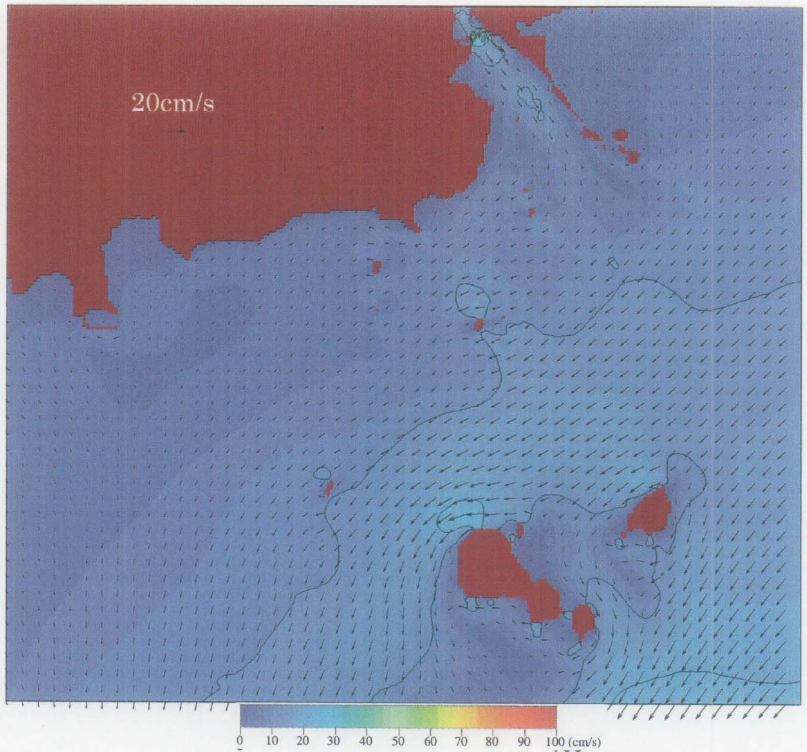


Figure A.3.12-1-1-3 Current Velocity : Existing Condition (Low Water)

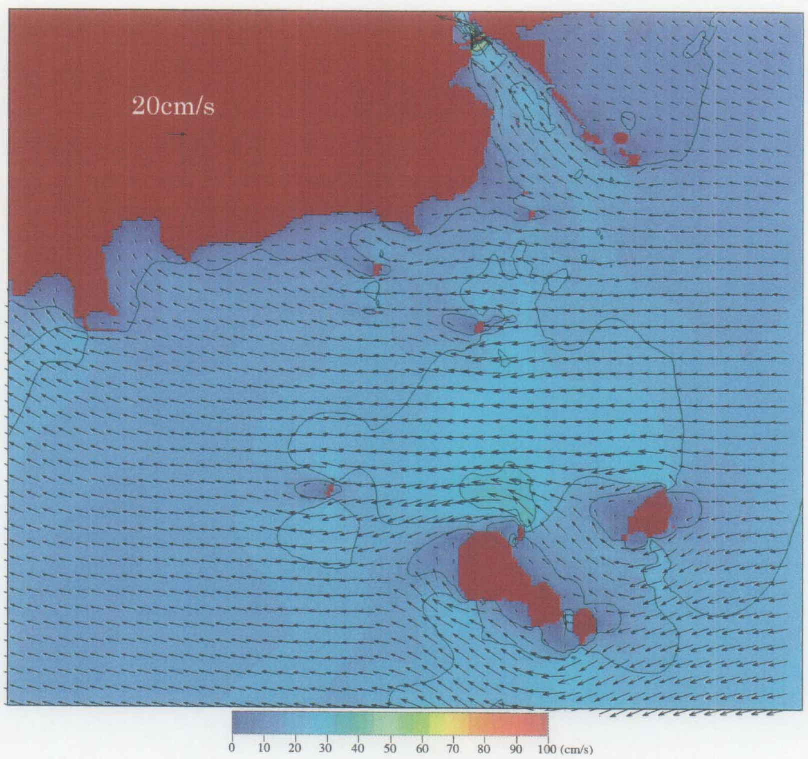


Figure A.3.12-1-1-4 Current Velocity : Existing Condition (Peak Flood)

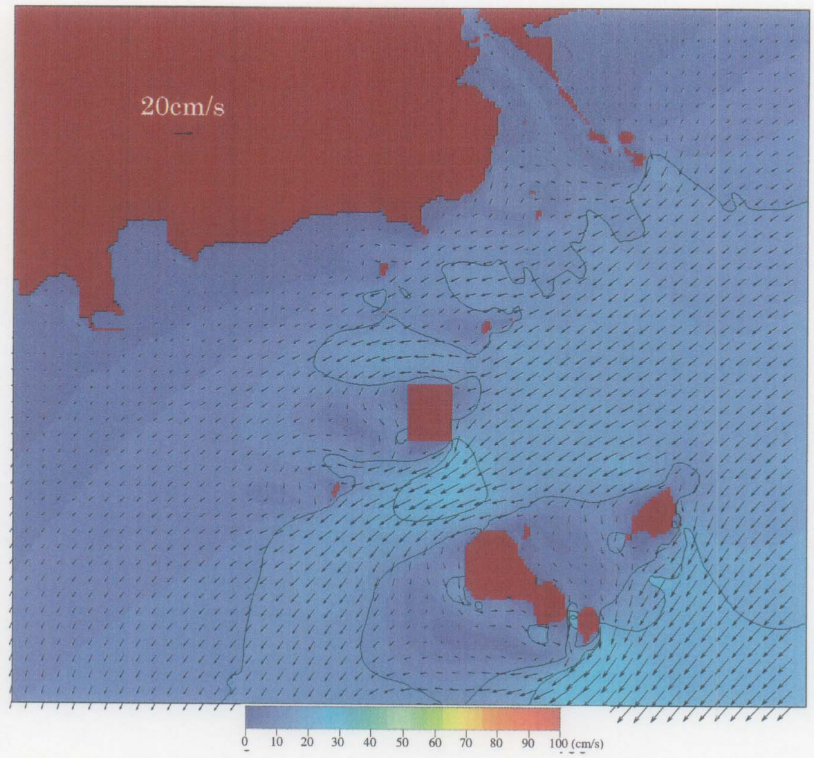


Figure A.3.12-1-2-1 Current Velocity : Plan A (No Accessway, High Water)

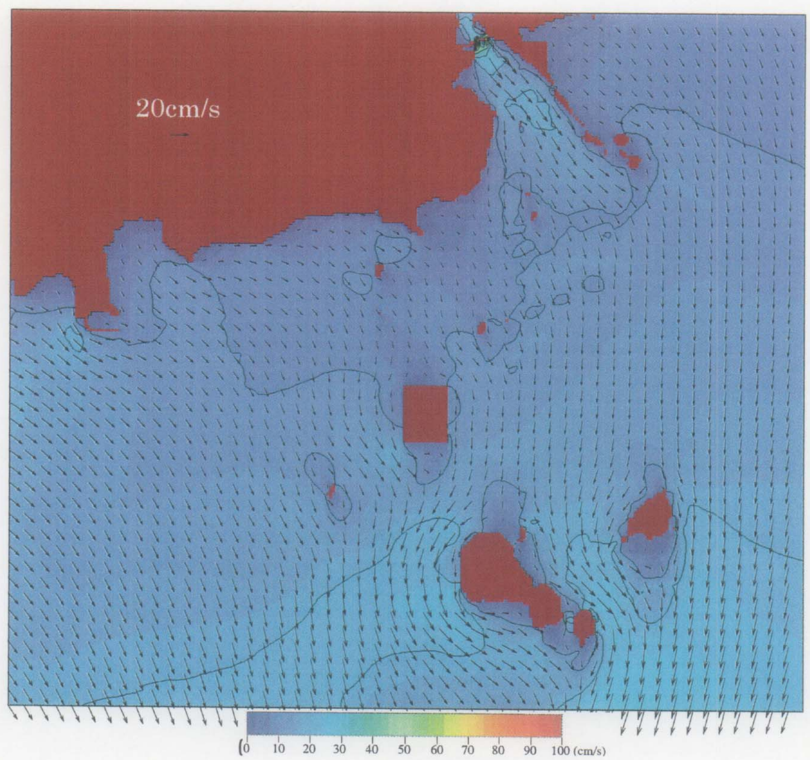


Figure A.3.12-1-2-2 Current Velocity : Plan A (No Accessway, Peak Ebb)

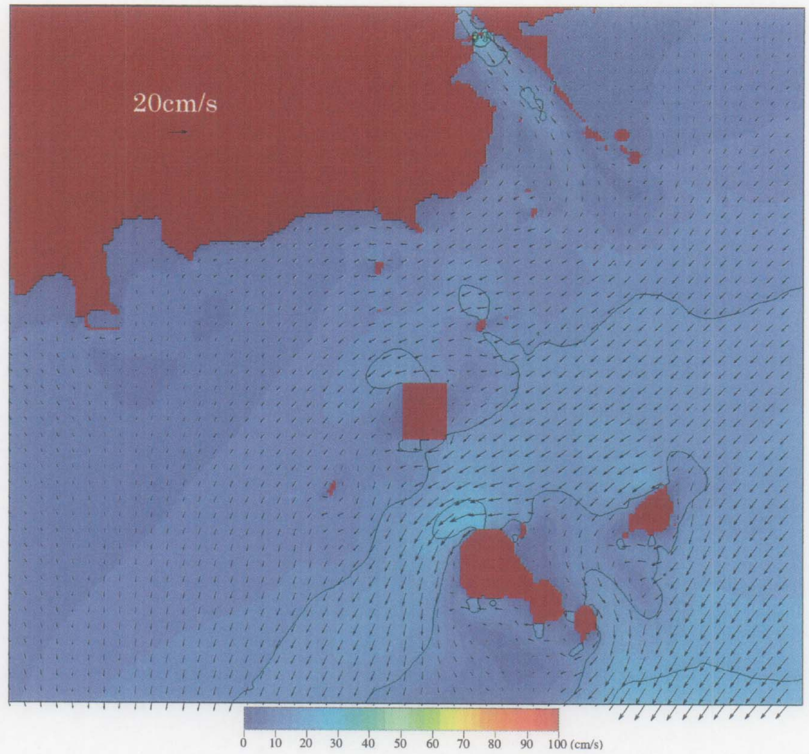


Figure A.3.12-1-2-1 Current Velocity : Plan A (No Accessway, Low Water)

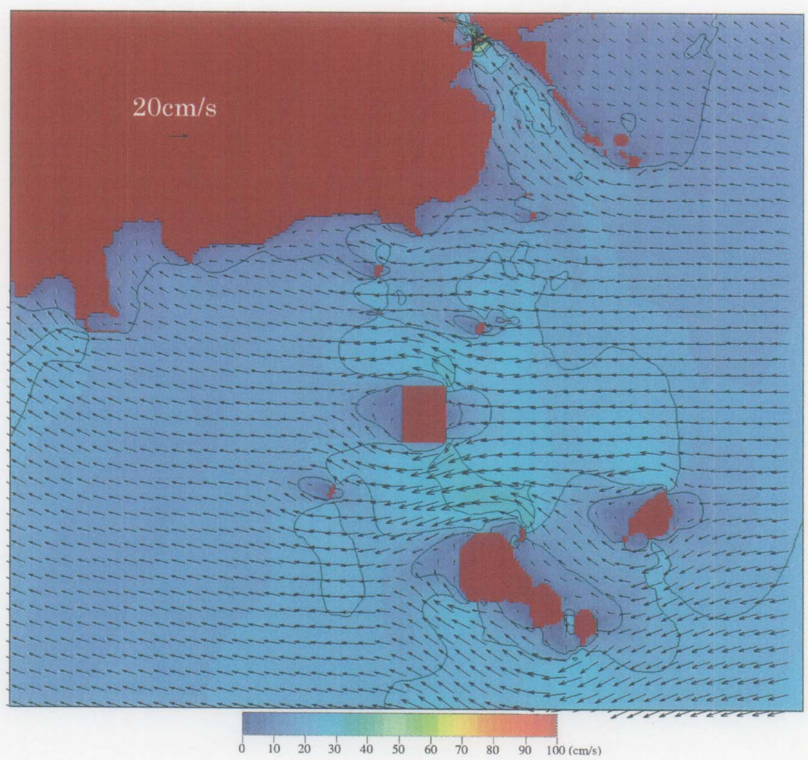


Figure A.3.12-1-2-2 Current Velocity : Plan A (No Accessway, Peak Flood)

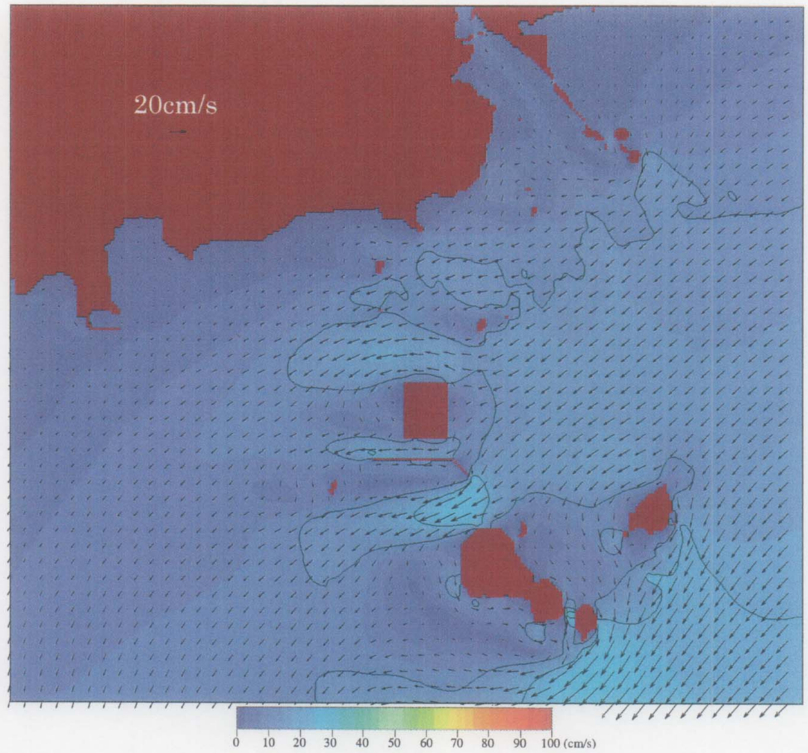


Figure A.3.12-1-2-5 Current Velocity : Plan A+Breakwater (No Accessway, High Water)

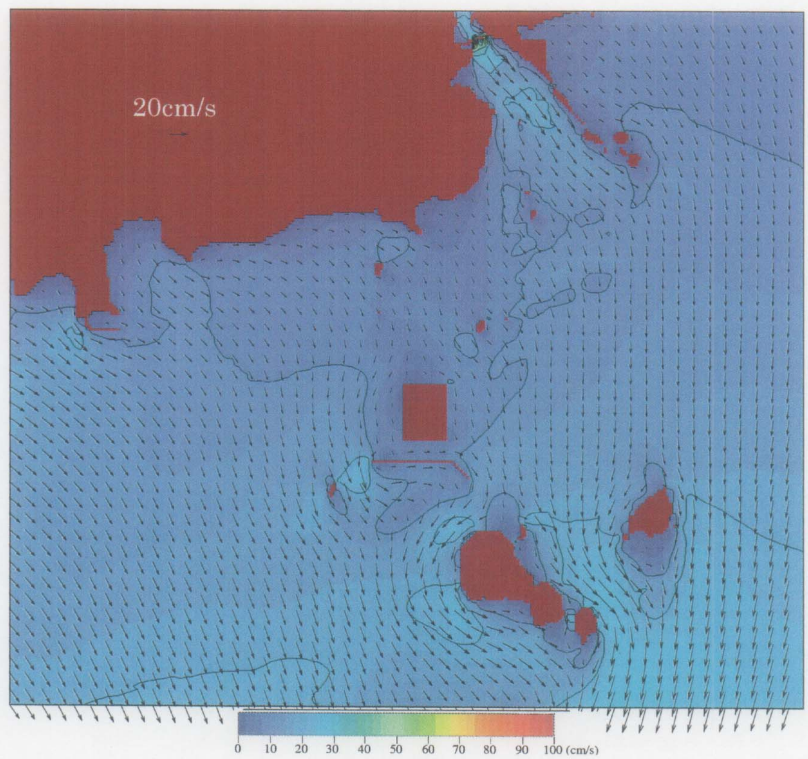


Figure A.3.12-1-2-6 Current Velocity : Plan A + Breakwater (No Accessway, Peak Ebb)

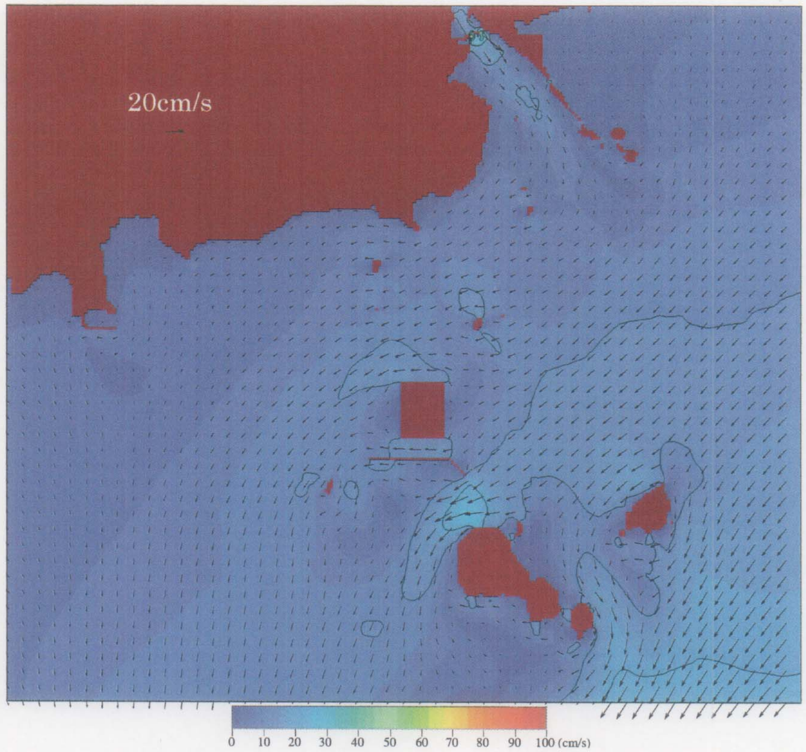


Figure A.3.12-1-2-7 Current Velocity : Plan A + Breakwater (No Accessway, Low Water)

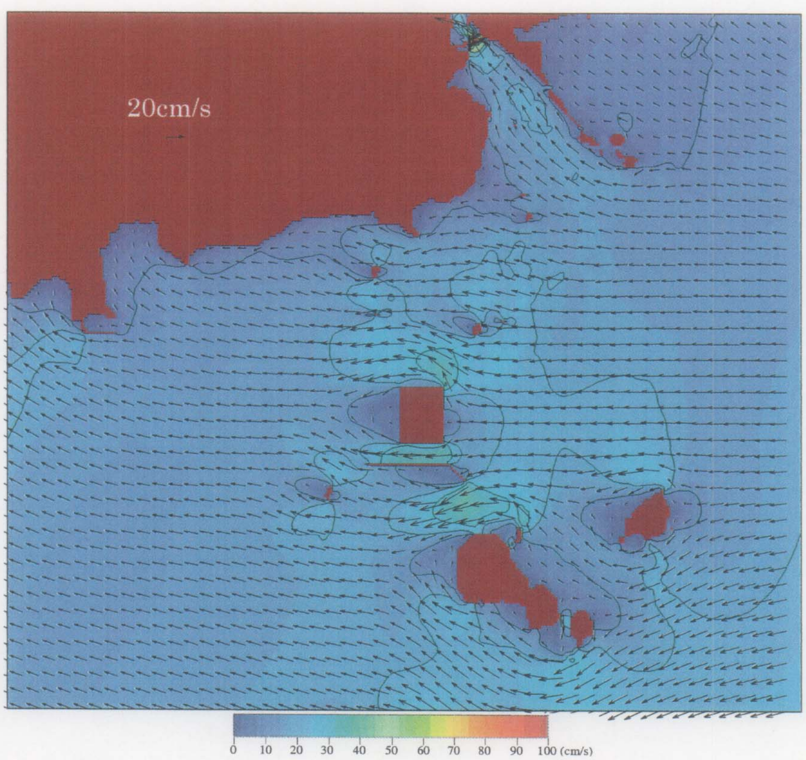


Figure A.3.12-1-2-8 Current Velocity : Plan A + Breakwater (No Accessway, Peak Flood)

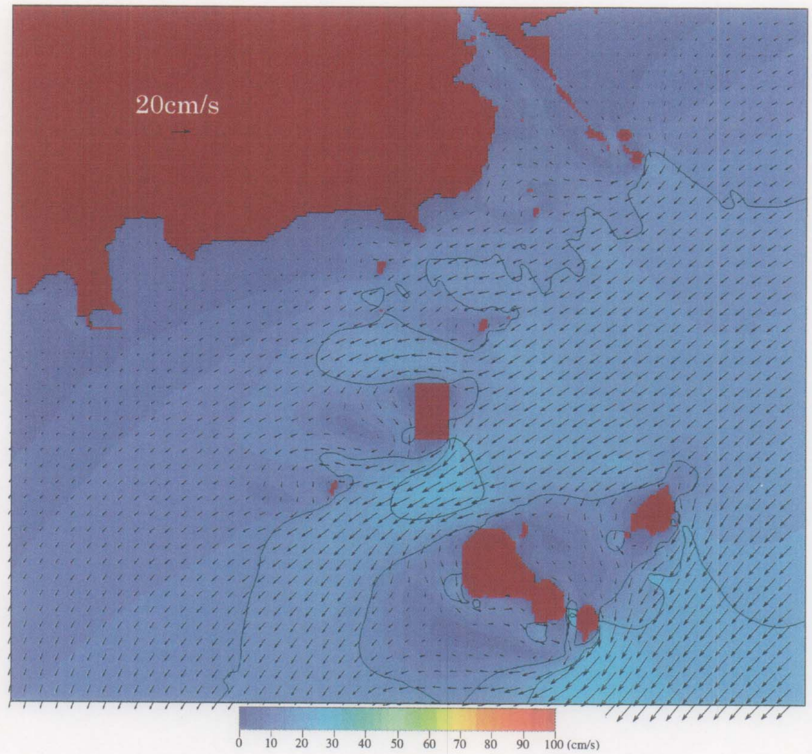


Figure A.3.12-1-3-1 Current Velocity : Plan B (No Accessway, High Water)

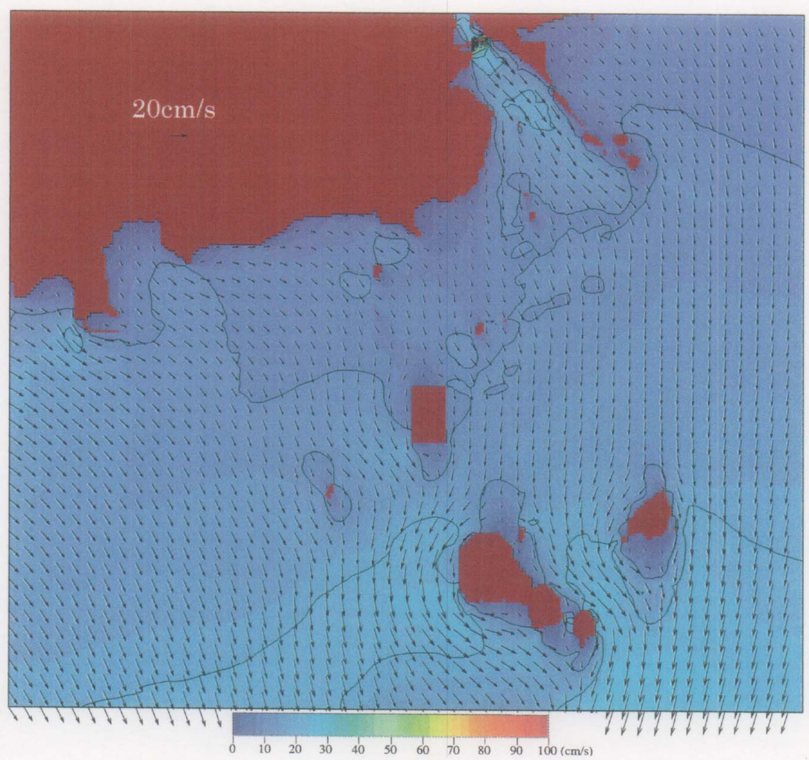


Figure A.3.12-1-3-2 Current Velocity : Plan B (No Accessway, Peak Ebb)

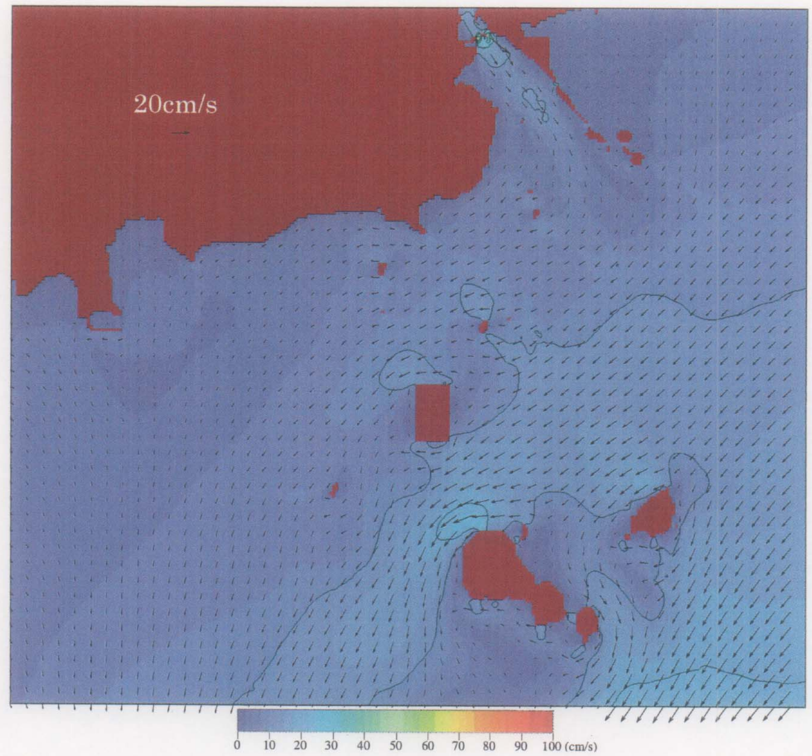


Figure A.3.12-1-3-3 Current Velocity : Plan B (No Accessway, Low Water)

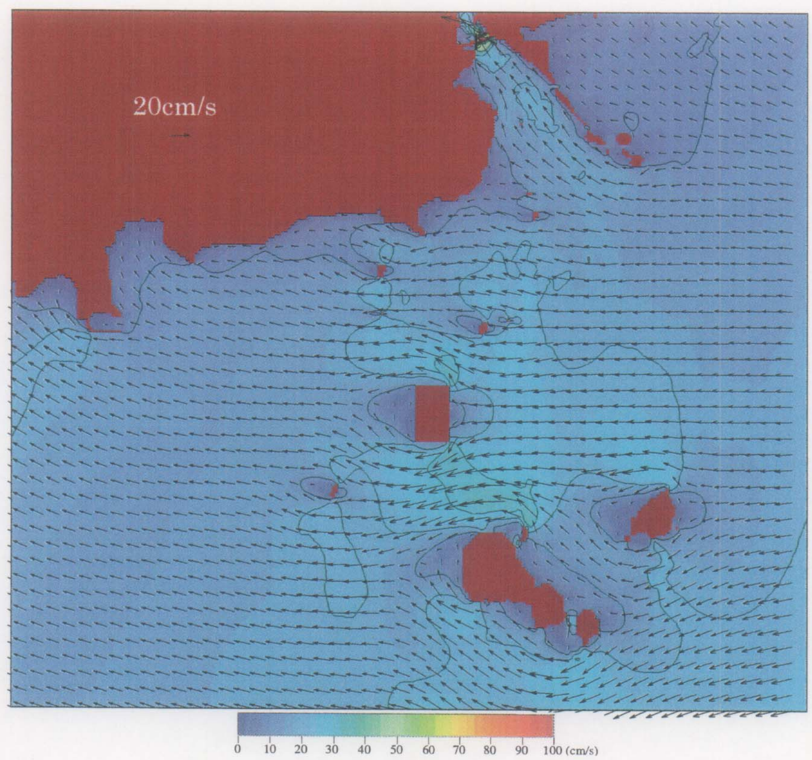


Figure A.3.12-1-3-4 Current Velocity : Plan B (No Accessway, Peak Flood)

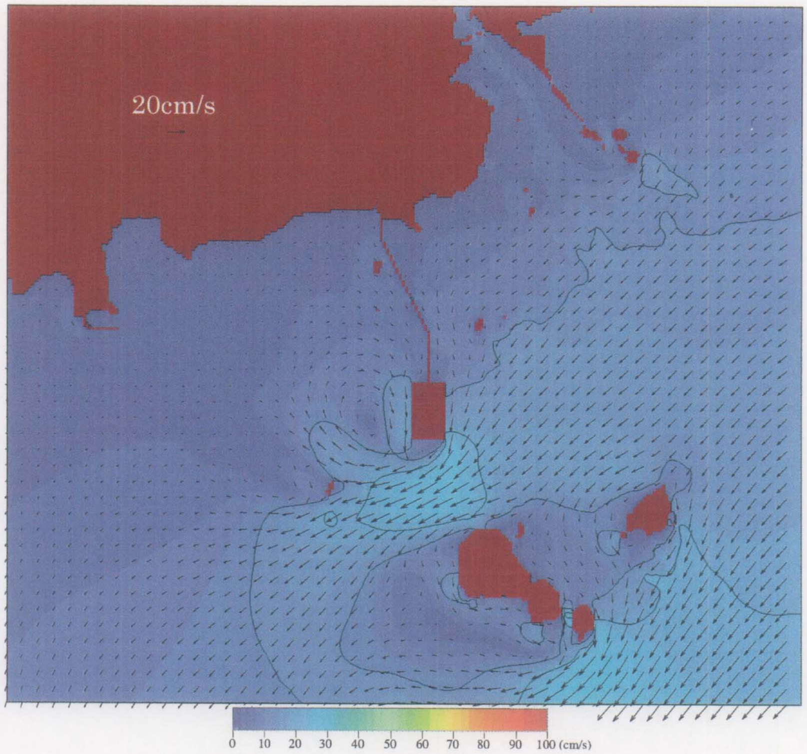


Figure A.3.12-1-3-5 Current Velocity : Plan B (Causeway, High Water)

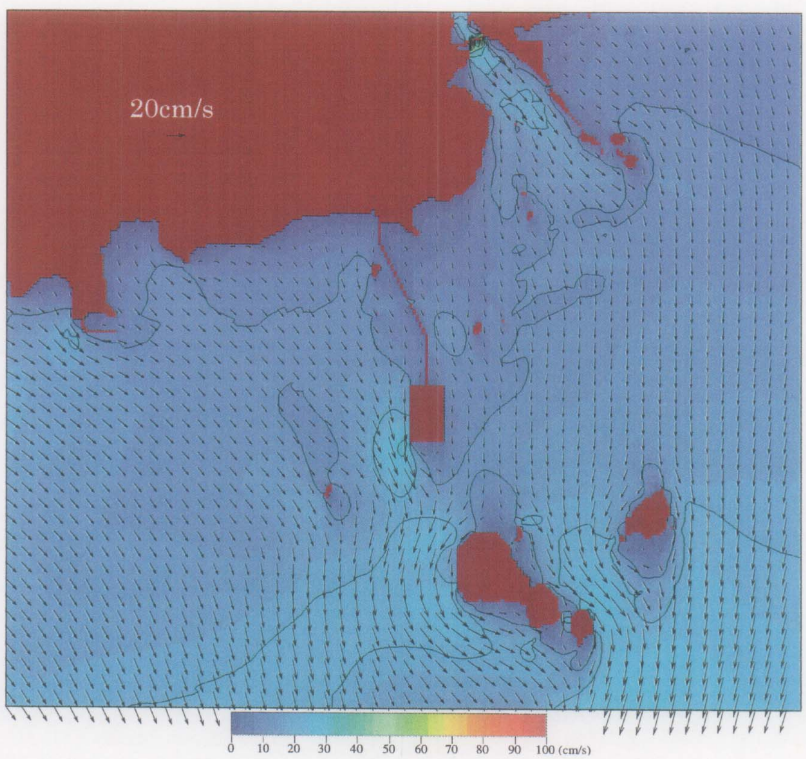


Figure A.3.12-1-3-6 Current Velocity : Plan B (Causeway, Peak Ebb)

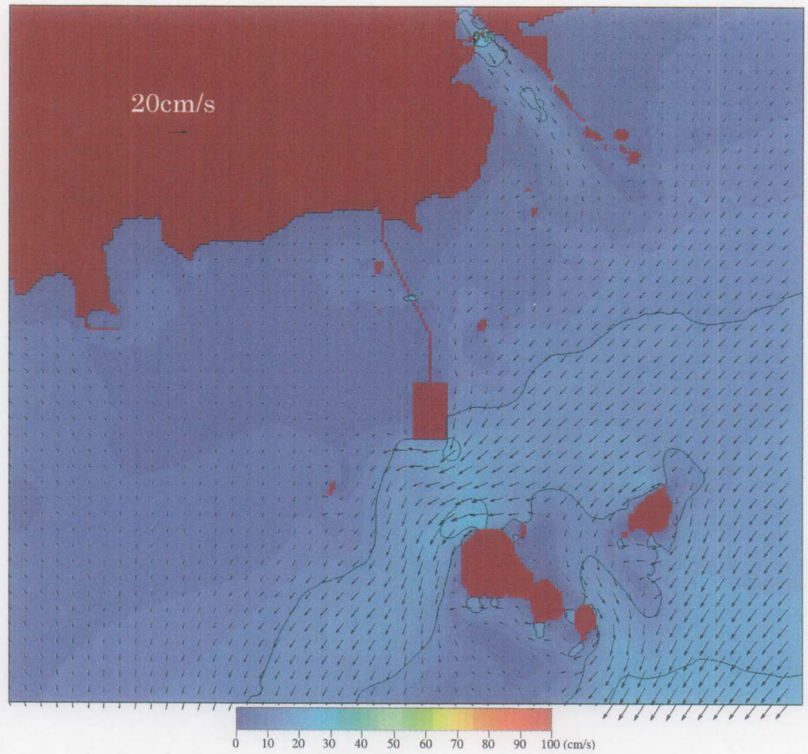


Figure A.3.12-1-3-7 Current Velocity : Plan B (Causeway, Low Water)

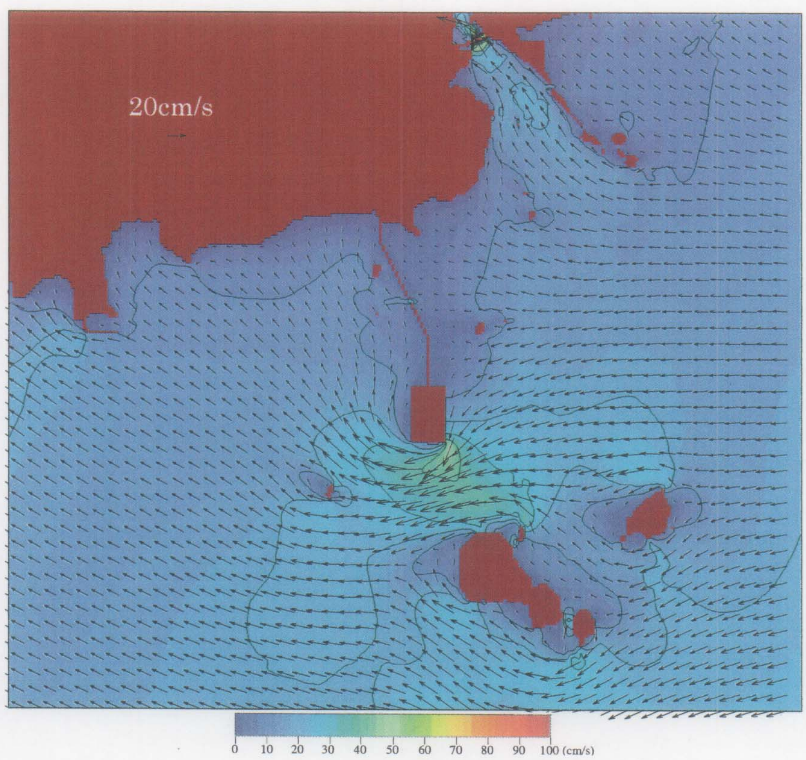


Figure A.3.12-1-3-8 Current Velocity : Plan B (Causeway, Peak Flood)

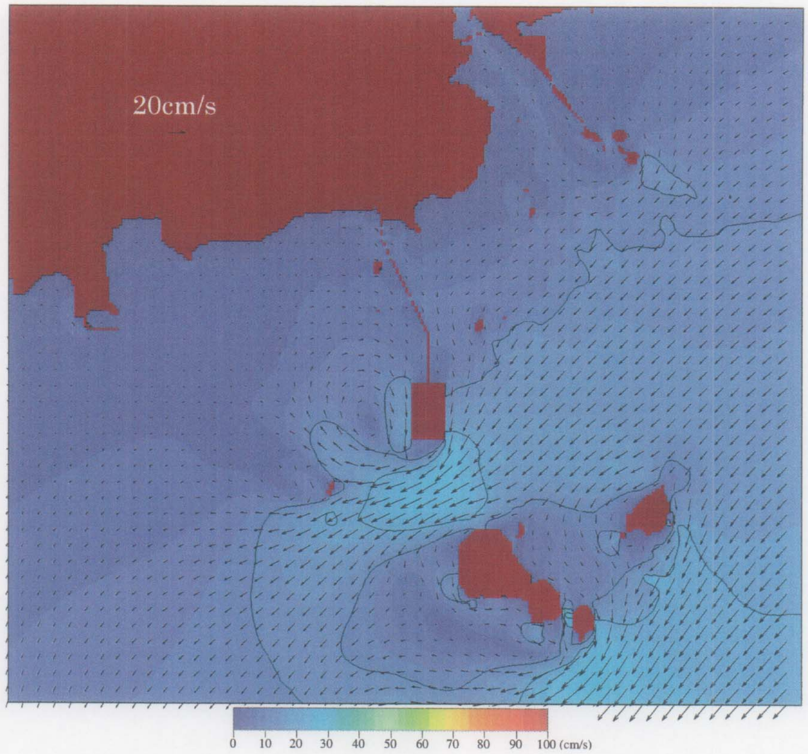


Figure A.3.12-1-3-9 Current Velocity : Plan B (Causeway + Trestle, High Water)

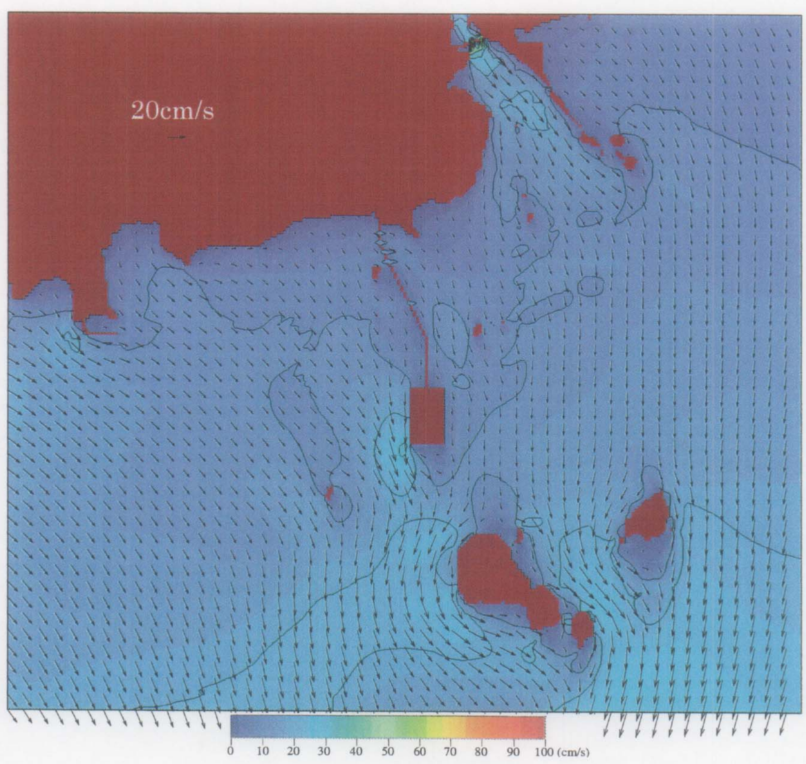


Figure A.3.12-1-3-10 Current Velocity : Plan B (Causeway + Trestle, Peak Ebb)

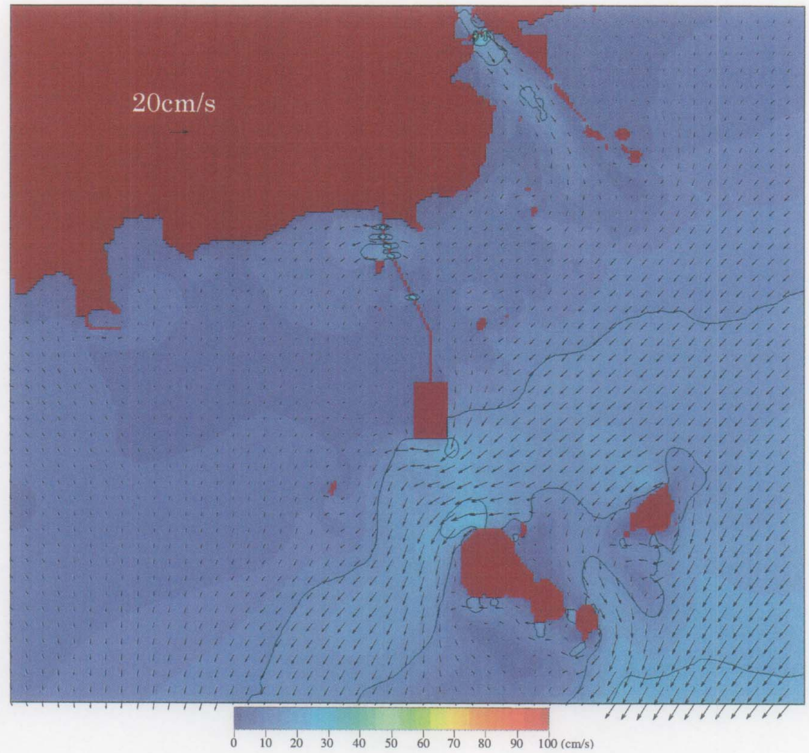


Figure A.3.12-1-3-11 Current Velocity : Plan B (Causeway + Trestle, Low Water)

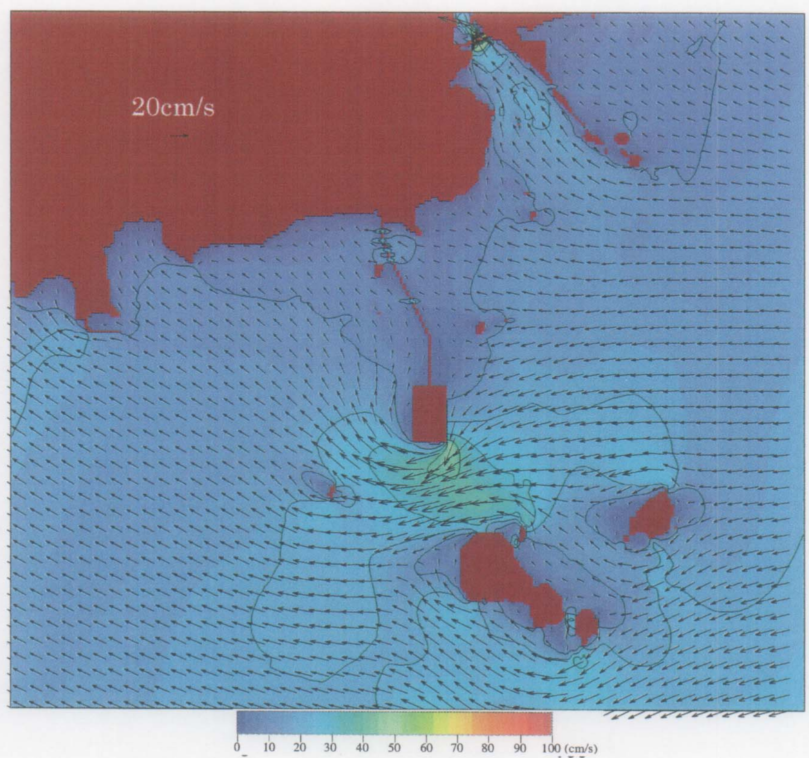


Figure A.3.12-1-3-12 Current Velocity : Plan B (Causeway + Trestle, Peak Flood)

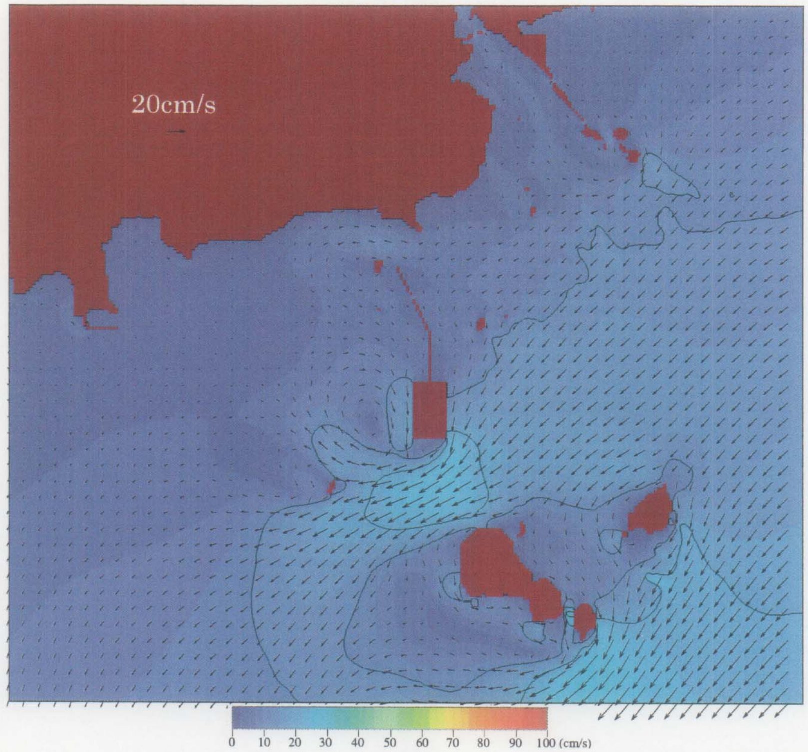


Figure A.3.12-1-3-13 Current Velocity : Plan B (Causeway + Bridge, High Water)

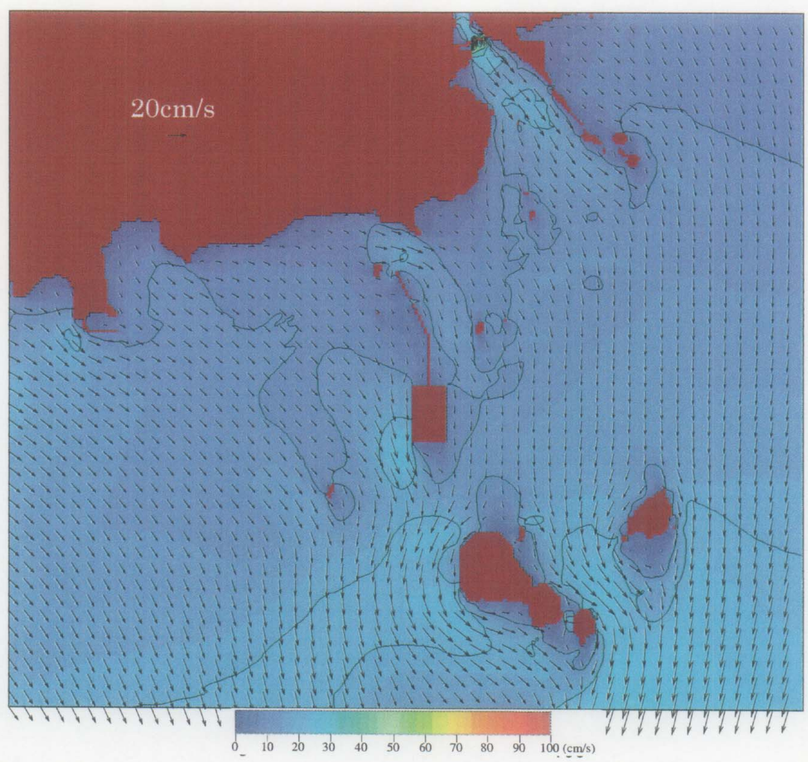


Figure A.3.12-1-3-14 Current Velocity : Plan B (Causeway + Bridge, Peak Ebb)

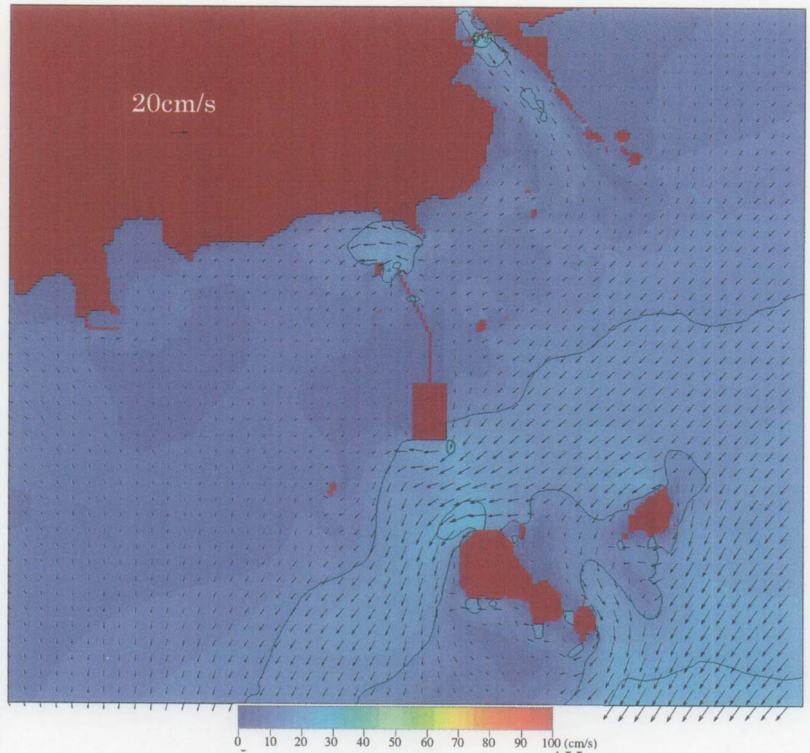


Figure A.3.12-1-3-15 Current Velocity : Plan B (Causeway + Bridge, Low Water)

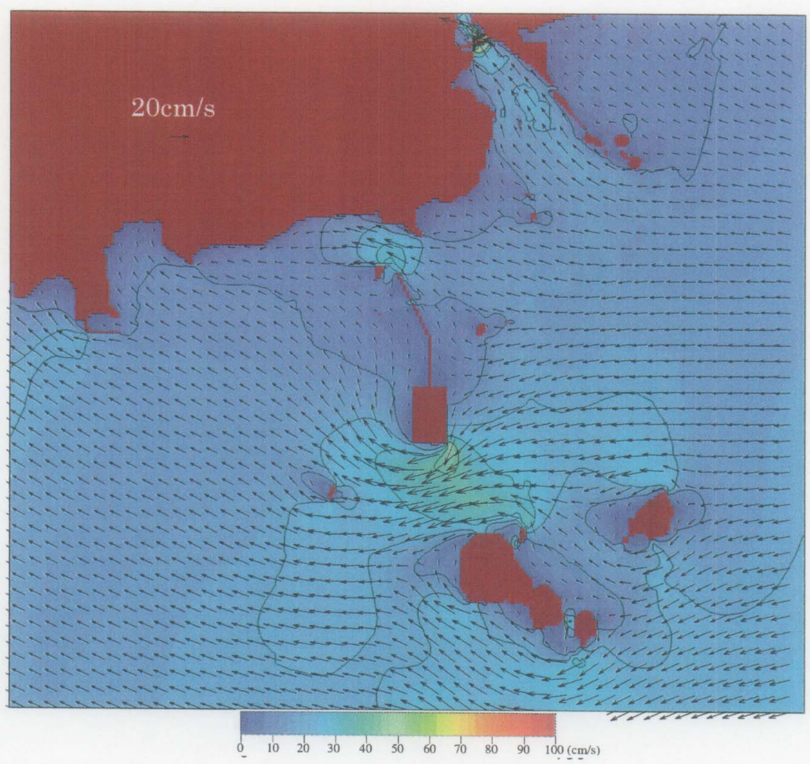


Figure A.3.12-1-3-16 Current Velocity : Plan B (Causeway + Bridge, Peak Flood)

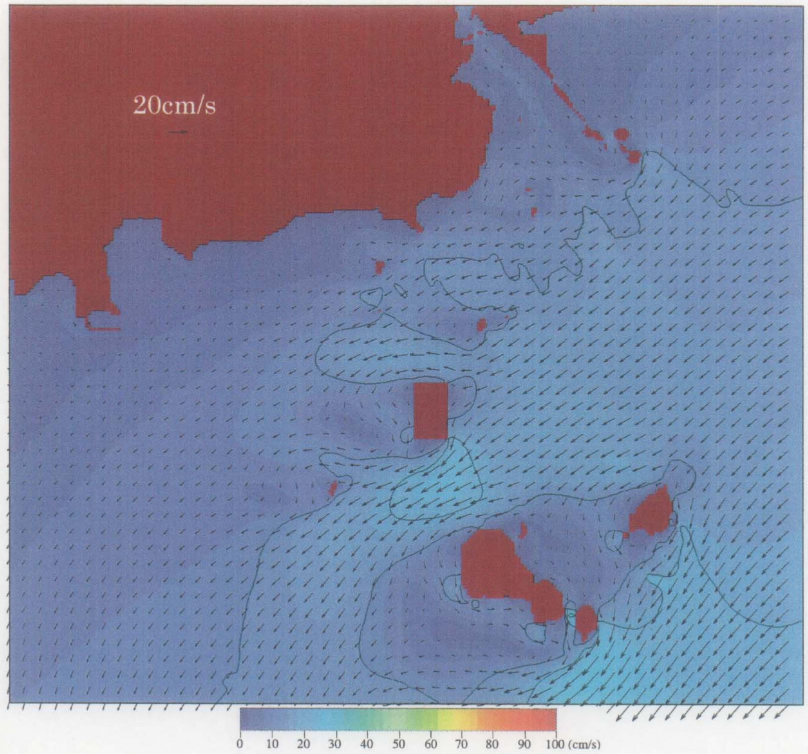


Figure A.3.12-1-3-17 Current Velocity : Plan B (Bridge, High Water)

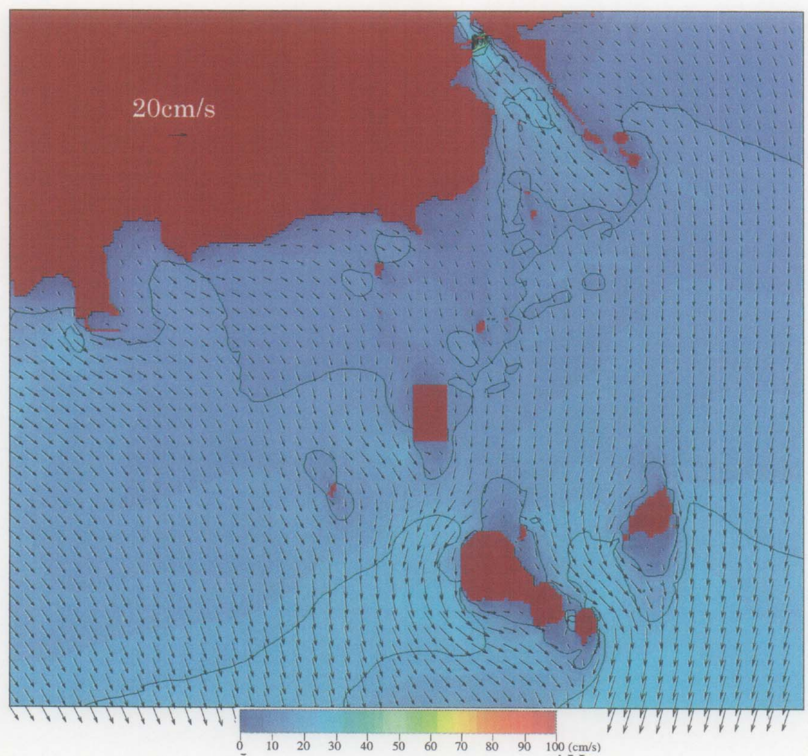


Figure A.3.12-1-3-18 Current Velocity : Plan B (Bridge, Peak Ebb)

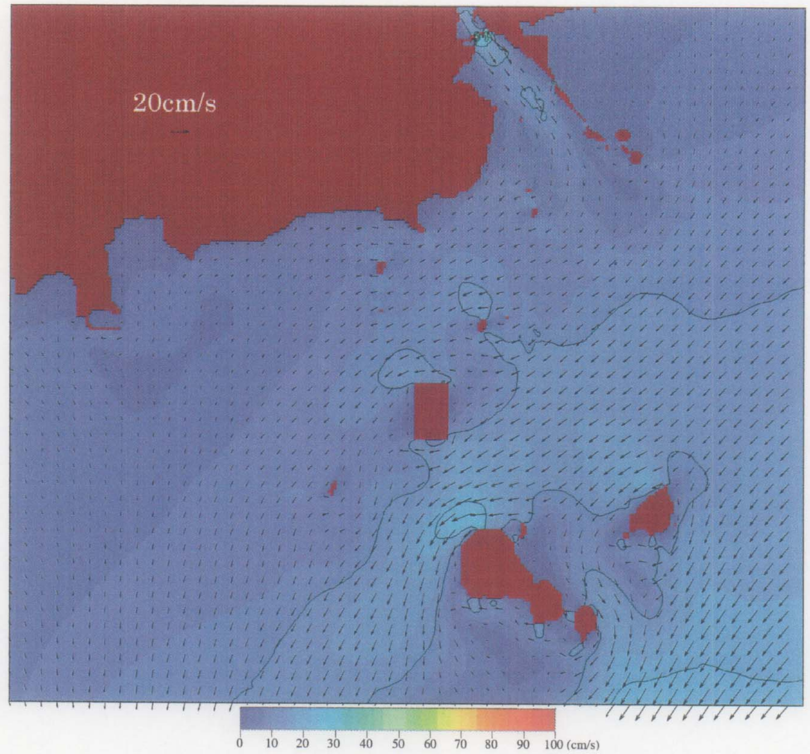


Figure A.3.12-1-3-19 Current Velocity : Plan B (Bridge, Low Water)

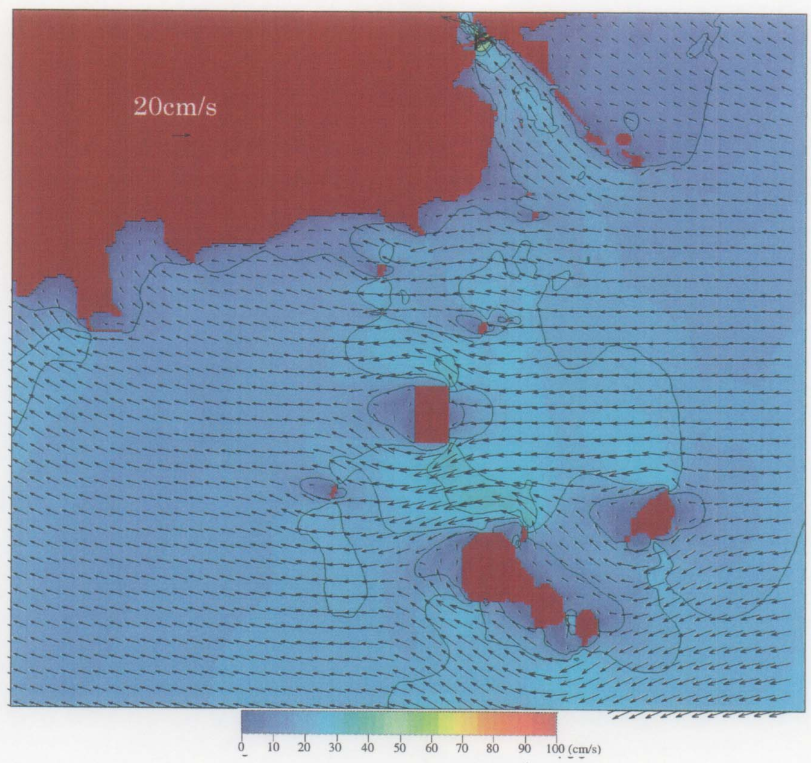


Figure A.3.12-1-3-20 Current Velocity : Plan B (Bridge, Peak Flood)

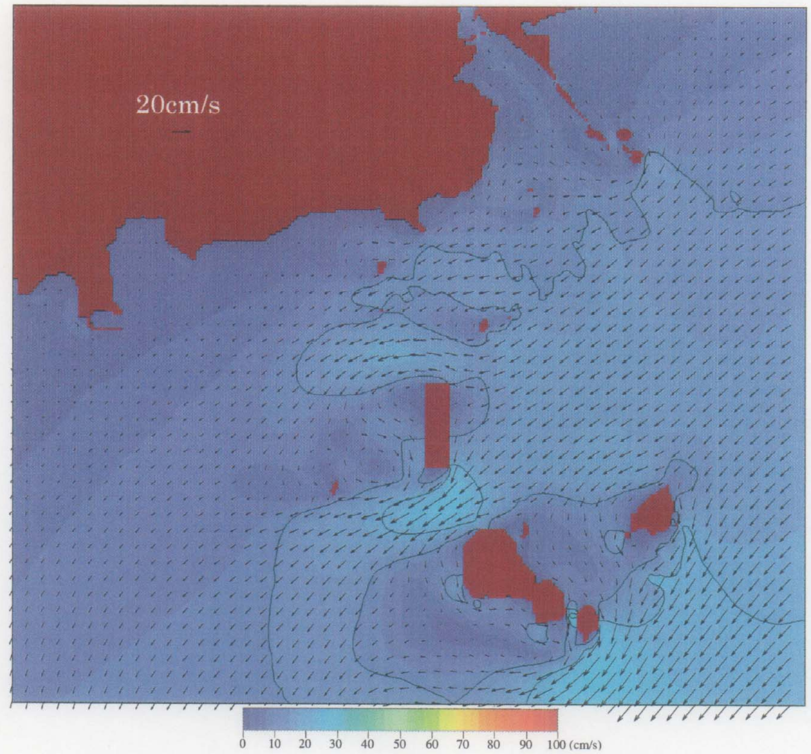


Figure A.3.12-1-4-1 Current Velocity : Plan C (No Accessway, High Water)

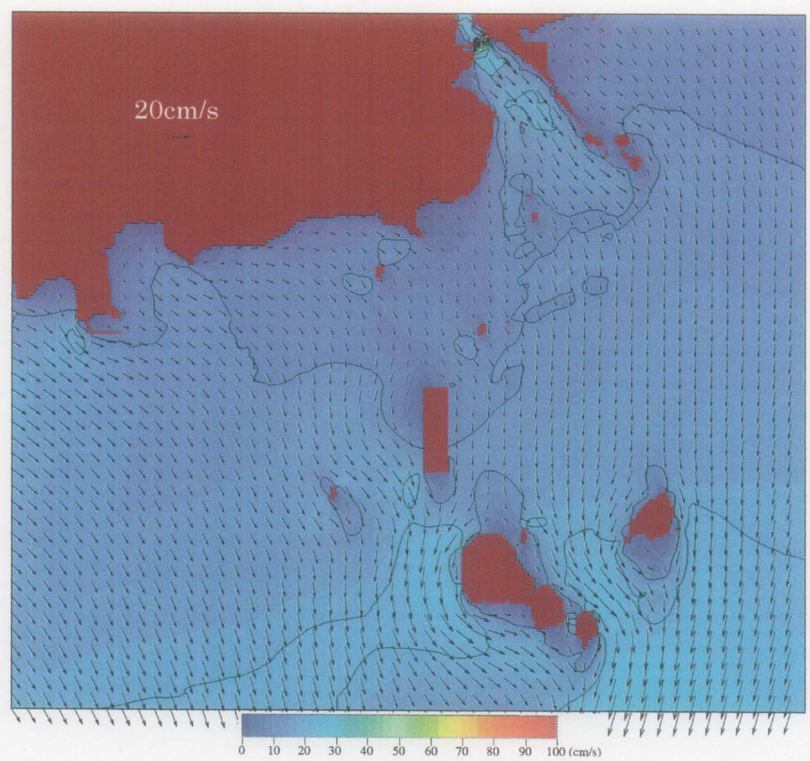


Figure A.3.12-1-4-2 Current Velocity : Plan C (No Accessway, Peak Ebb)

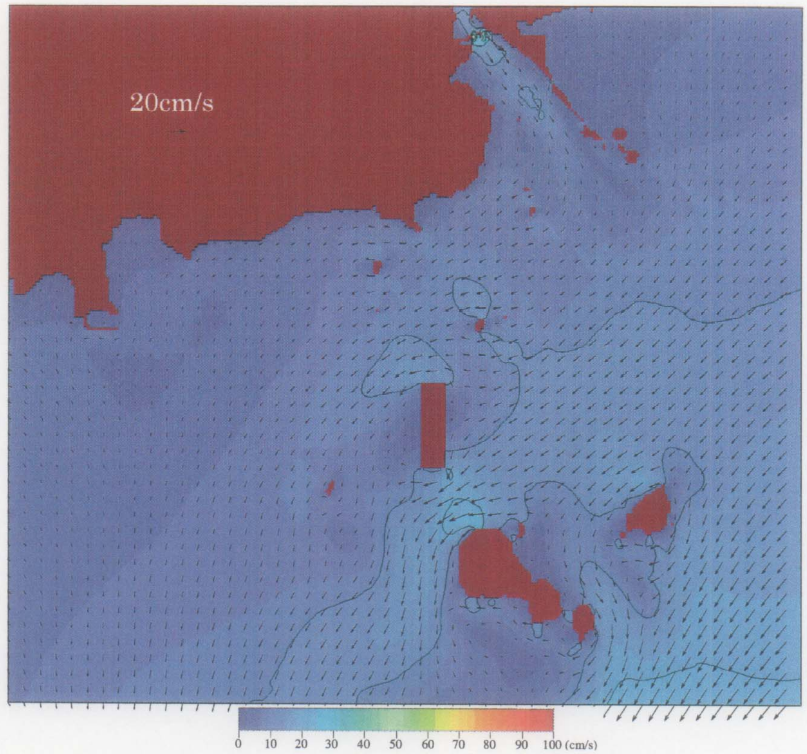


Figure A.3.12-1-4-3 Current Velocity : Plan C (No Accessway, Low Water)

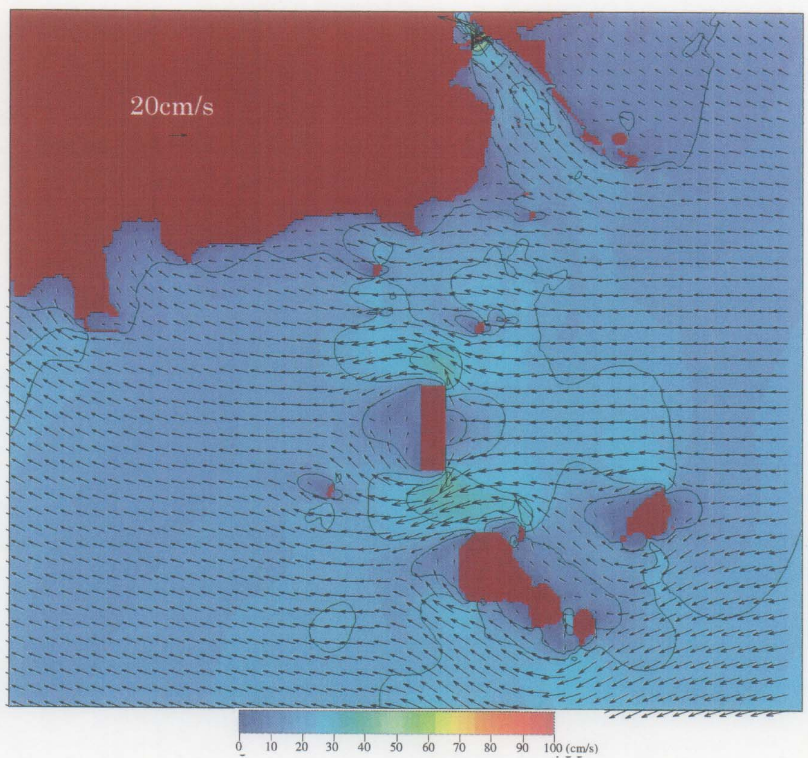


Figure A.3.12-1-4-4 Current Velocity : Plan C (No Accessway, Peak Flood)

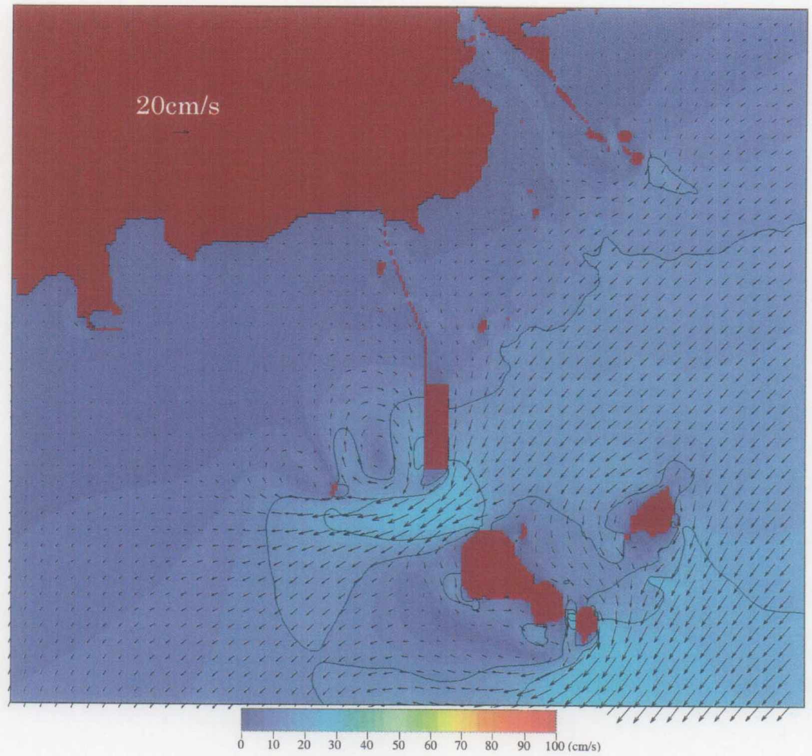


Figure A.3.12-1-4-5 Current Velocity : Plan C (Causeway, High Water)

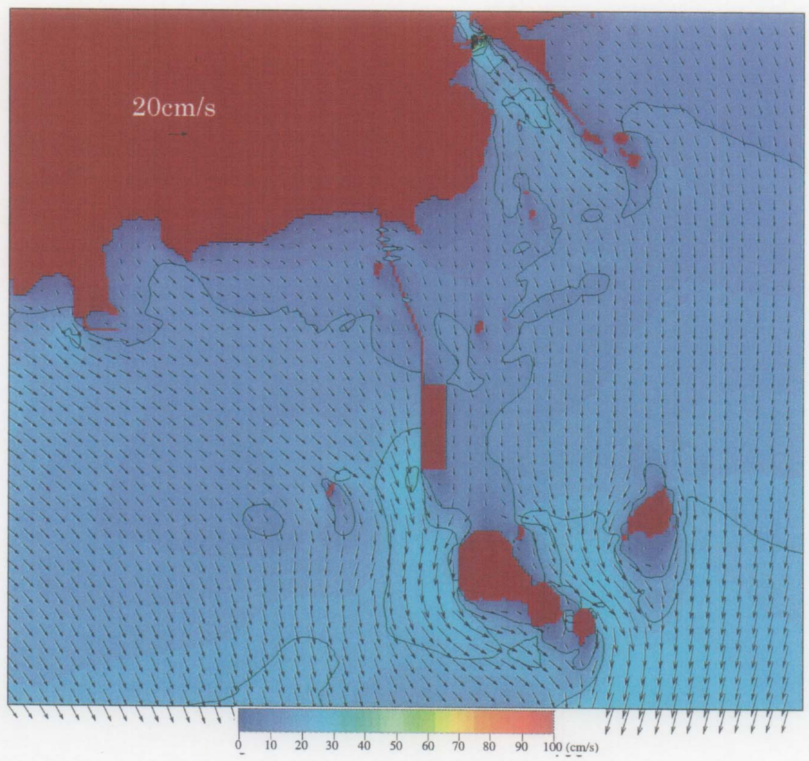


Figure A.3.12-1-4-6 Current Velocity : Plan C (Causeway, Peak Ebb)

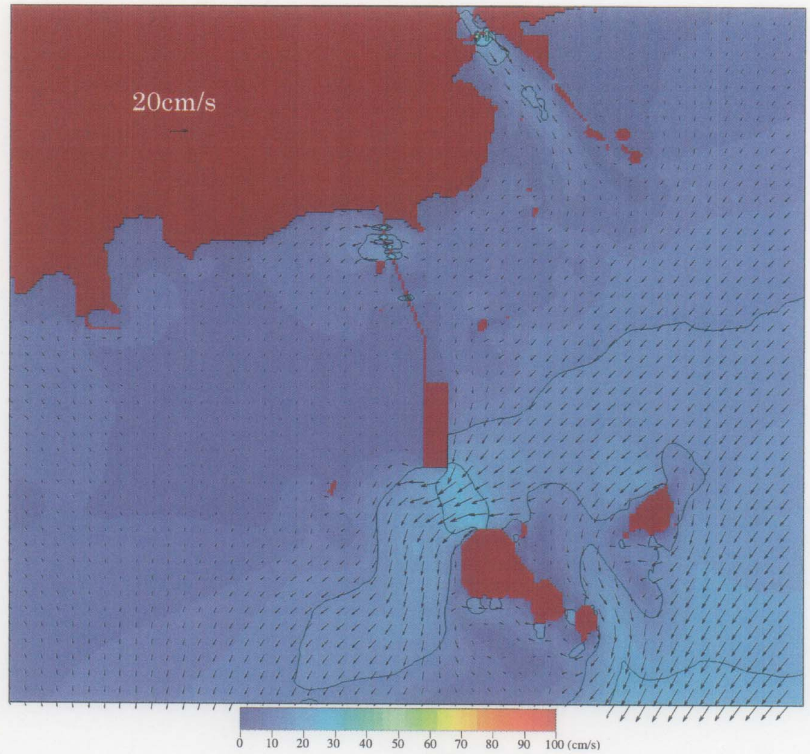


Figure A.3.12-1-4-7 Current Velocity : Plan C (Causeway, Low Water)

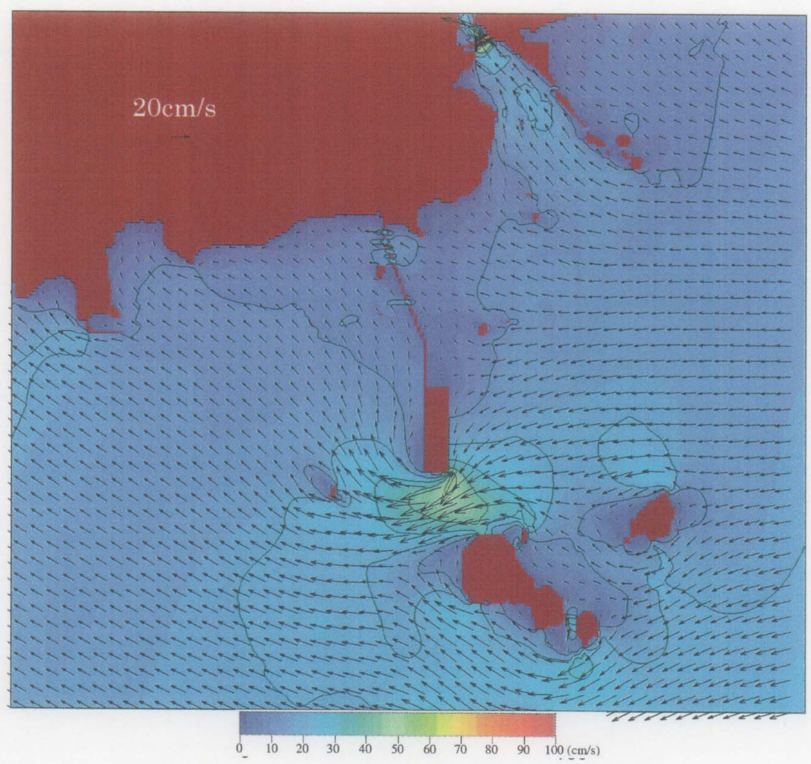


Figure A.3.12-1-4-8 Current Velocity : Plan C (Causeway, Peak Flood)

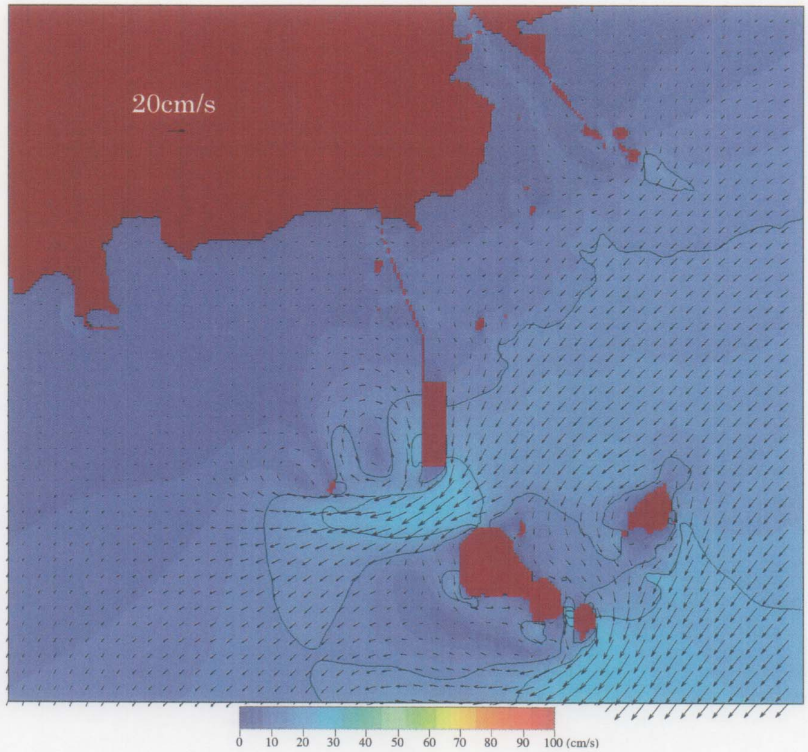


Figure A.3.12-1-4-9 Current Velocity : Plan C (Causeway + Trestle, High Water)

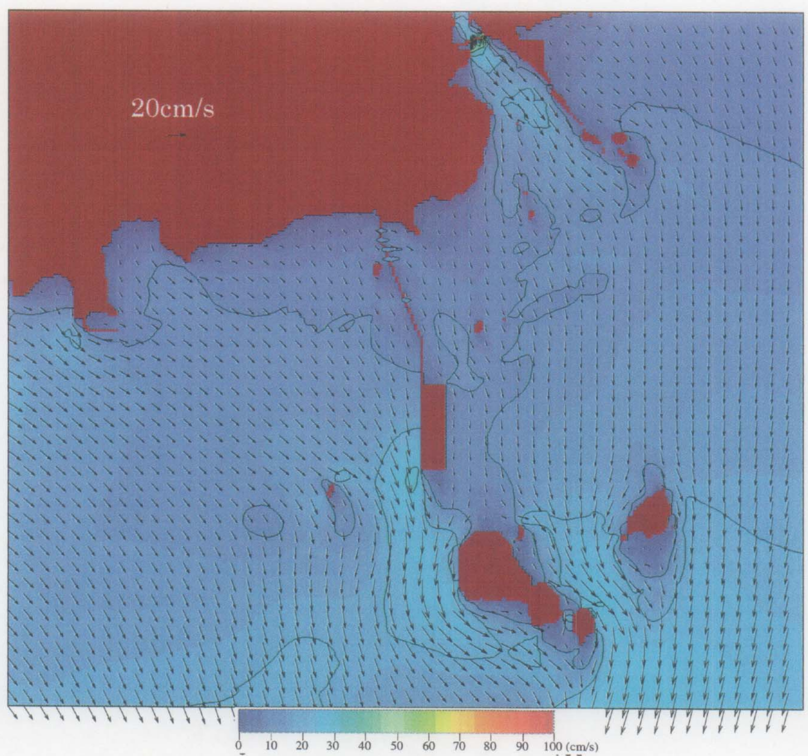


Figure A.3.12-1-4-10 Current Velocity : Plan C (Causeway + Trestle, Peak Ebb)

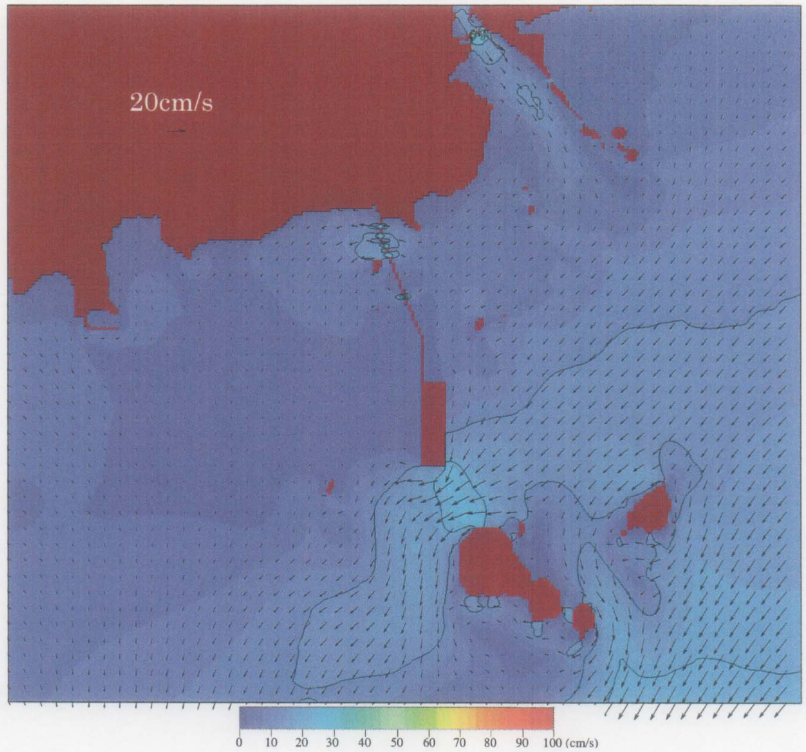


Figure A.3.12-1-4-11 Current Velocity : Plan C (Causeway + Trestle, Low Water)

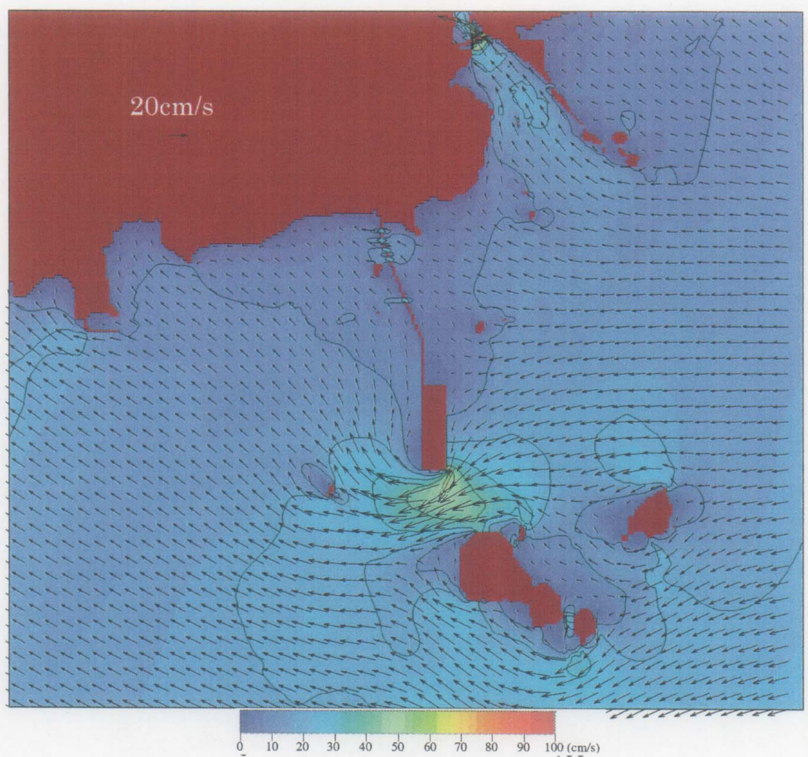


Figure A.3.12-1-4-12 Current Velocity : Plan C (Causeway + Trestle, Peak Flood)

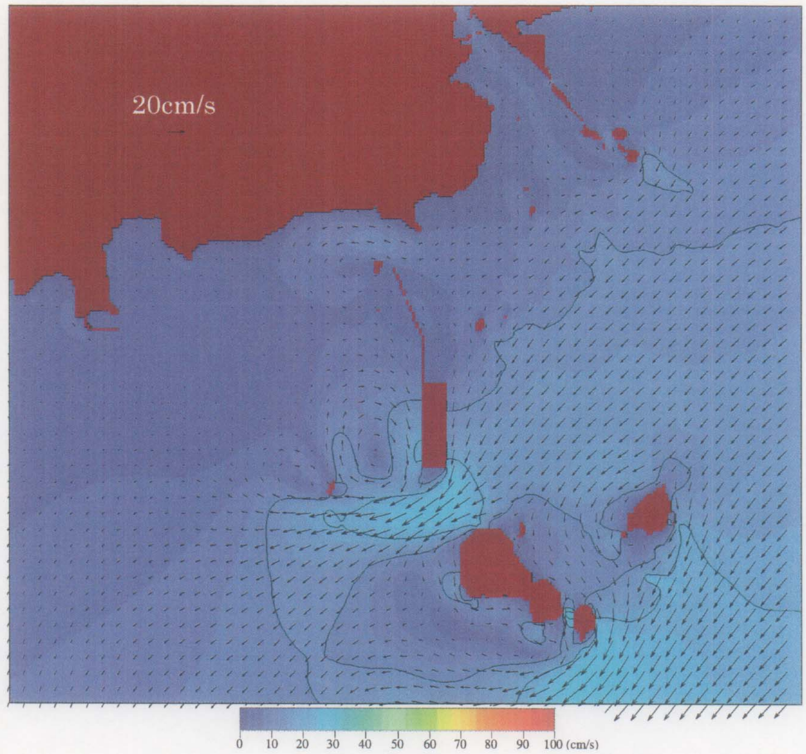


Figure A.3.12-1-4-13 Current Velocity : Plan C (Causeway + Bridge, High Water)

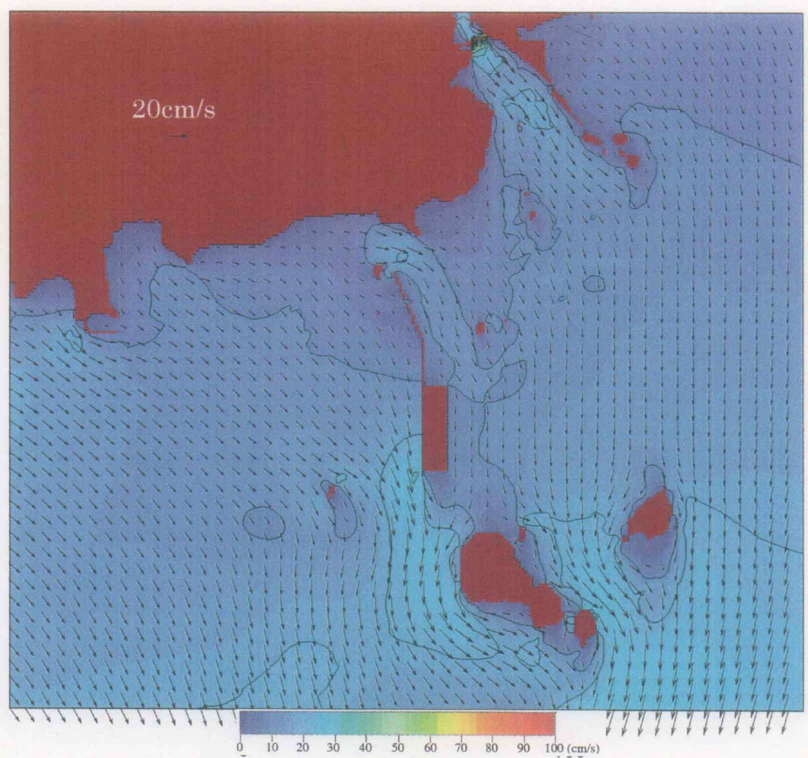


Figure A.3.12-1-4-14 Current Velocity : Plan C (Causeway + Bridge, Peak Ebb)

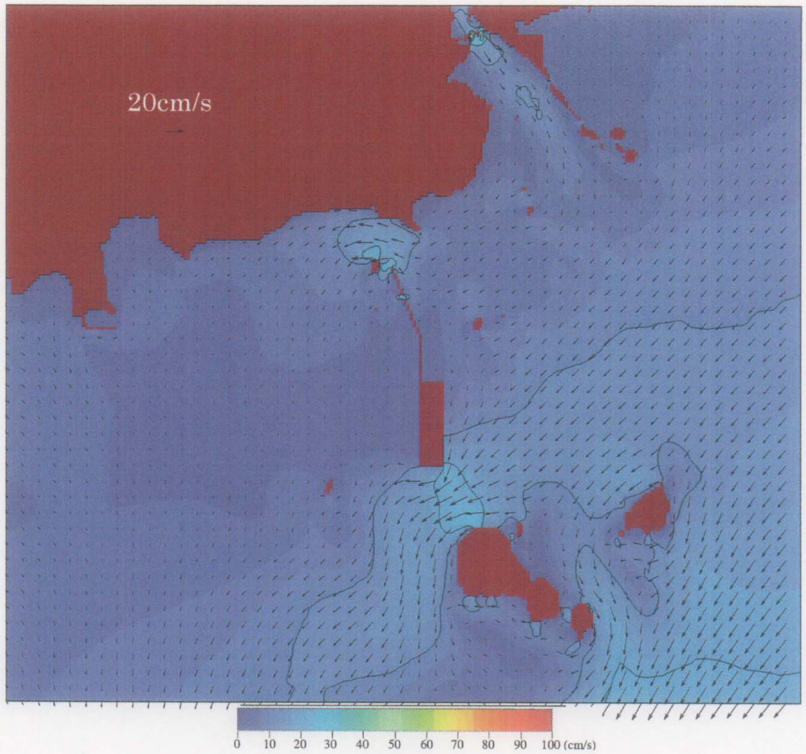


Figure A.3.12-1-4-15 Current Velocity : Plan C (Causeway + Bridge, Low Water)

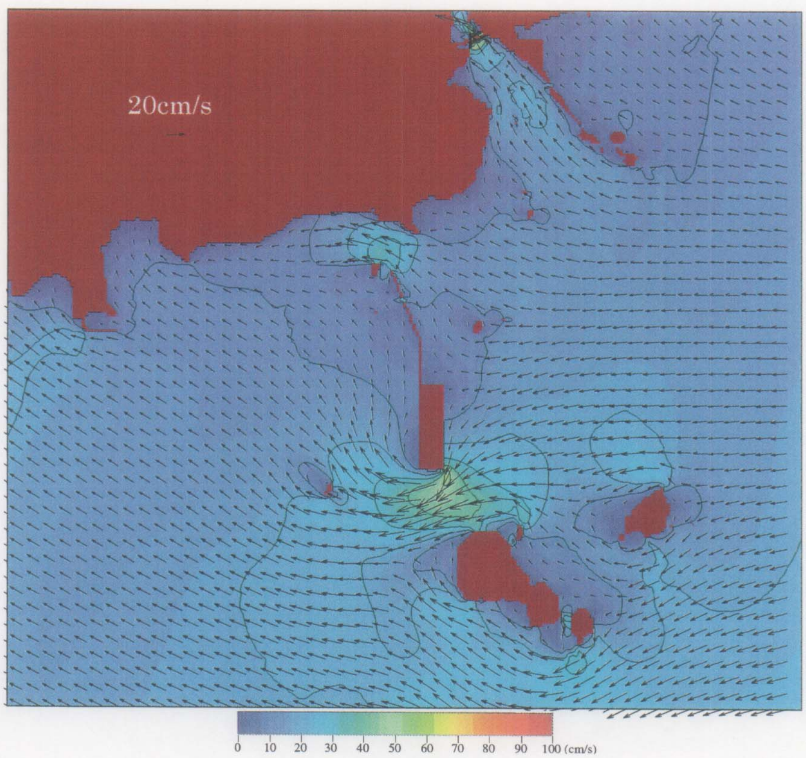


Figure A.3.12-1-4-16 Current Velocity : Plan C (Causeway + Bridge, Peak Flood)

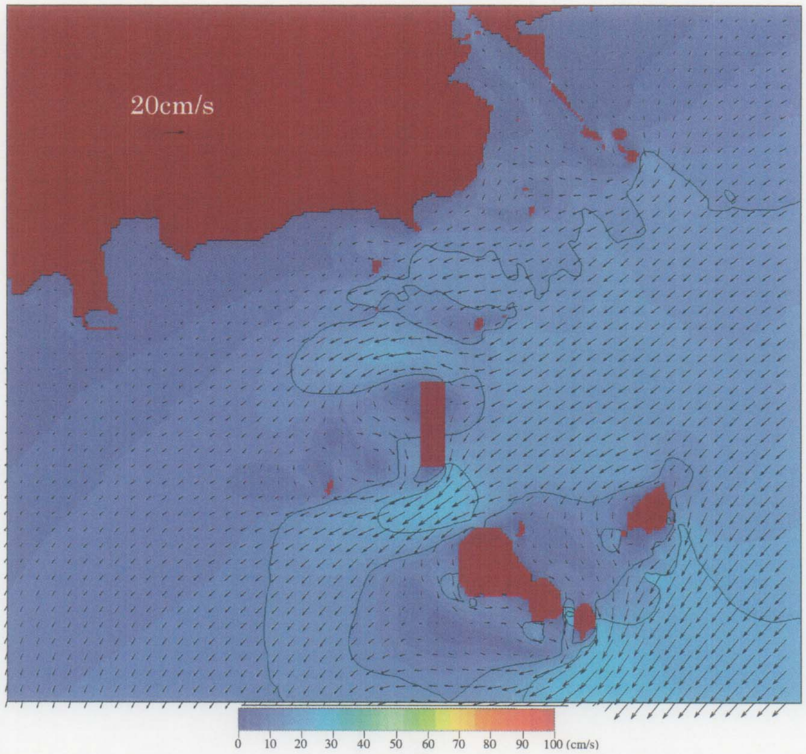


Figure A.3.12-1-4-17 Current Velocity : Plan C (Bridge, High Water)

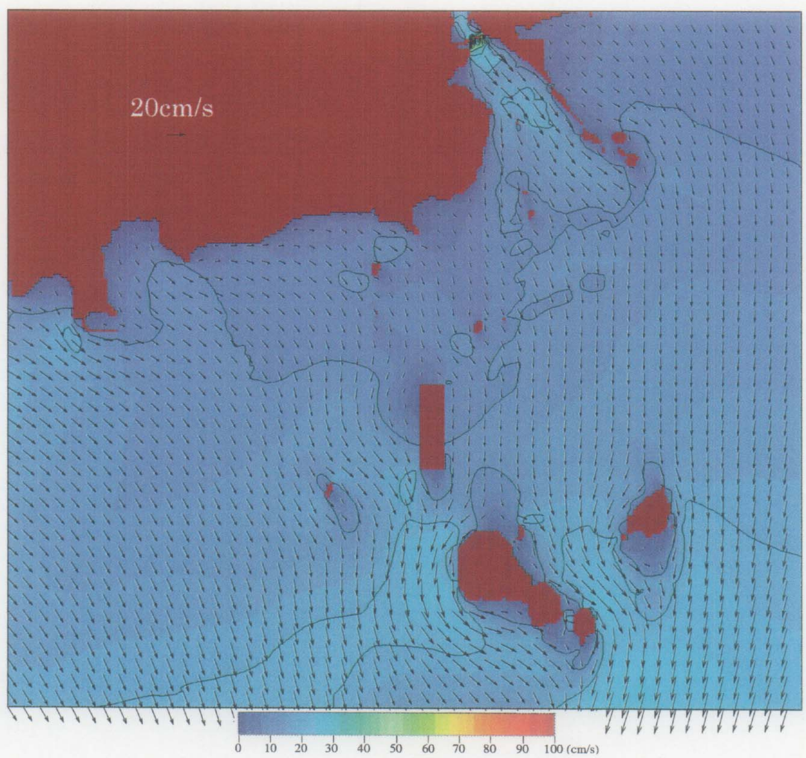


Figure A.3.12-1-4-18 Current Velocity : Plan C (Bridge, Peak Ebb)

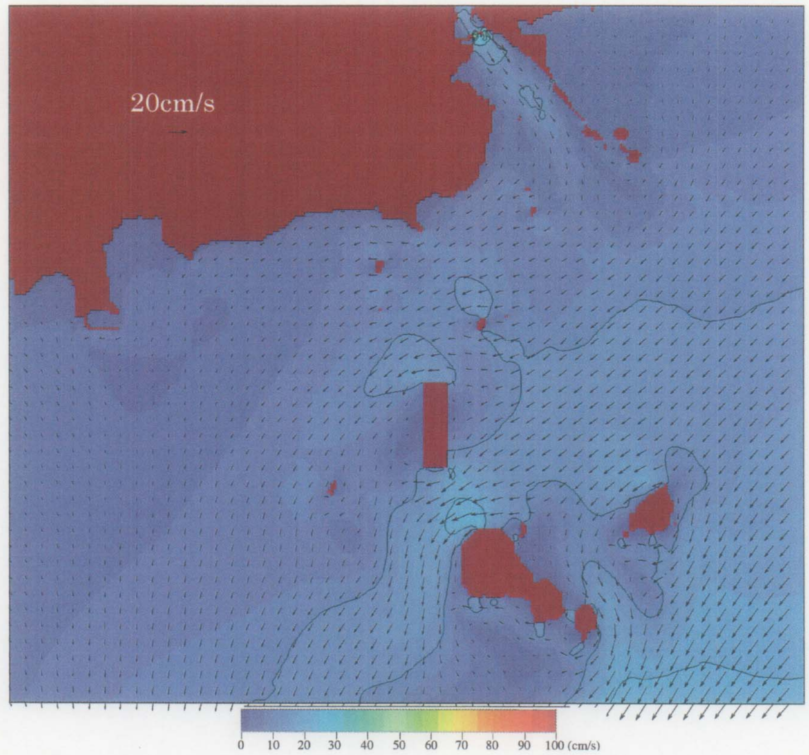


Figure A.3.12-1-4-19 Current Velocity : Plan C (Bridge, Low Water)

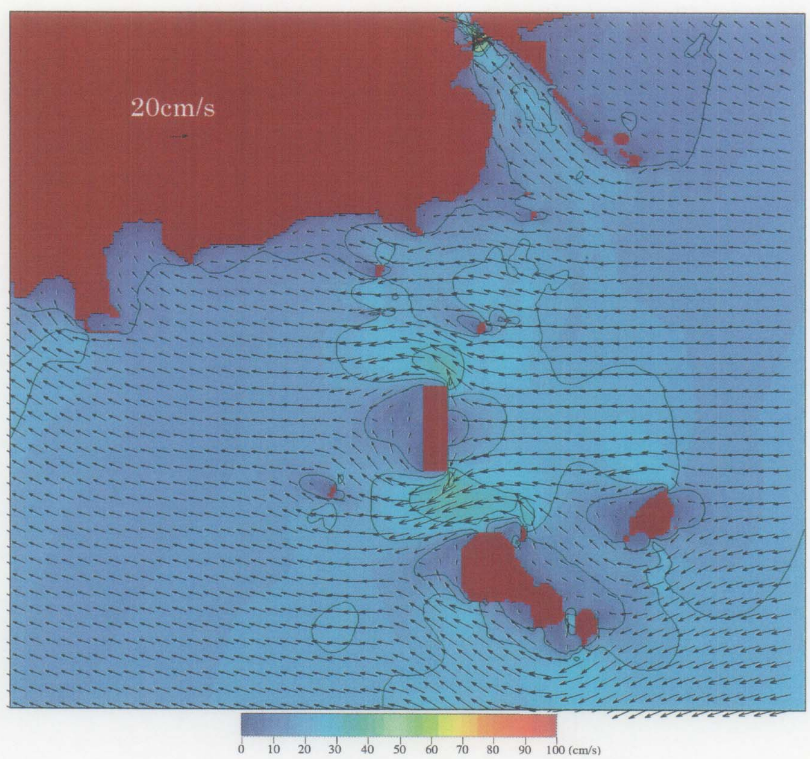


Figure A.3.12-1-4-20 Current Velocity : Plan C (Bridge, Peak Flood)

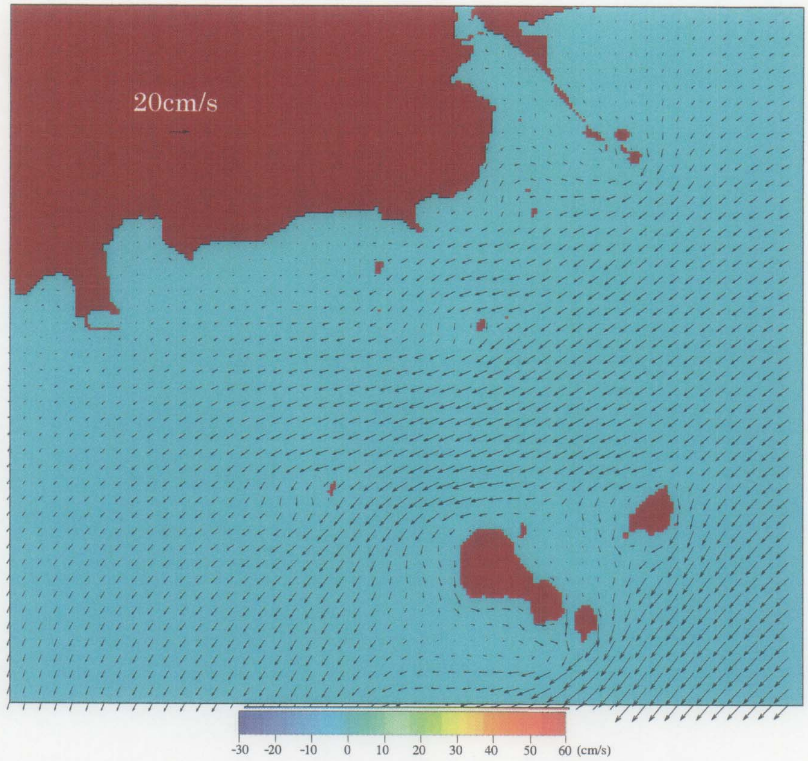


Figure A.3.12-2-1-1 Comparison of Current Velocity : Existing Condition (High Water)

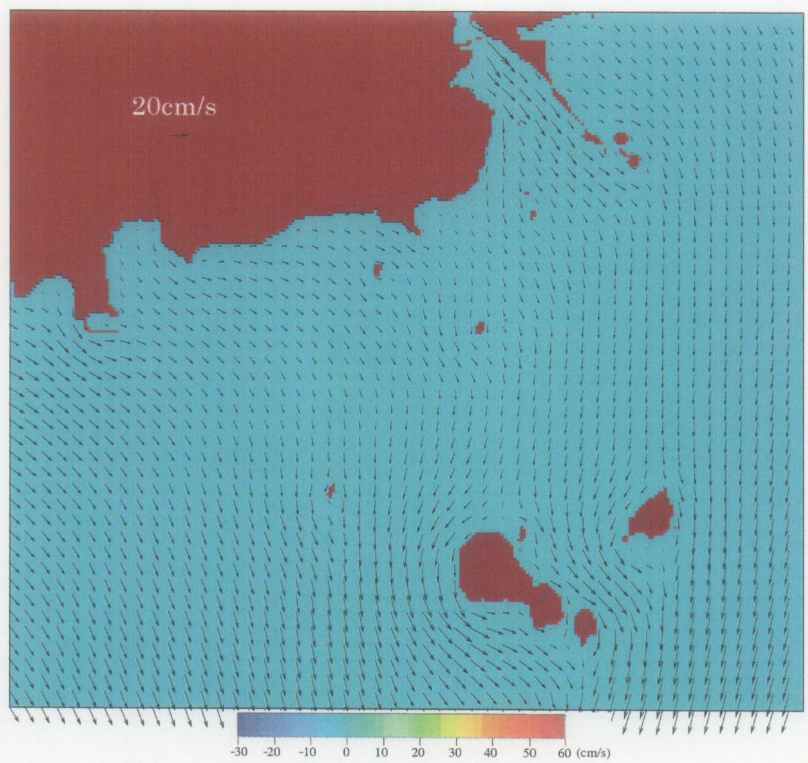


Figure A.3.12-2-1-2 Comparison of Current Velocity : Existing Condition (Peak Ebb)

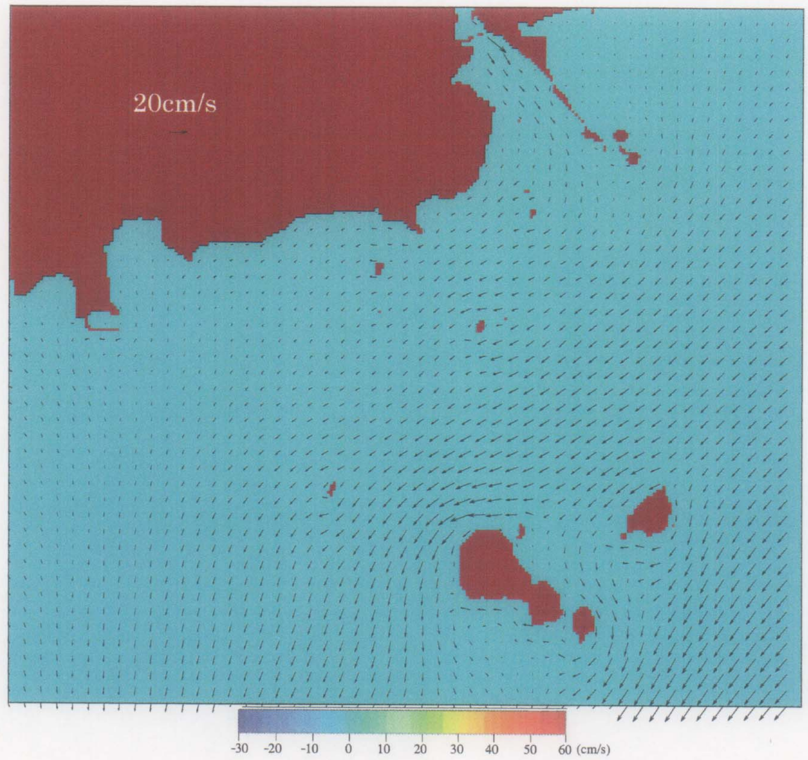


Figure A.3.12-2-1-3 Comparison of Current Velocity : Existing Condition (Low Water)

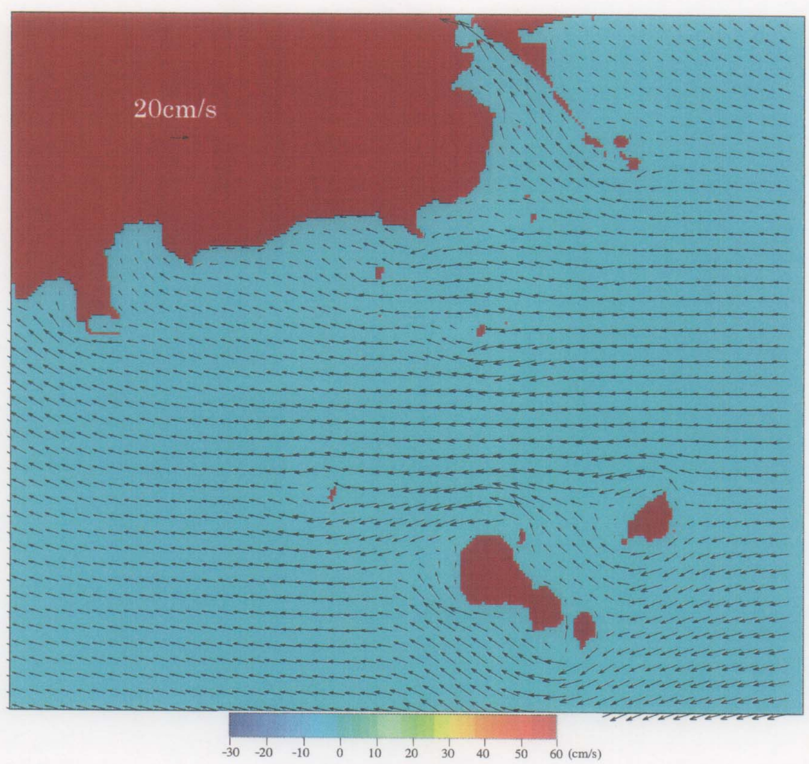


Figure A.3.12-2-1-4 Comparison of Current Velocity : Existing Condition (Peak Flood)

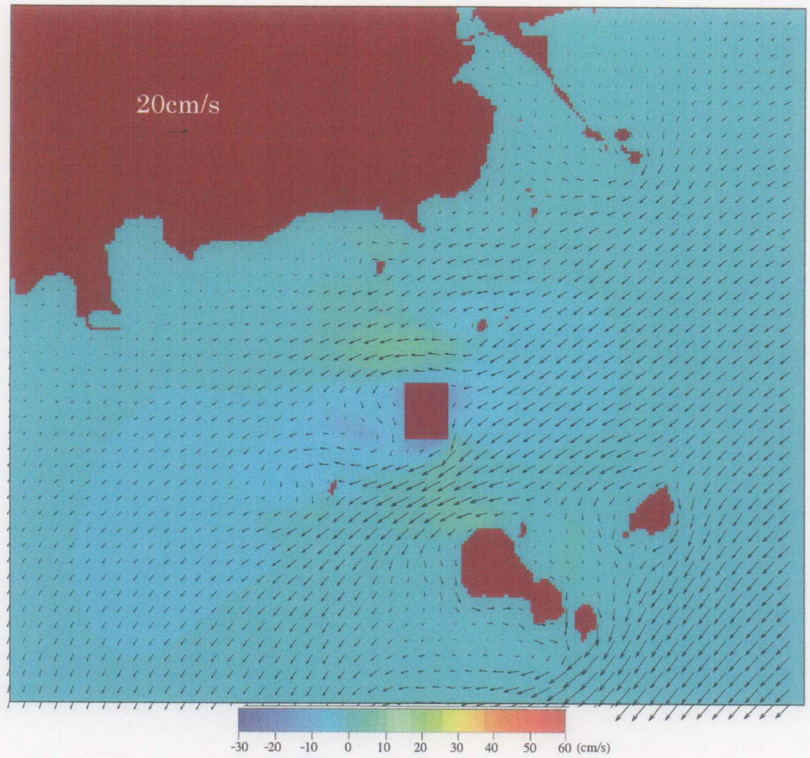


Figure A.3.12-2-2-1 Comparison of Current Velocity : Plan A (No Accessway, High Water)

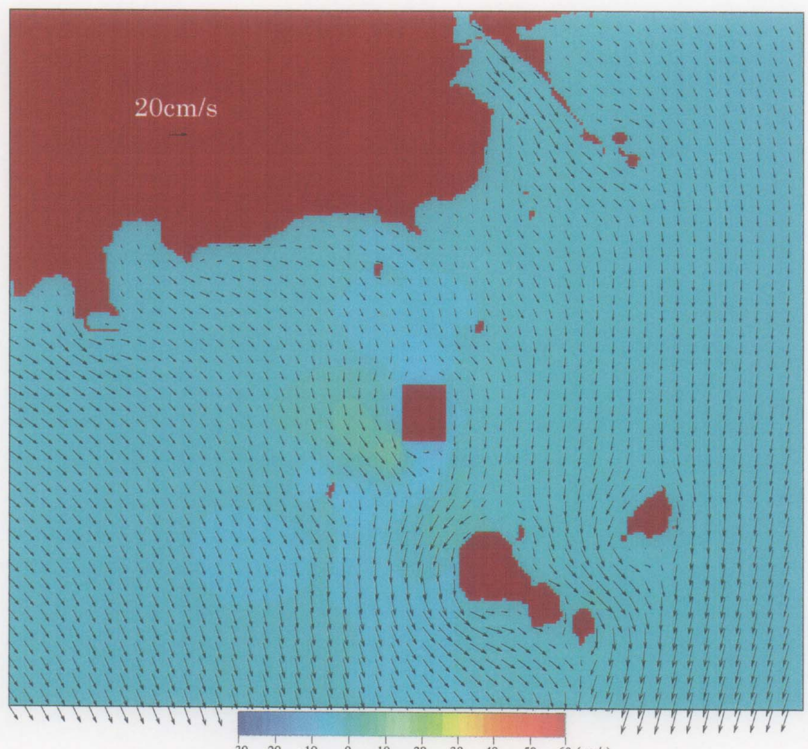


Figure A.3.12-2-2-2 Comparison of Current Velocity : Plan A (No Accessway, Peak Ebb)

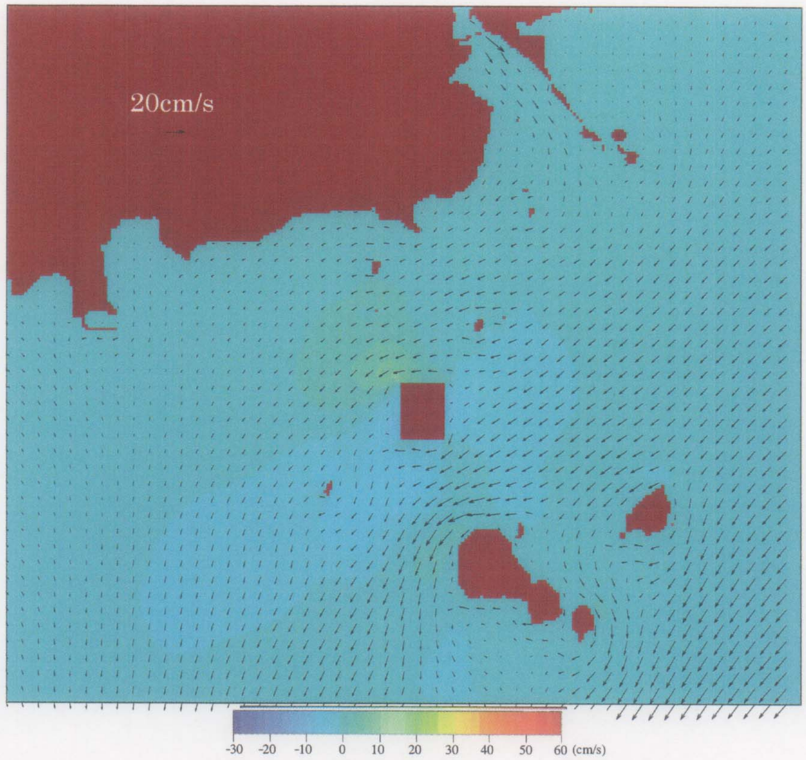


Figure A.3.12-2-2-1 Comparison of Current Velocity : Plan A (No Accessway, Low Water)

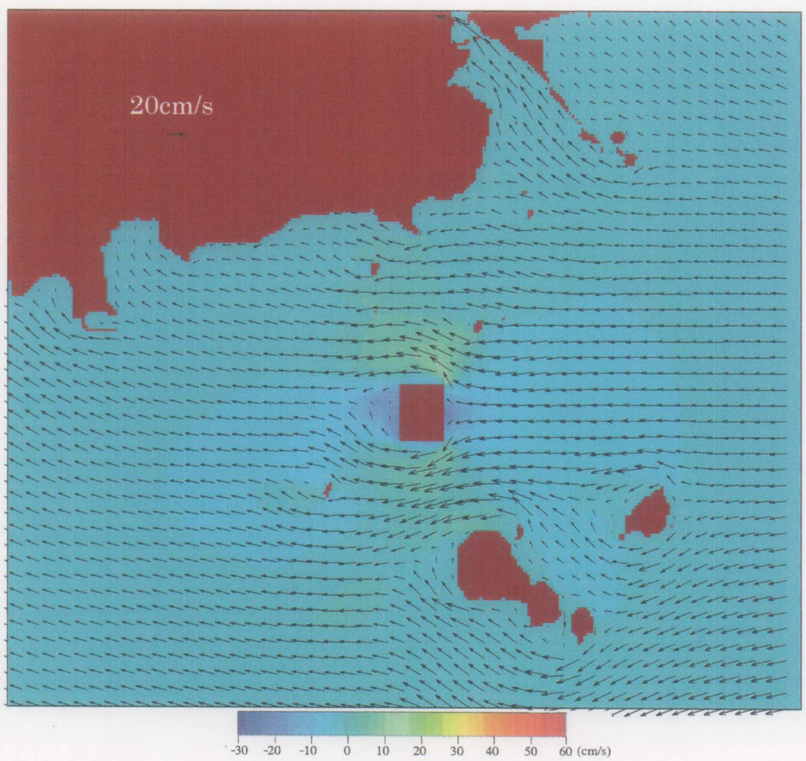


Figure A.3.12-2-2-2 Comparison of Current Velocity : Plan A (No Accessway, Peak Flood)

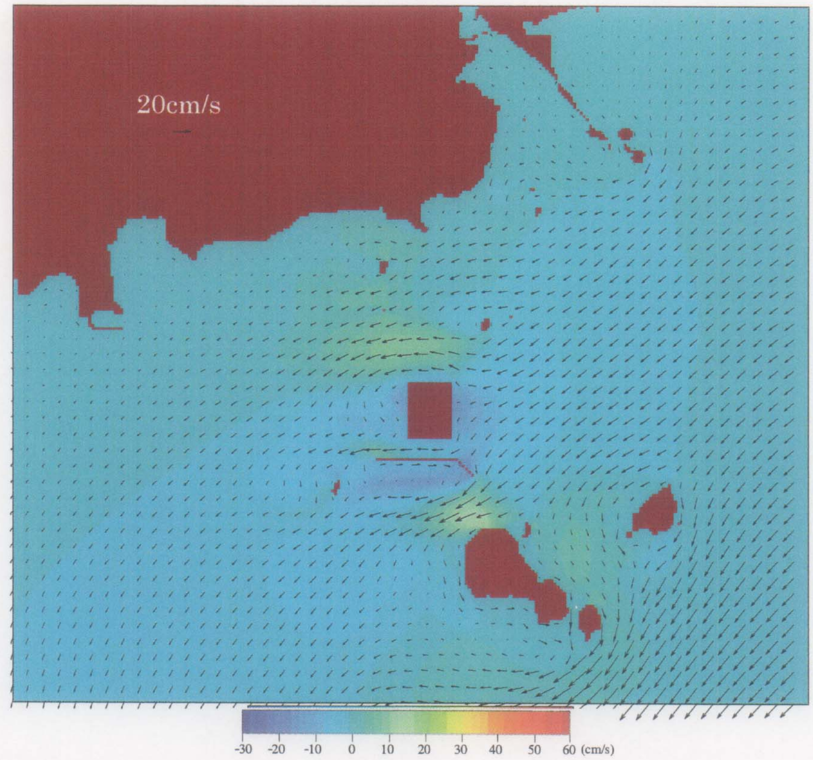


Figure A.3.12-2-2-5 Comparison of Current Velocity : Plan A+Breakwater (No Accessway, High Water)

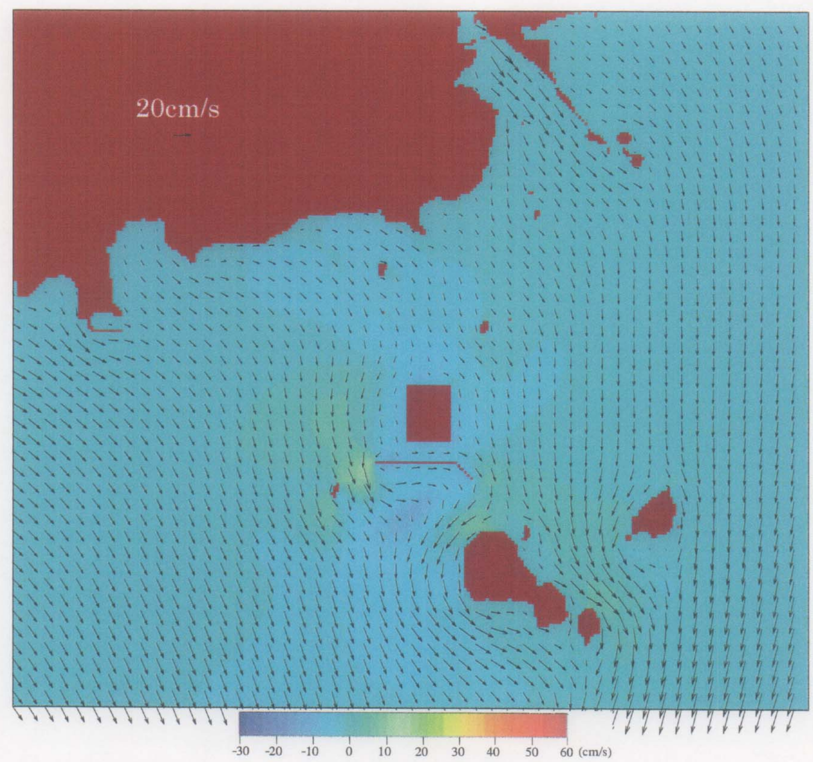


Figure A.3.12-2-2-6 Comparison of Current Velocity : Plan A+Breakwater (No Accessway, Peak Ebb)

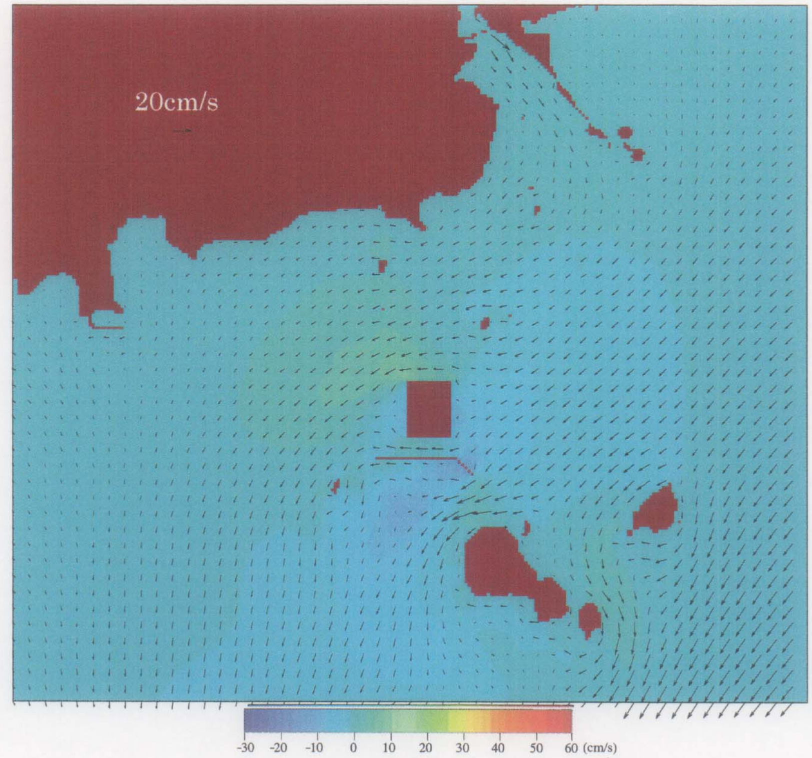


Figure A.3. 12-2-2-7 Comparison of Current Velocity : Plan A + Breakwater (No Accessway, Low Water)

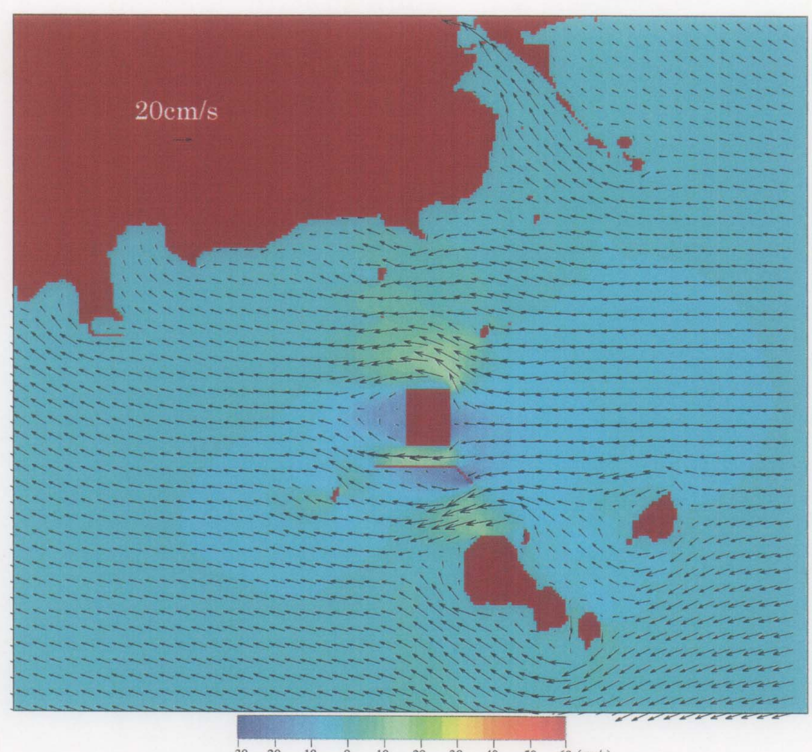


Figure A.3.12-2-2-8 Comparison of Current Velocity : Plan A + Break Water (No Accessway, Peak Flood)

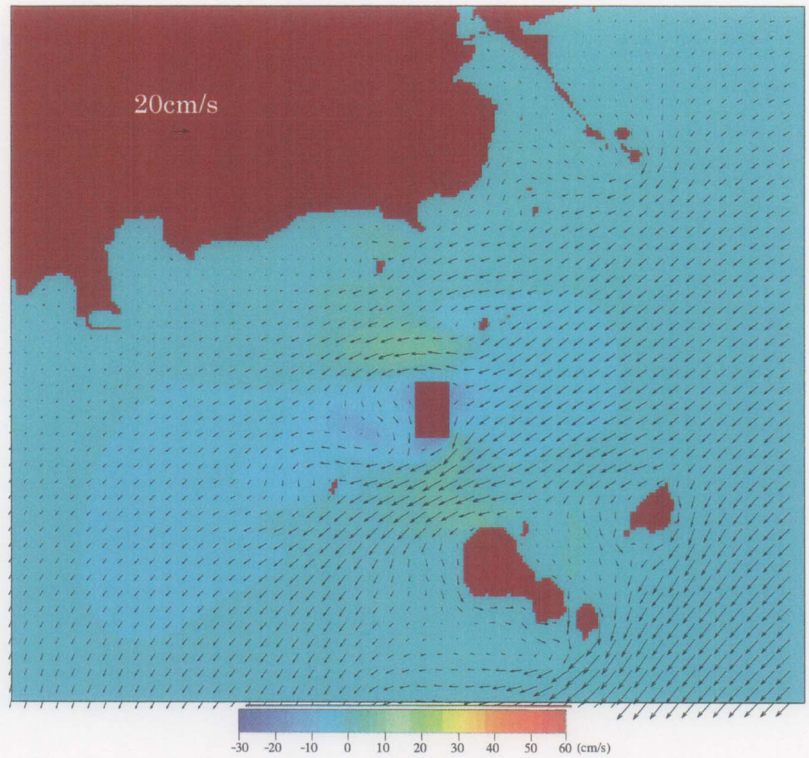


Figure A.3.12-2-3-1 Comparison of Current Velocity : Plan B (No Accessway, High Water)

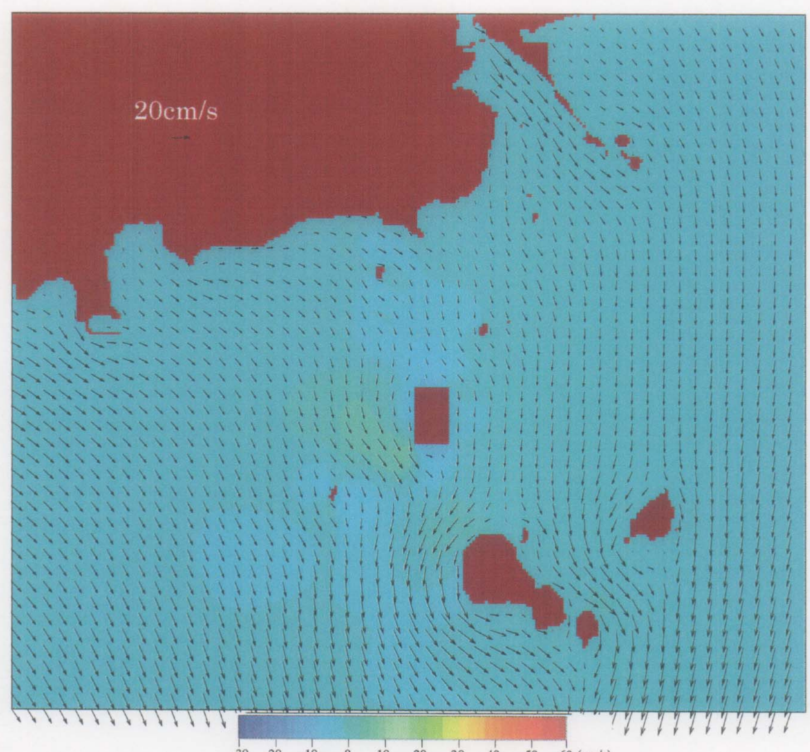


Figure A.3.12-2-3-2 Comparison of Current Velocity : Plan B (No Accessway, Peak Ebb)

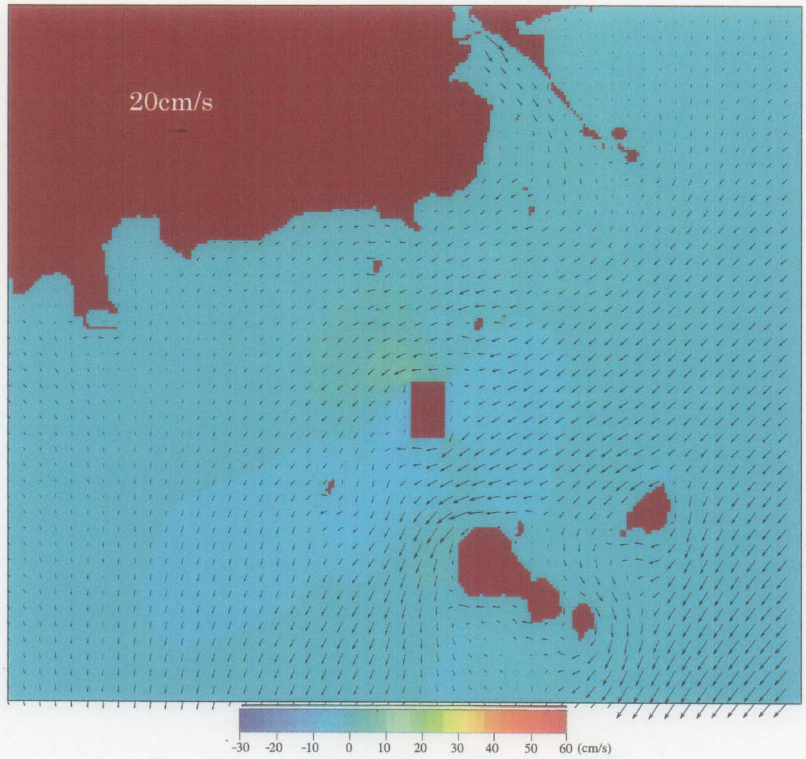


Figure A.3.12-2-3-3 Comparison of Current Velocity : Plan B (No Accessway, Low Water)

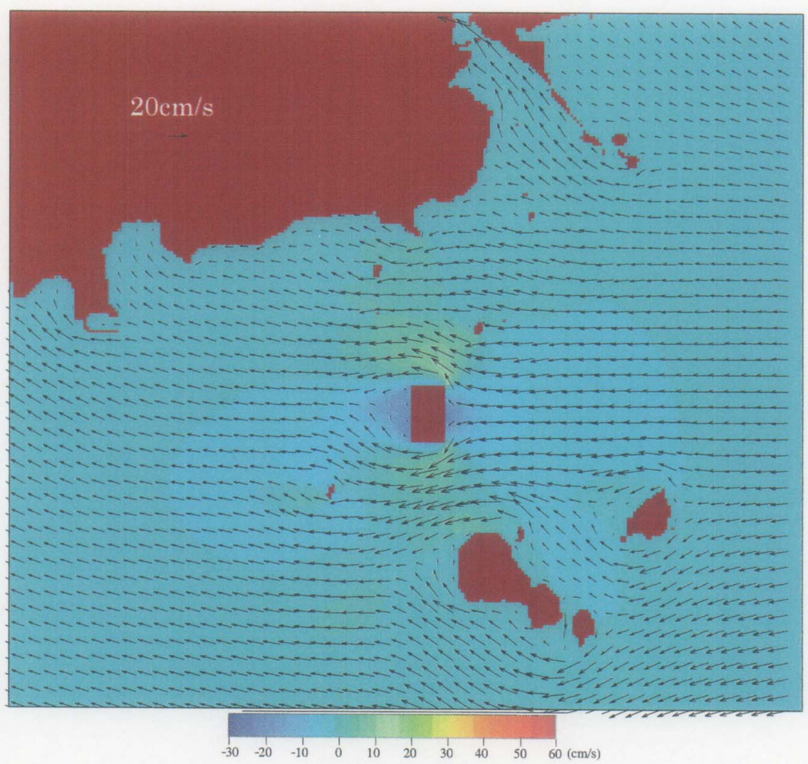


Figure A.3.12-2-3-4 Comparison of Current Velocity : Plan B (No Accessway, Peak Flood)

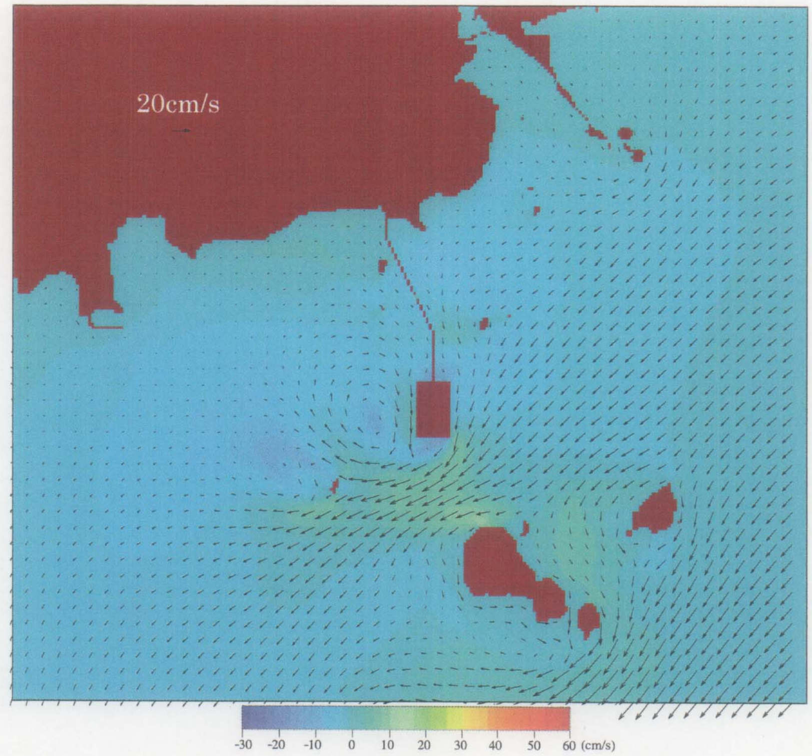


Figure A.3.12-2-3-5 Comparison of Current Velocity : Plan B (Causeway, High Water)

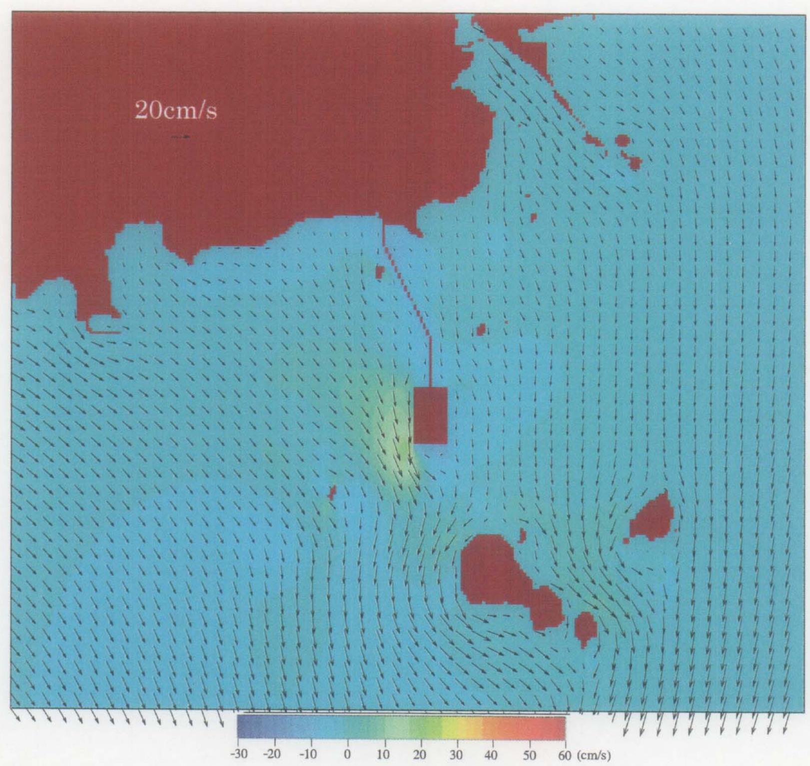


Figure A.3.12-2-3-6 Comparison of Current Velocity : Plan B (Causeway, Peak Ebb)

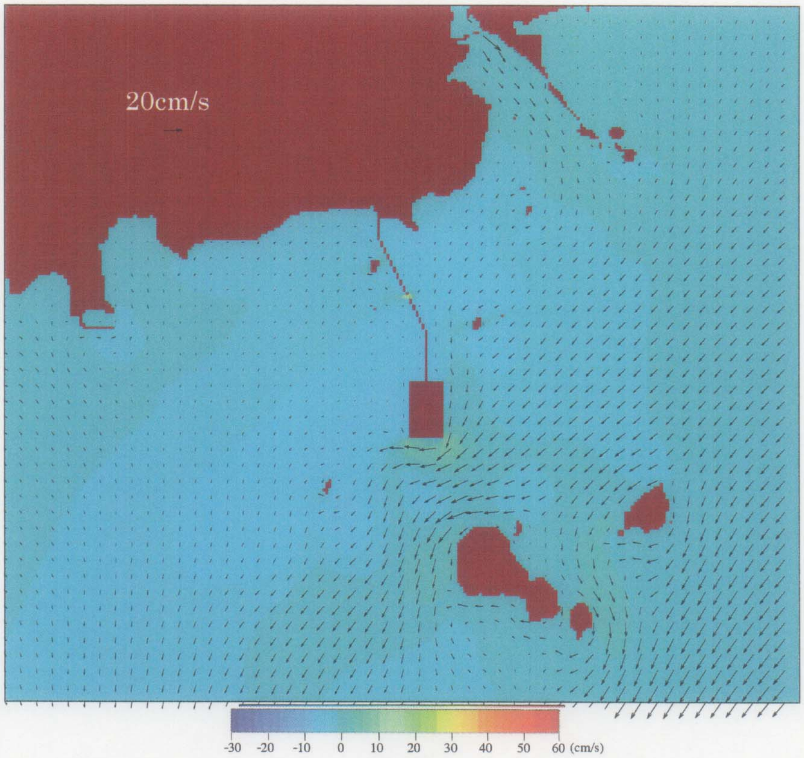


Figure A.3.12-2-3-7 Comparison of Current Velocity : Plan B (Causeway, Low Water)

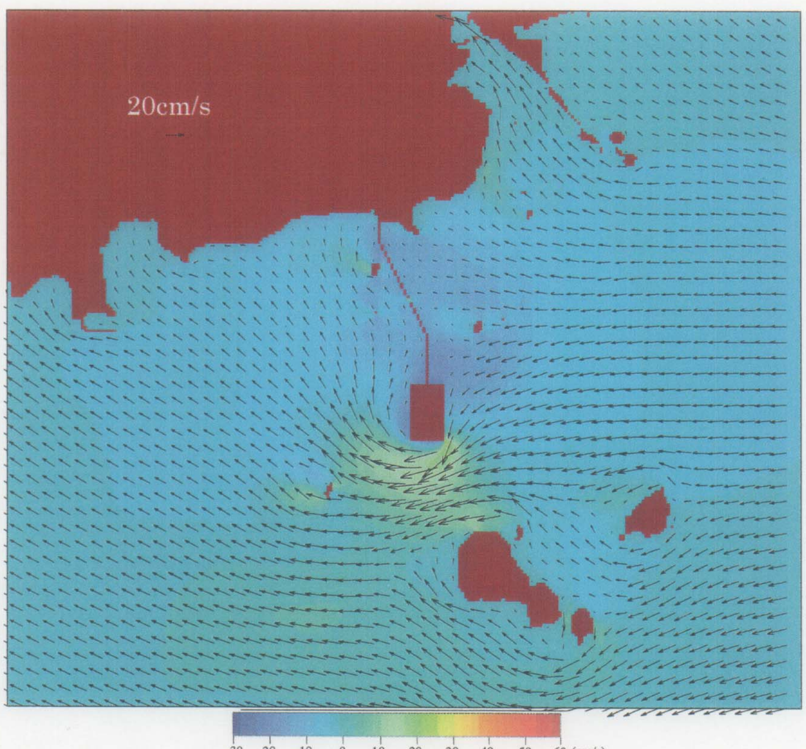


Figure A.3.12-2-3-8 Comparison of Current Velocity : Plan B (Causeway, Peak Flood)

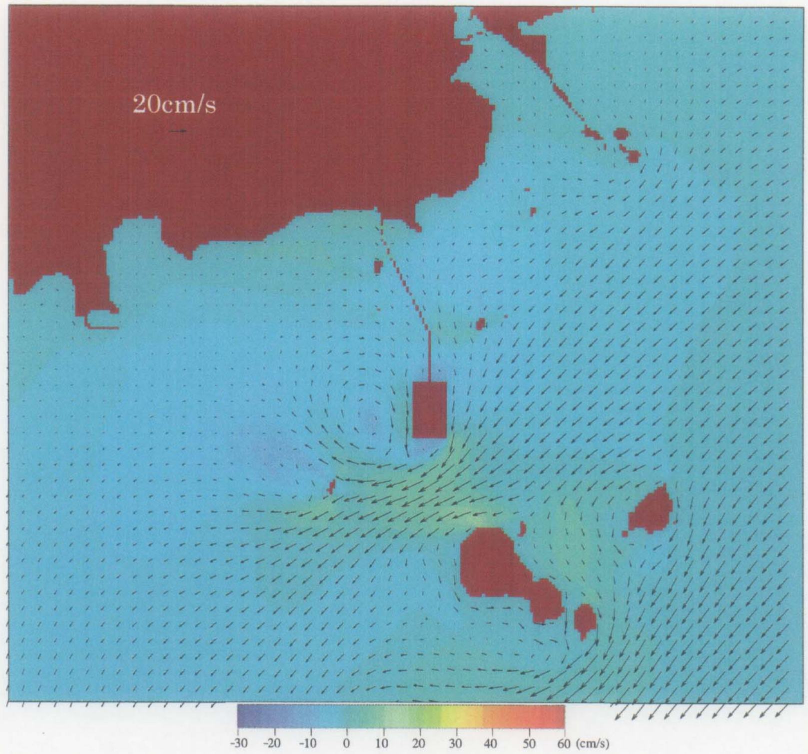


Figure A.3.12-2-3-9 Comparison of Current Velocity : Plan B (Causeway + Trestle, High Water)

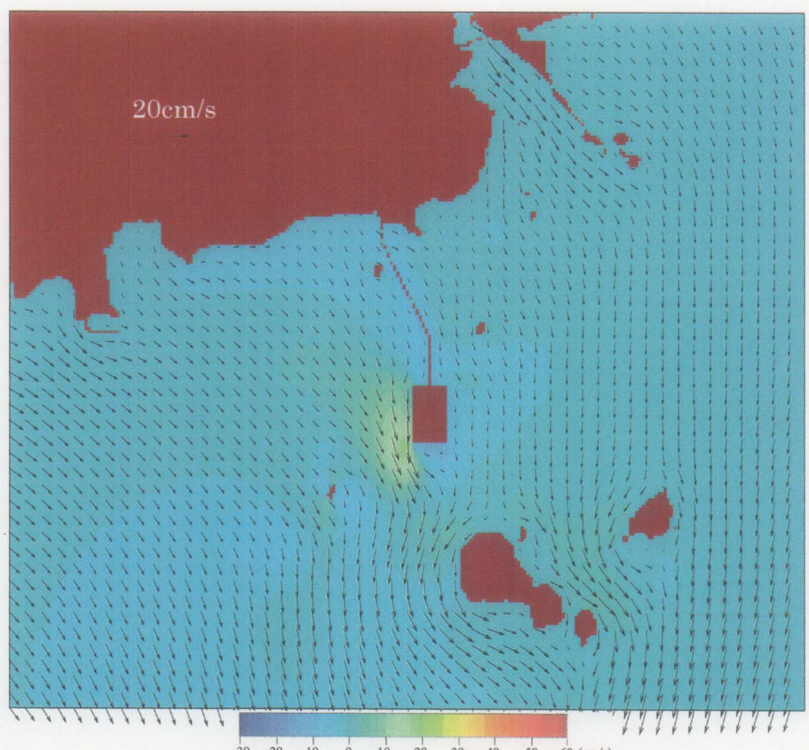


Figure A.3.12-2-3-10 Comparison of Current Velocity : Plan B (Causeway + Trestle, Peak Ebb)

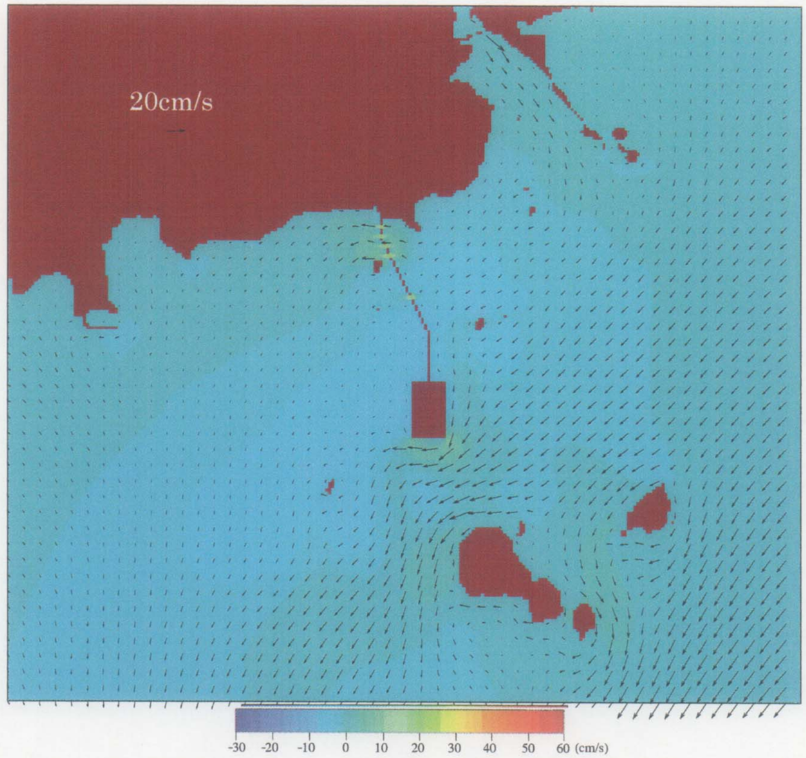


Figure A.3.12-2-3-11 Comparison of Current Velocity : Plan B (Causeway + Trestle, Low Water)

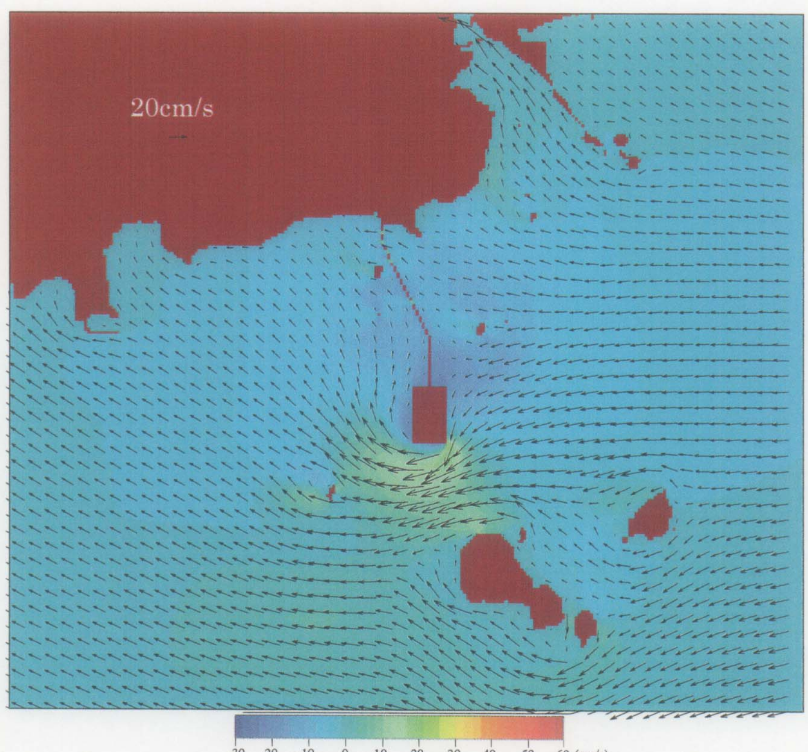


Figure A.3.12-2-3-12 Comparison of Current Velocity : Plan B (Causeway + Trestle, Peak Flood)

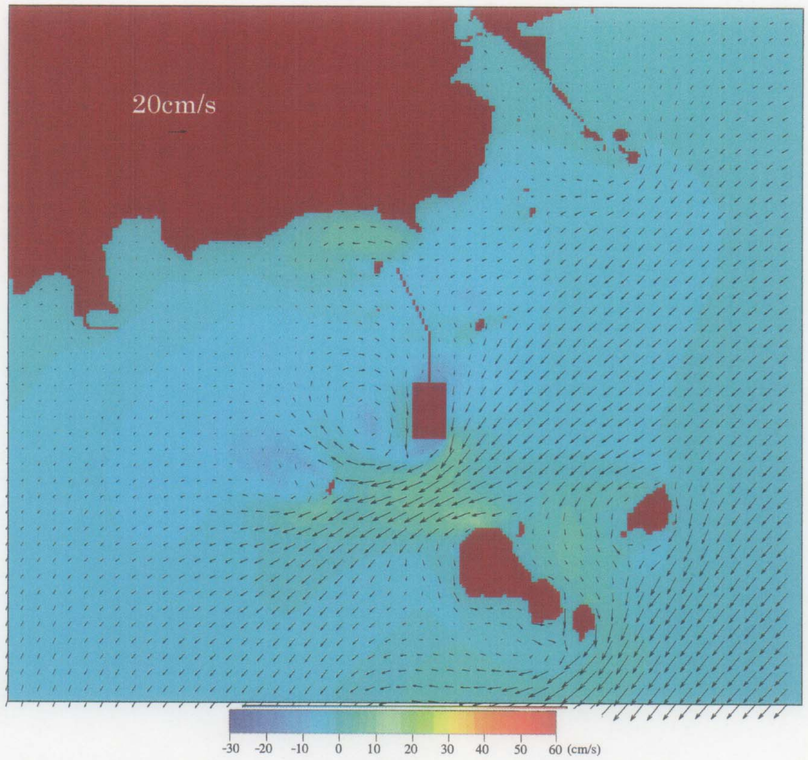
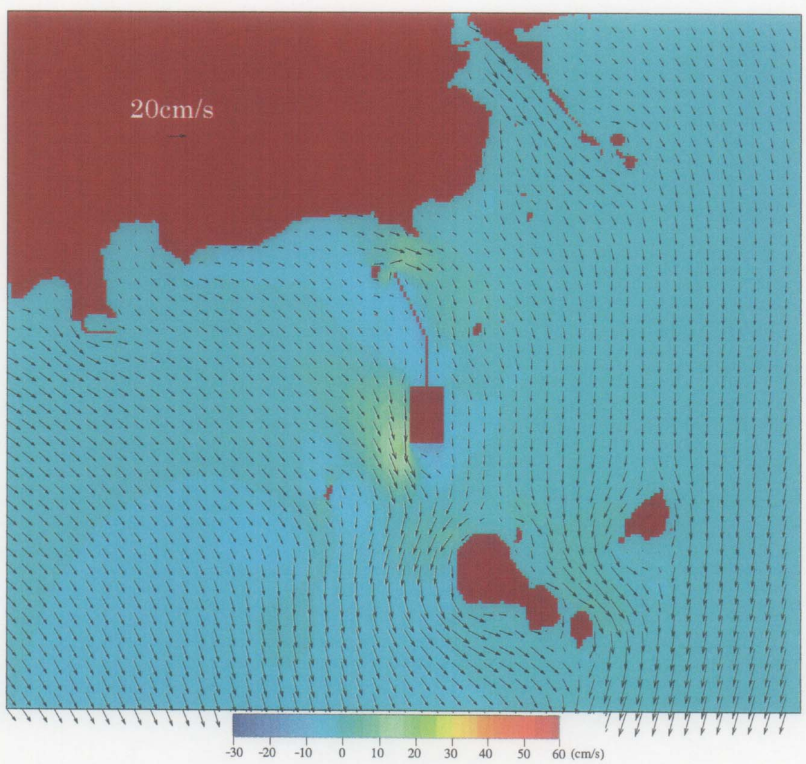


Figure A.3.12-2-3-13 Comparison of Current Velocity : Plan B (Causeway + Bridge, High Water)



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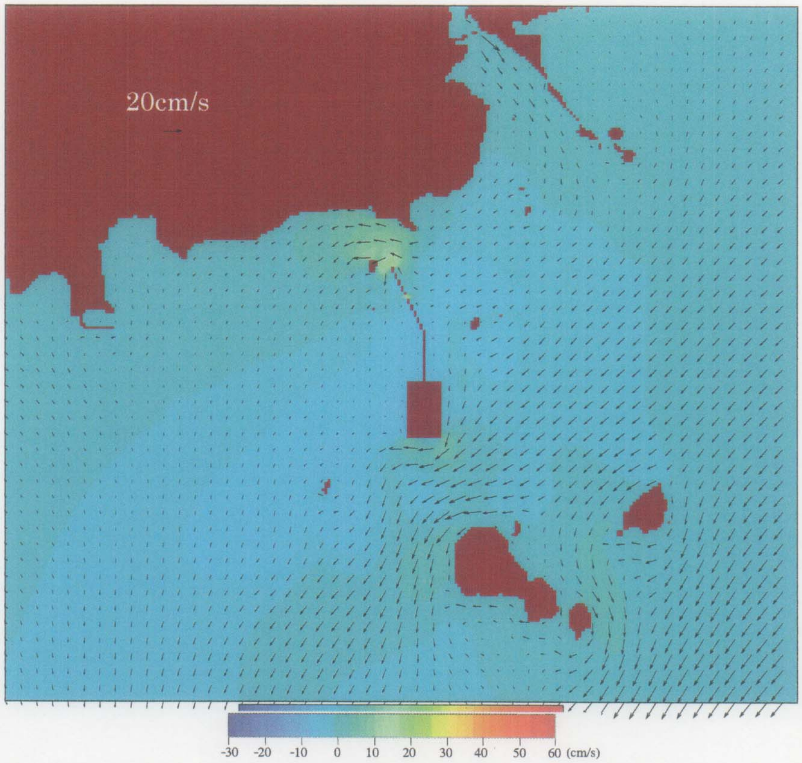

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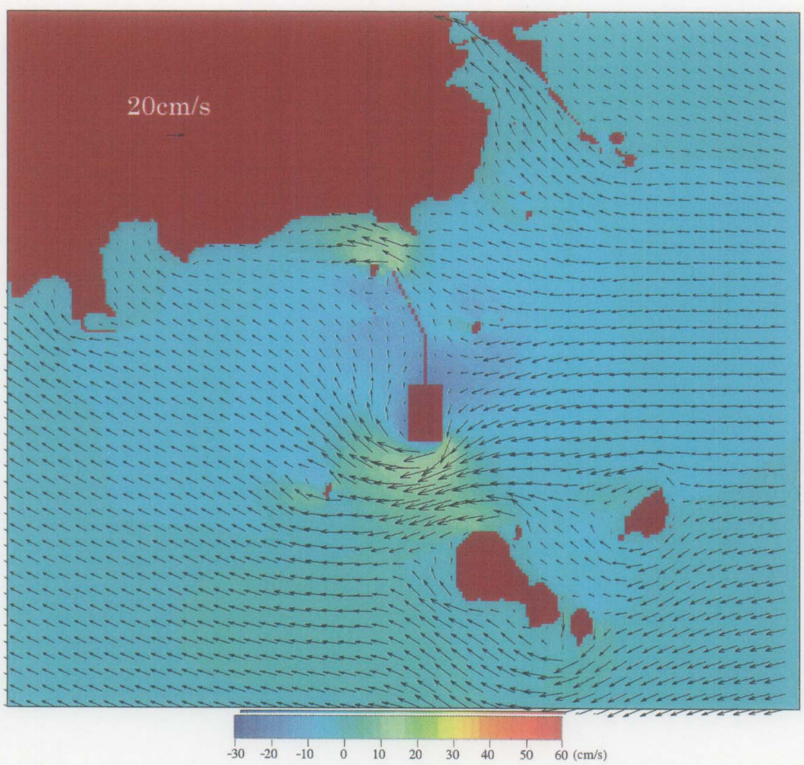


Figure A.3.12-2-3-16 Comparison of Current Velocity : Plan B (Causeway + Bridge, Peak Flood)

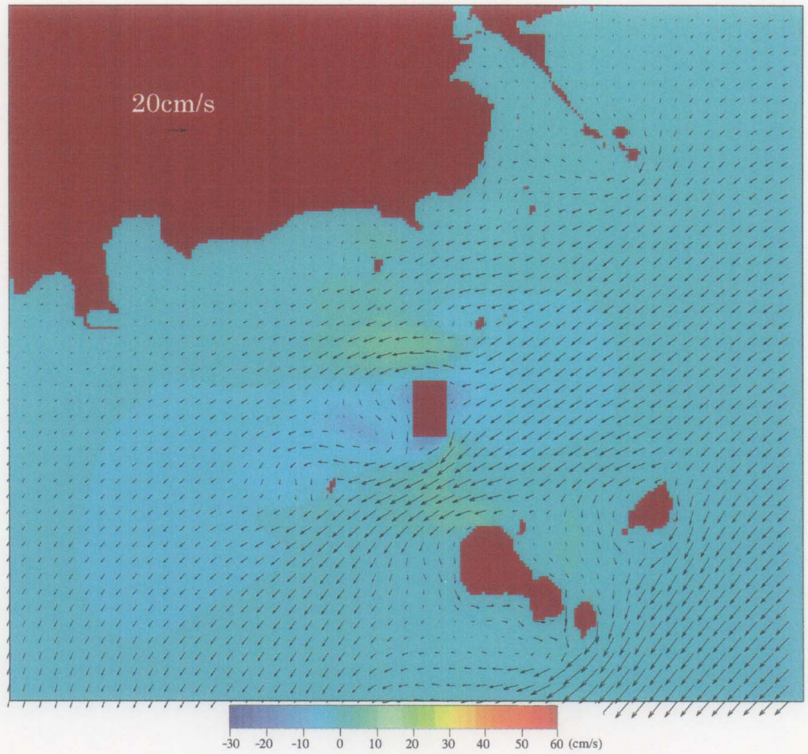


Figure A.3.12-2-3-17 Comparison of Current Velocity : Plan B (Bridge, High Water)

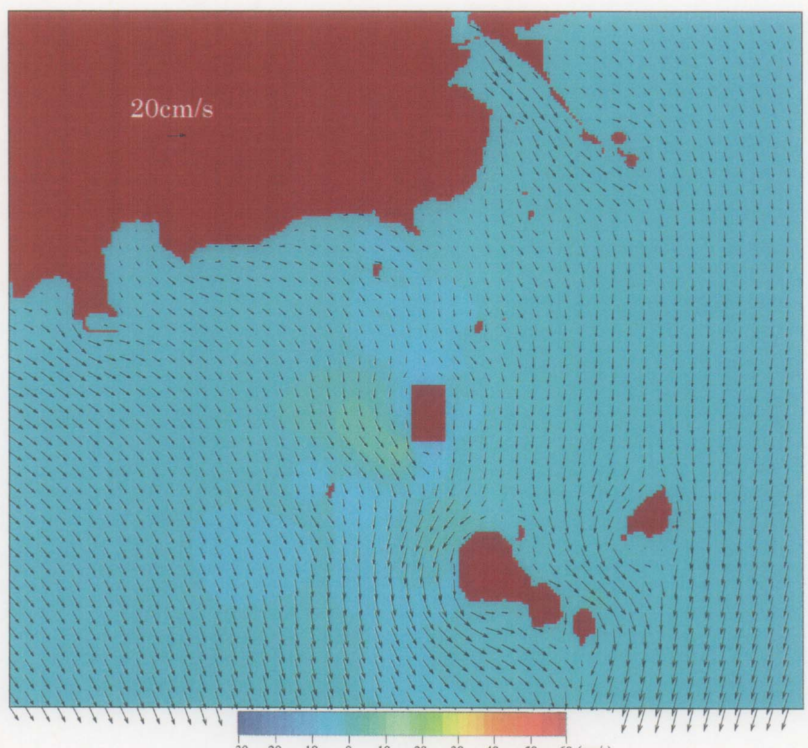
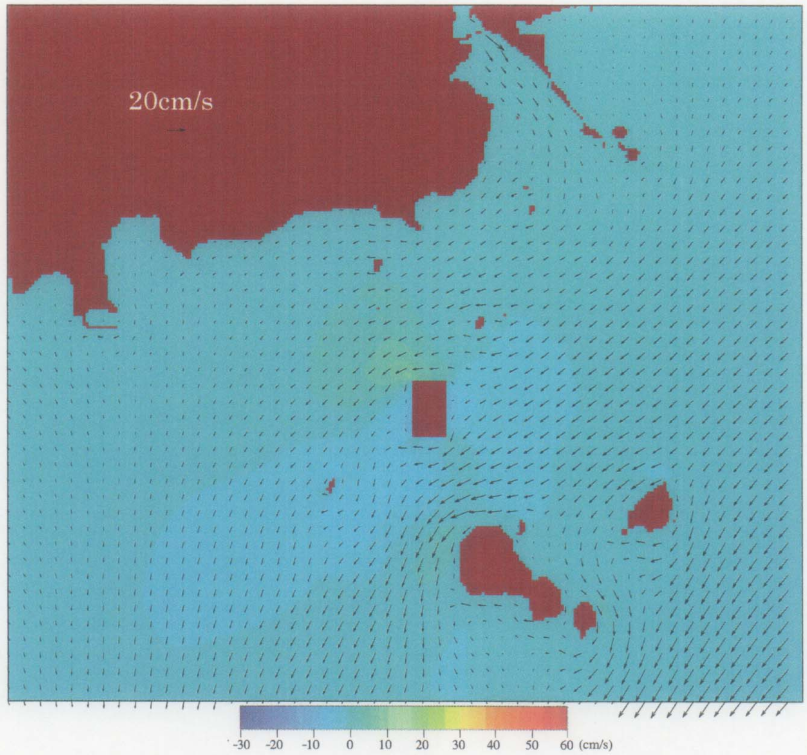


Figure A.3.12-2-3-18 Comparison of Current Velocity : Plan B (Bridge, Peak Ebb)



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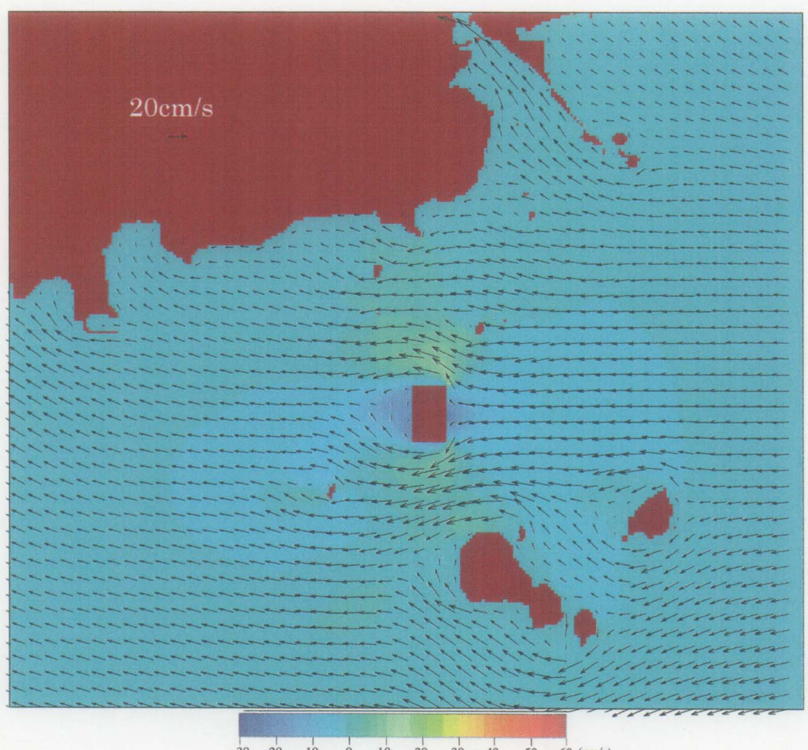


Figure A.3.12-2-3-20 Comparison of Current Velocity : Plan B (Bridge, Peak Flood)

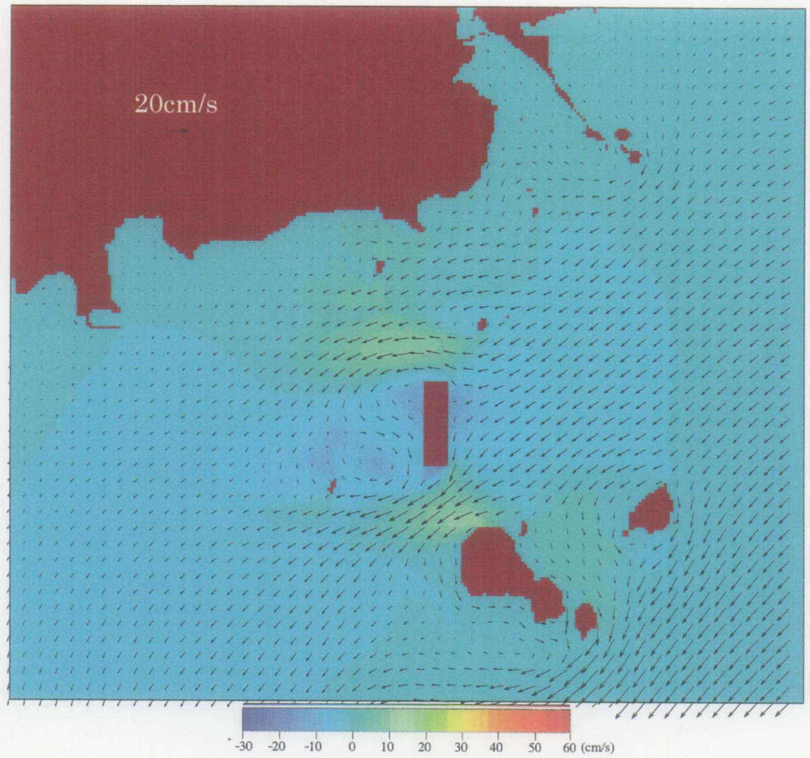


Figure A.3.12-2-4-1 Comparison of Current Velocity : Plan C (No Accessway, High Water)

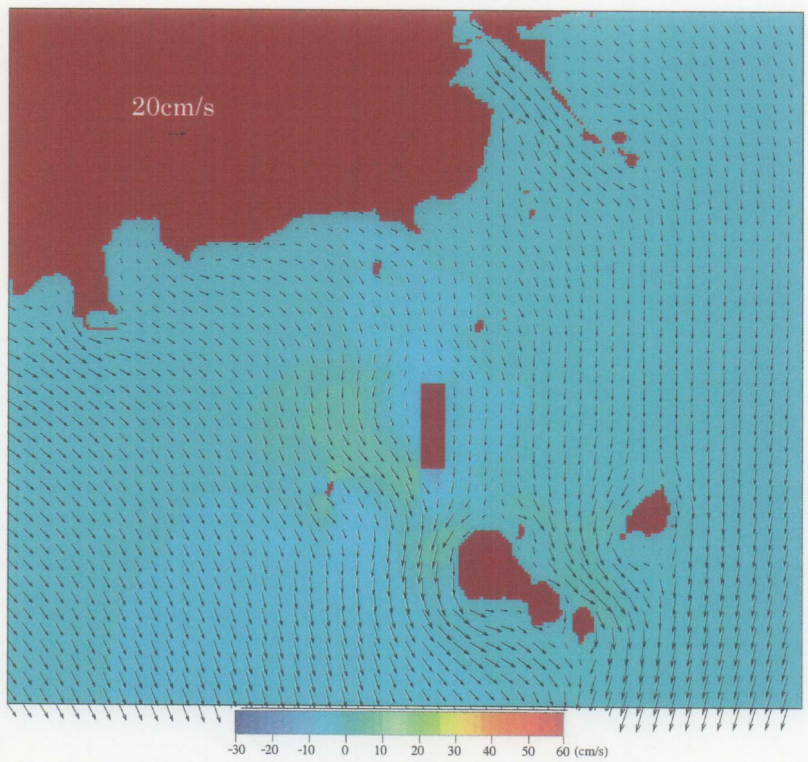


Figure A.3.12-2-4-2 Comparison of Current Velocity : Plan C (No Accessway, Peak Ebb)

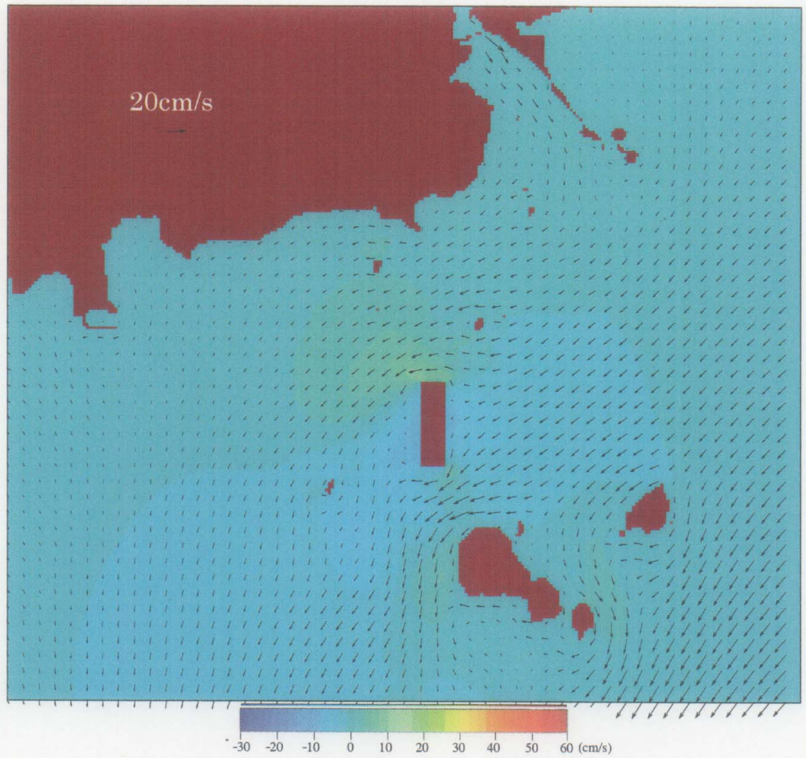
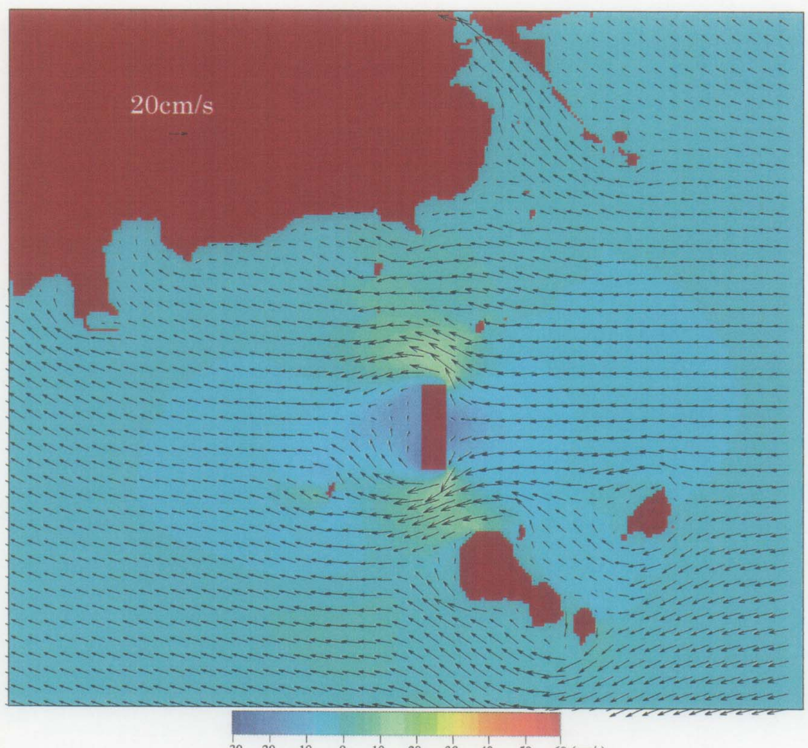


Figure A.3.12-2-4-3 Comparison of Current Velocity : Plan C (No Accessway, Low Water)



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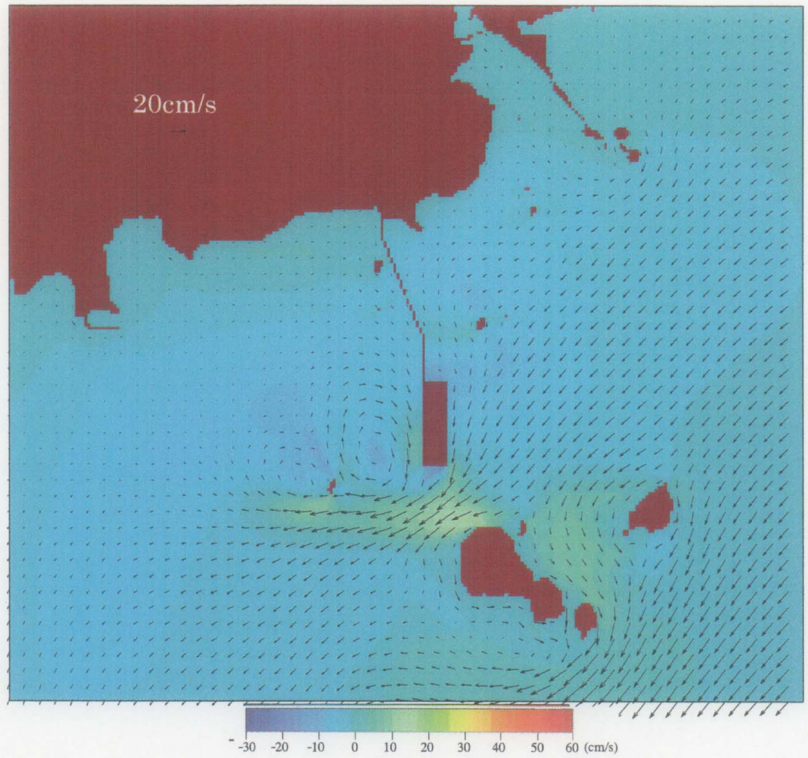
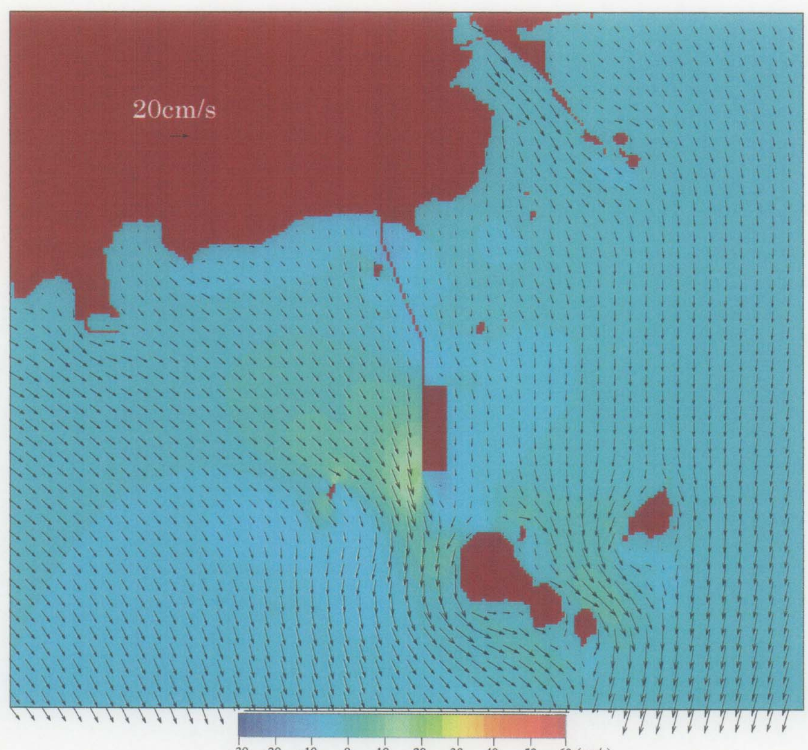


Figure A.3.12-2-4-5 Comparison of Current Velocity : Plan C (Causeway, High Water)



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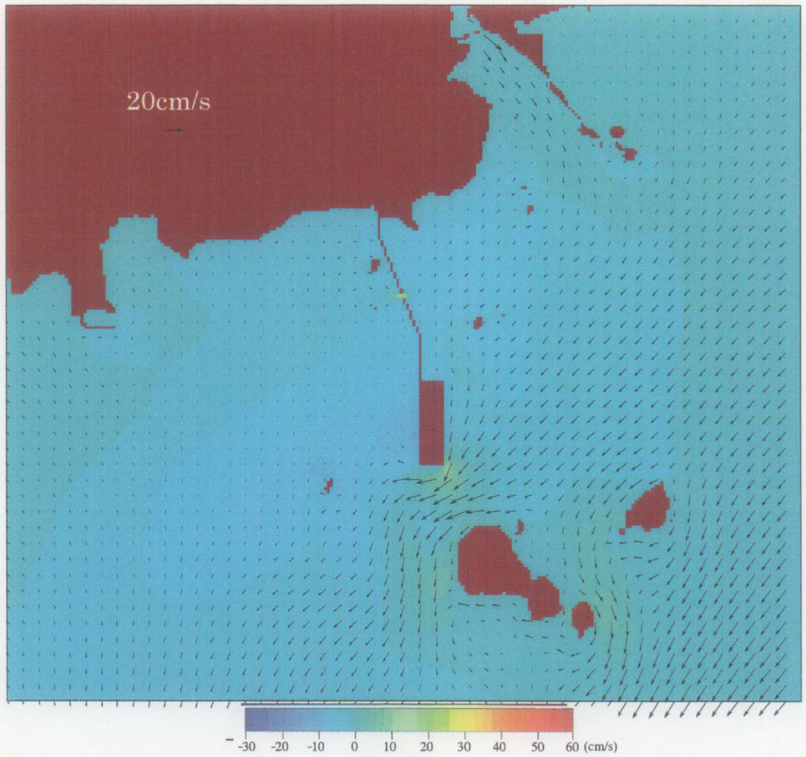

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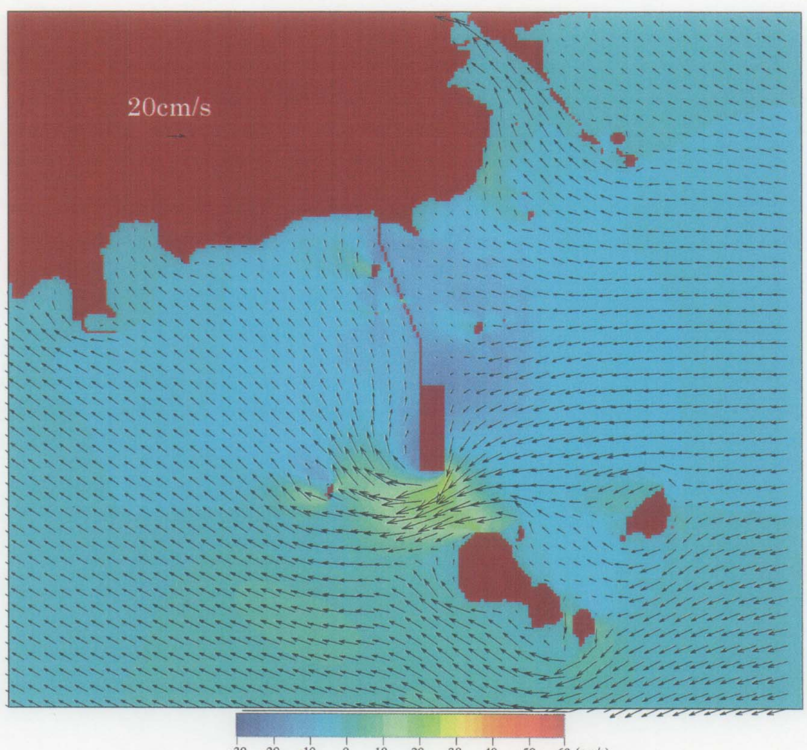


Figure A.3.12-2-4-8 Comparison of Current Velocity : Plan C (Causeway, Peak Flood)

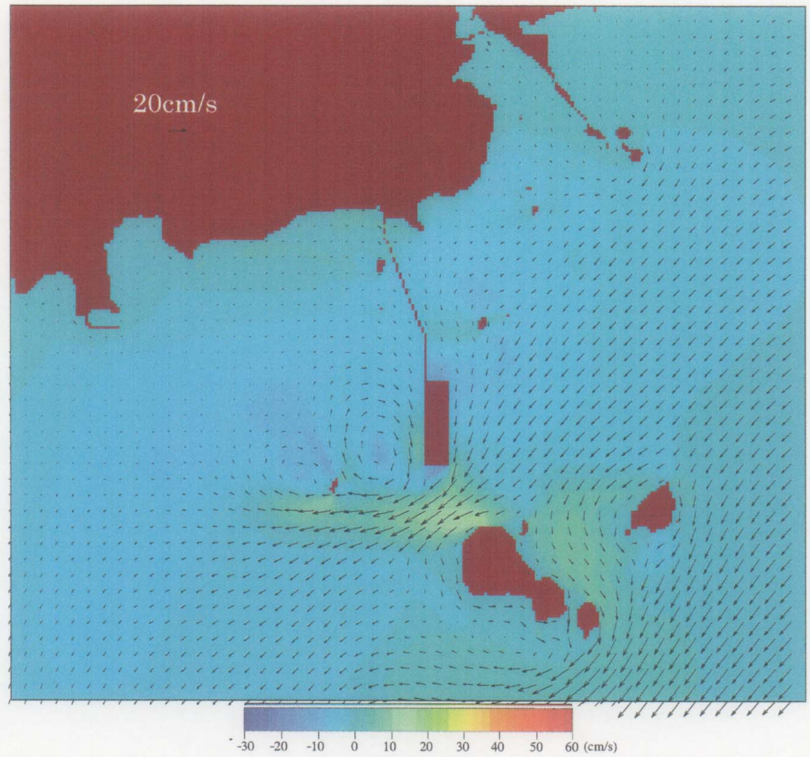


Figure A.3.12-2-4-9 Comparison of Current Velocity : Plan C (Causeway + Trestle, High Water)

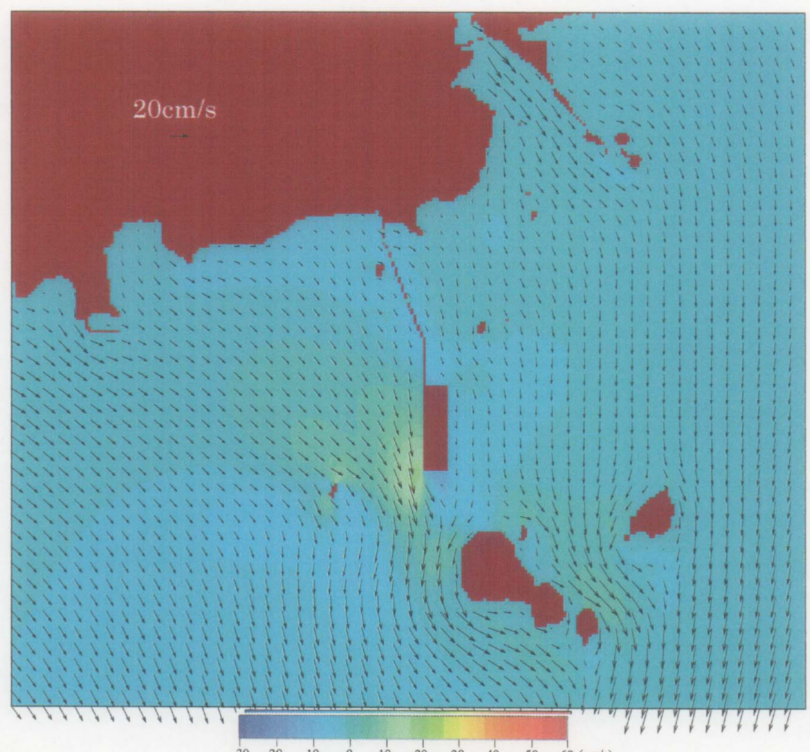


Figure A.3.12-2-4-10 Comparison of Current Velocity : Plan C (Causeway + Trestle, Peak Ebb)

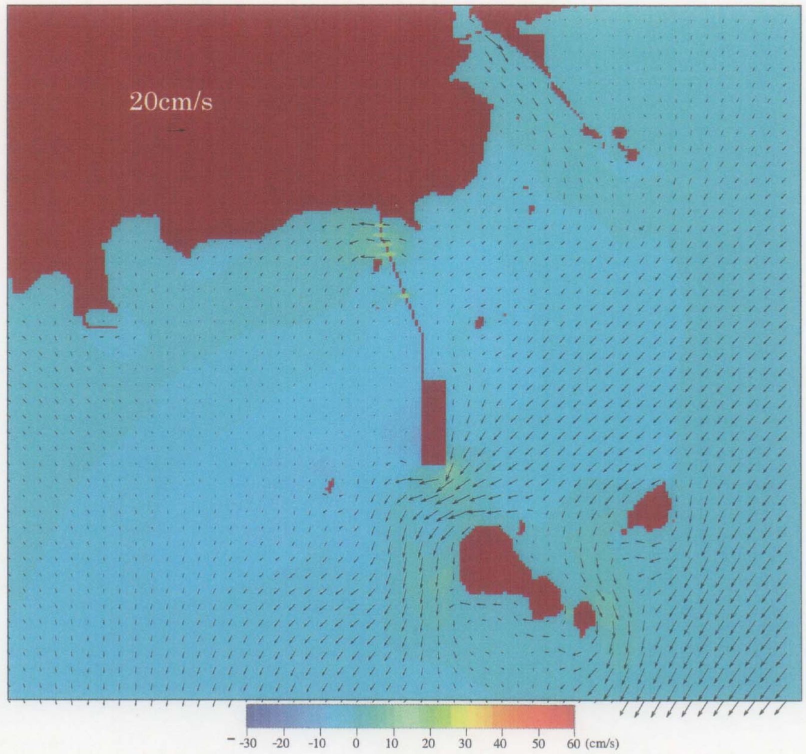


Figure A.3.12-2-4-11 Comparison of Current Velocity : Plan C (Causeway + Trestle, Low Water)

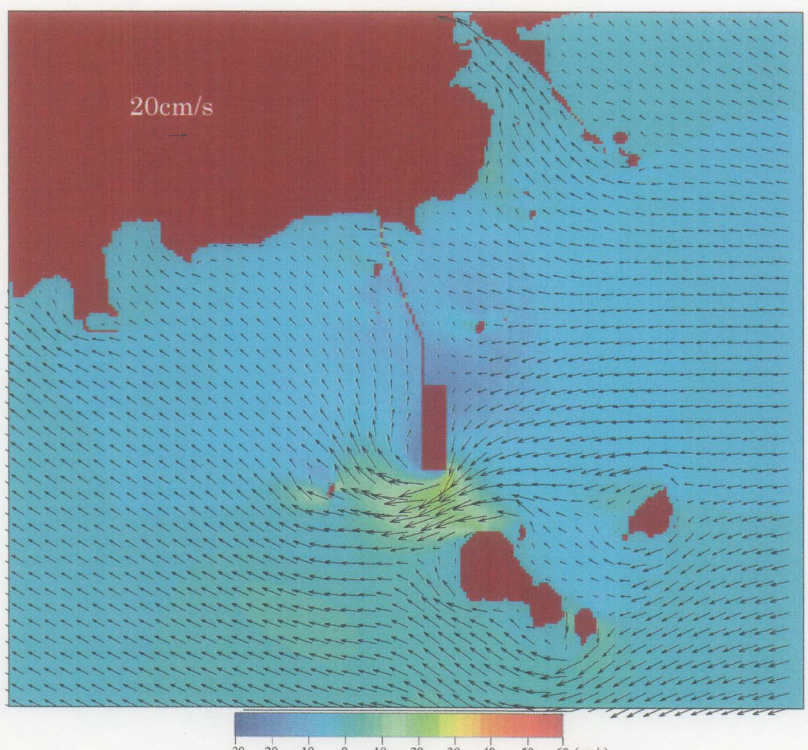


Figure A.3.12-2-4-12 Comparison of Current Velocity : Plan C (Causeway + Trestle, Peak Flood)

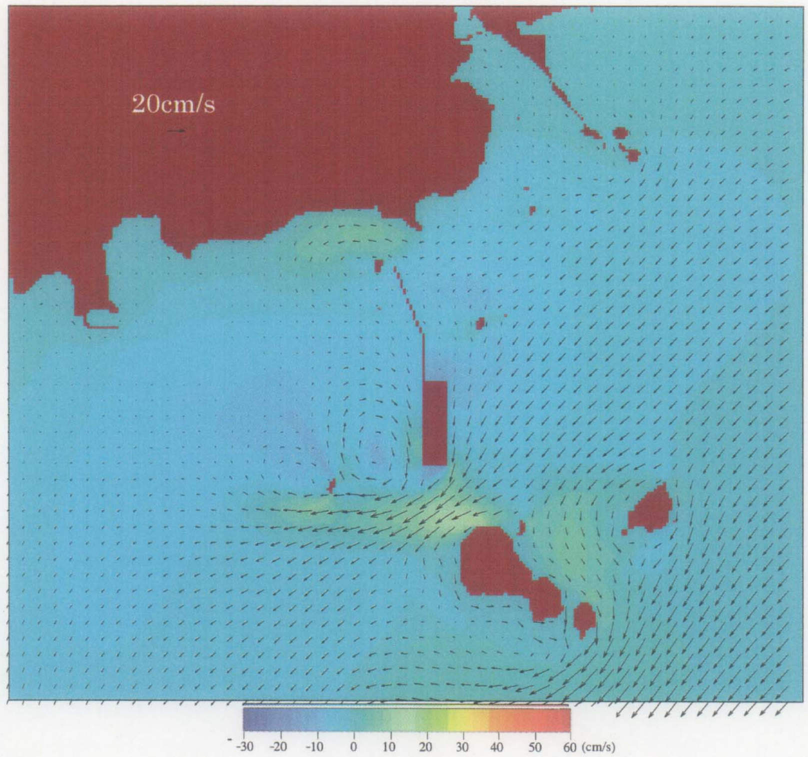
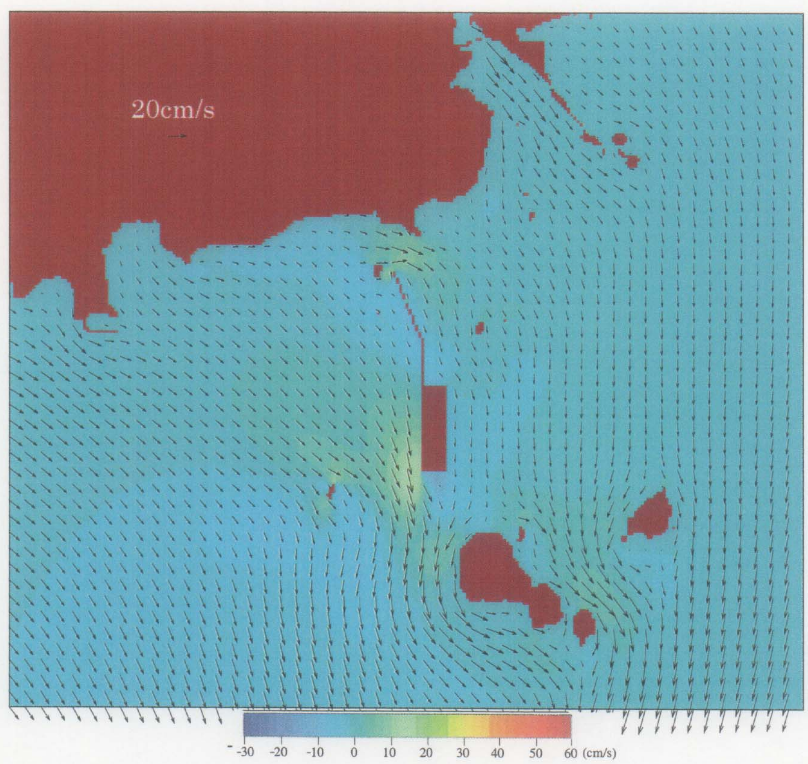


Figure A.3.12-2-4-13 Comparison of Current Velocity : Plan C (Causeway + Bridge, High Water)



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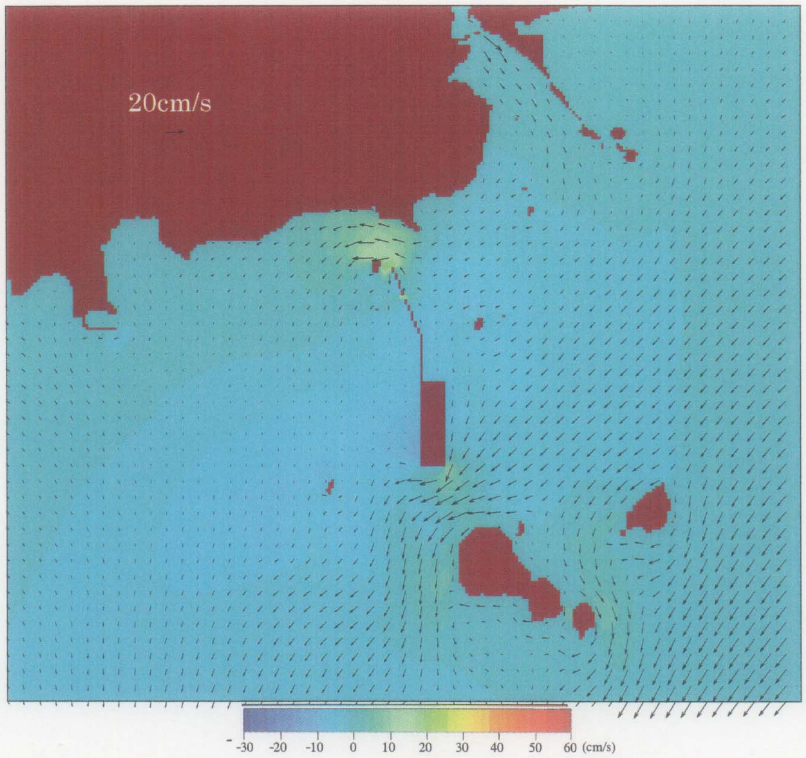

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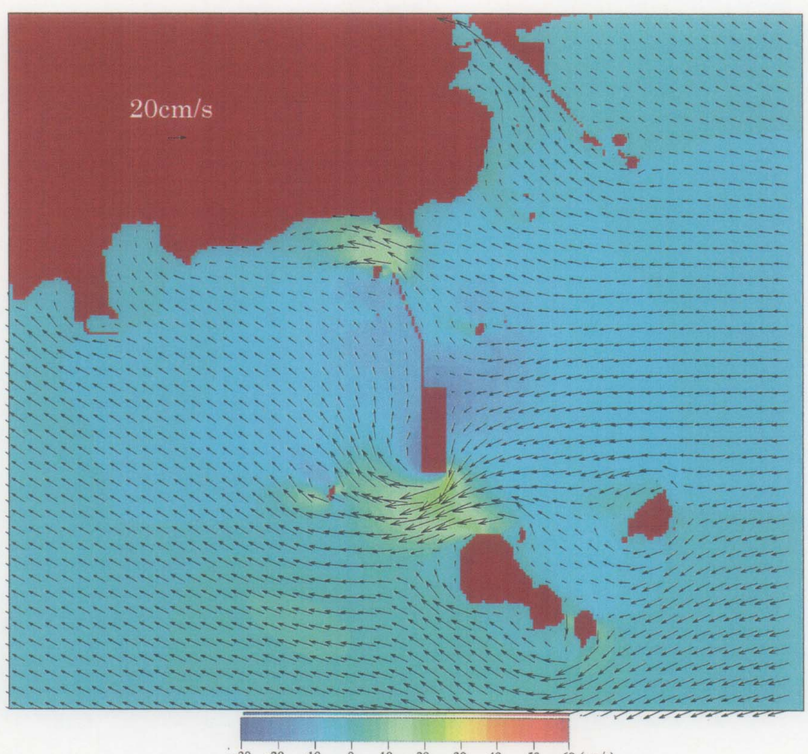

Figure A.3.12-2-4-16 Comparison of Current Velocity : Plan C (Causeway + Bridge, Peak Flood)

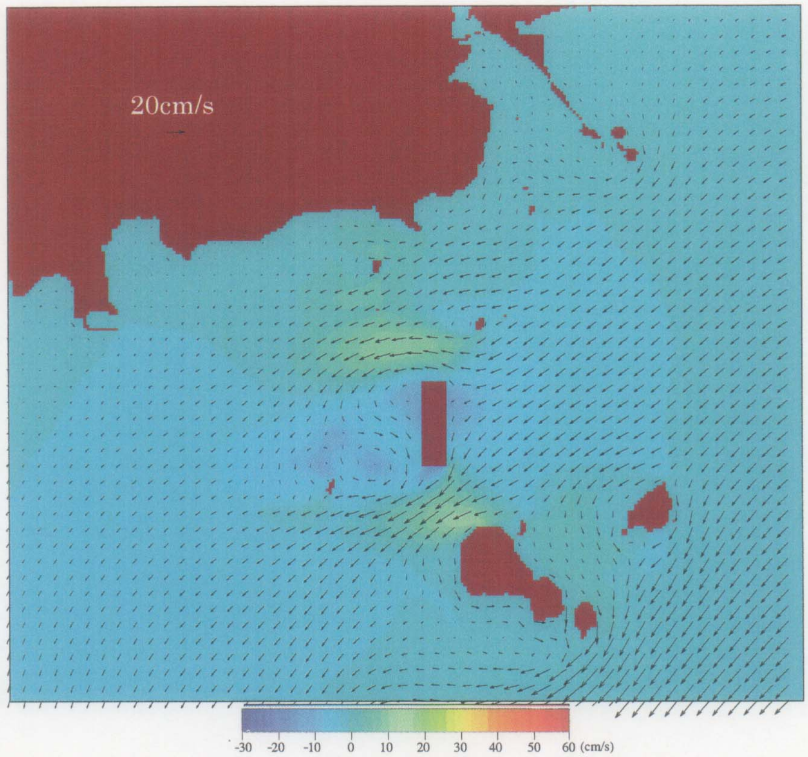

Figure A.3.12-2-4-17 Comparison of Current Velocity : Plan C (Bridge, High Water)

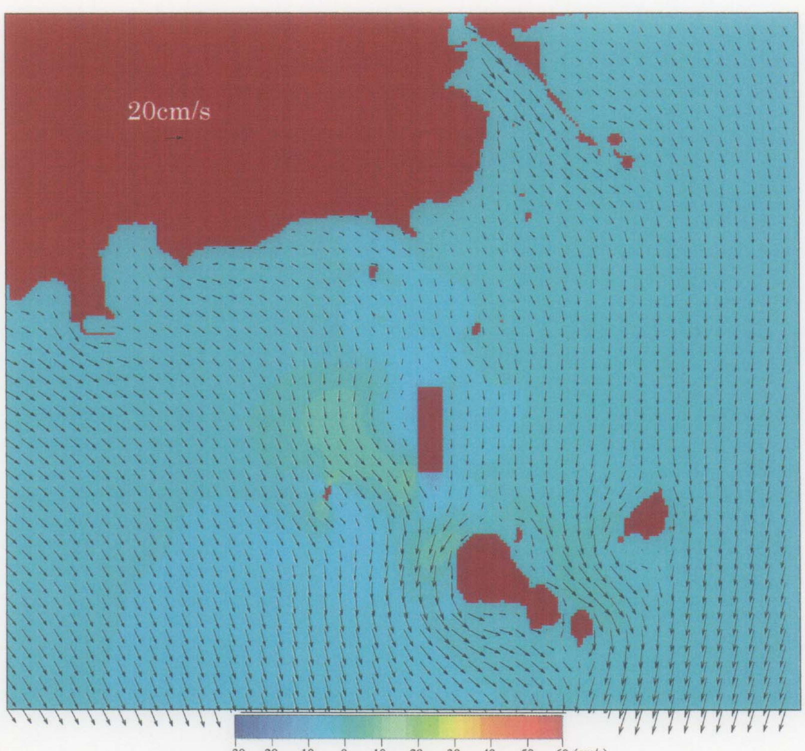

Figure A.3.12-2-4-18 Comparison of Current Velocity : Plan C (Bridge, Peak Ebb)

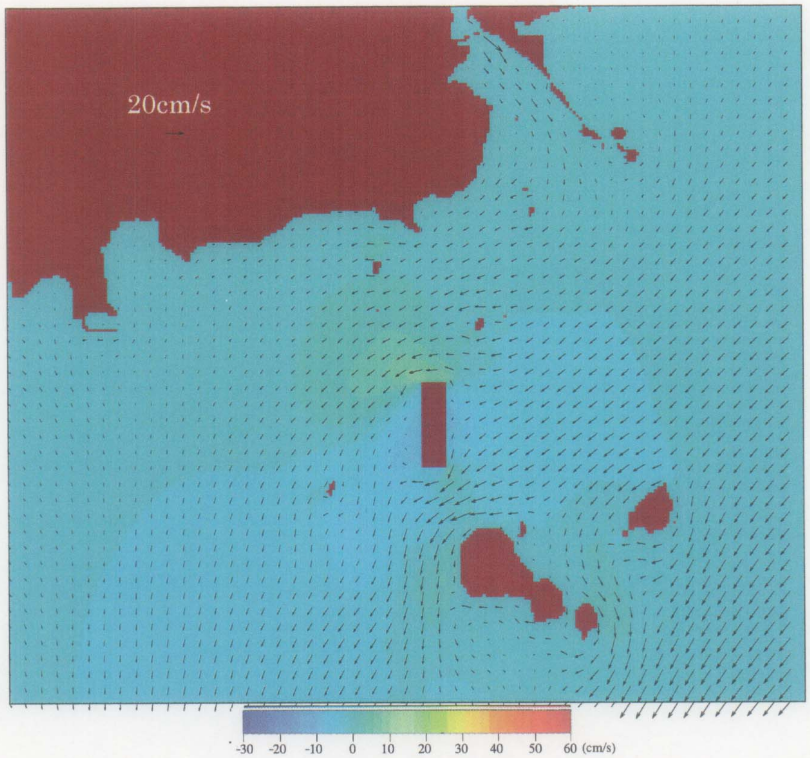

Figure A.3.12-2-4-19 Comparison of Current Velocity : Plan C (Bridge, Low Water)

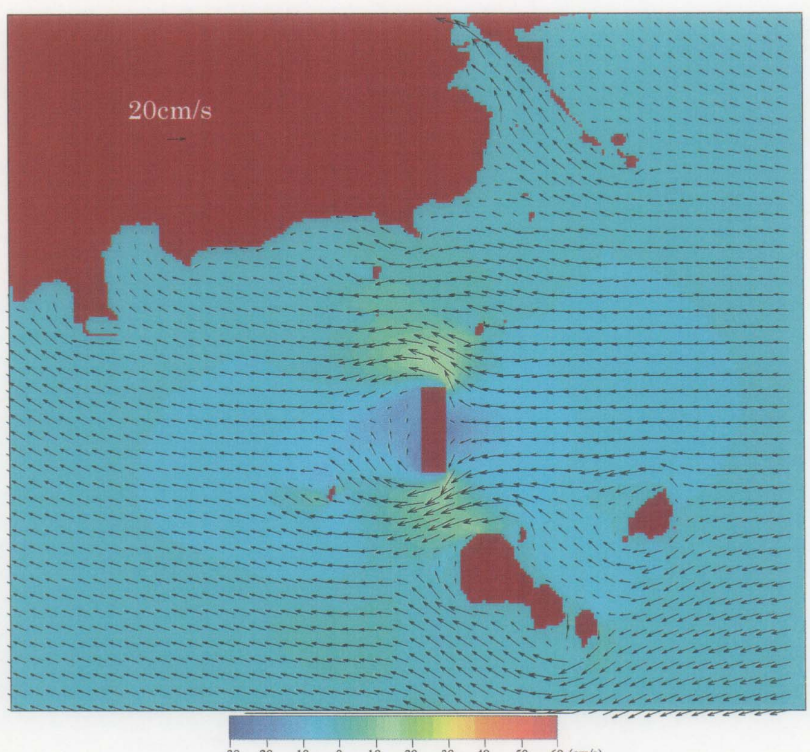

Figure A.3.12-2-4-20 Comparison of Current Velocity : Plan C (Bridge, Peak Flood)