8. PORT FACILITY DESIGN

8.1. Basic Concept

In accordance with the long-term development plan in Chapter 7.1, the basic concept and project components of the development plan for Phase I, Phase II and Phase III are summarized as follows.

8.1.1 Basic Concept for Phase I, Phase II and Phase III development

The existing container terminal with depth of -10.5 m can accommodate only 25,000 DWT class container vessels (around 2,000 TEUs), called Under-Panamax size. On the other hand, the large-size trend of container vessels has been observed worldwide. In the East Asia Region Route, 60,000 DWT class container vessels (around 4,000 TEUs) have drastically increased as mentioned in Chapter 6.1.1 (2), and it is supposed that 60,000 DWT class container vessels will ply Sihanoukville Port along with the steady increase in container cargoes. In order to meet the large-size vessel trend, PAS eagerly requested the construction of a berth facility to accommodate Over-Panamax size container vessels. It is a fact that accommodating Over-Panamax size container vessels are considerable advantage of port sales for shipping lines.

1) Target Vessel

   One Over-Panamax size container vessel for 1 berth
   Maximum. 60,000 DWT: Draft =13.8 m, LOA =285 m, Beam=40.0 m

   Two Under-Panamax size container vessels for 1 berth
   8,000 DWT~15,000 DWT: Draft= 7.3 m~ 9.0 m, LOA= 127 m~158 m,
   Beam=20.4 m~ 24.5 m

2) Container Terminal Capacity: Phase I (350 m berth length), Phase II and Phase III (300 m berth length)

   Phase I: 450,000 TEUs /year
   Phase II: 400,000 TEUs /year
   Phase III. 400,000 TEUs/year

3) Container Handling Method

   Quayside Container Crane (QC) + RTG + Tractor trailer

4) Tide

   LWL=+0.0 m CDL
   HWL=+1.43 m CDL
   (for Multipurpose Terminal Project)

8.1.2 Project Component for Phase I, Phase II and Phase III Development

Design dimensions of the port facility were decided in consideration of the following aspects;

- Container vessels seldom navigate in full load condition;
- Economic performance of construction cost;
- Dominant container vessel size at present and in near future; and
- Tidal navigation is available.

1) Access Channel Dredging

Channel Length	: Approx. 4 km
Channel Width	: 150 m
Channel Water depth	: -13.5 m CDL

2) Port Basin Dredging

Basin Water depth	:-13.5 m CDL
Berth Box in front of Quay	:-14.5 m in water depth and 50 m in width

3) Alongside Berth Construction

Quay Length	: 350 m for Phase I and 300 m for Phase II (Total 650 m)
Quay Crest Height	: +3.3 m CDL (considered for the climate change)

4) Container Yard Construction

Container Yard Area	: 14 ha for Phase I and 12 ha each for Phase II and Phase III.
Yard Elevation	: +3.5 m ~ + 4.0 m CDL
Pavement	: Heavy duty Interlocking Concrete Block

5) Seawall Construction

Type of Seawall	: Rubble rock mound with Armor rock protection
Seawall Length	: Approx. 1,400 m
Seawall Elevation	: +3.5 m CDL

6) Outside Road and Container Trailer Parking

Area of the Road & Parking: 3.5 ha for Phase I and 3 ha each for Phase II and Phase III.
Road and Parking Elevation : + 4.0 m CDL

7) Terminal Facilities (for Phase I and II. Each facility will be considered for Phase III)

- P.C Slabs for RTG and Container Sleepers (Pre-stress concrete plate)
- Main Office (Administration Building): 2,500 m^2 , RC structure 4 stories
- Terminal Gate: 820 m^2 RC Structure (3 lanes for in, 4 lanes for out)
- Maintenance work shop: 1200 m^2 (RC structure, maintenance office in second story)
- Workers' building: 600 m^2 (RC structure)
- Generator house and sub-station: 300 m^2 (Three generators, panels & transformer)
- Container Reefer Rack with Panel & Plugs: 100 plugs, three stacking
- Trailer & chaises parking: 1500 m^2, Officer visitor & workers' car parking: 2,500 m^2
- Fuel station: 400 m^2 (Fuel reservoir tank & distributer)
- Water reservoir tank and pump house: 800 tons (RC Structure)
- Storm water drainage, Yard lighting system, Water distribution system, Firefighting system, Electric power distribution system, Road lighting system,
- Sewerage treatment and collection system: 1 large unit for 200 persons & 2 small units for 30 persons.

8) Customs Inspection Yard: Yard reclamation and seawall construction for 2.4 Ha, location is shown in Figure 8.7-1, Area = 300 m x 80 m for all Phases

9) Container Handling Equipment (for each Phase)

- Quay Gantry Crane (44 m outreach) : 3 units
- Rubber tyred gantry crane (RTG) : 9 units
- Top Lifter (10 tons) : 3 units
- Tractor and Trailer : 16 units
- CCTV system : 1 lot each
- Emergency Generator : 3000 KVA
- Computer Yard Control System : 1 set

8.2. Container Berth

The basic design criteria would be determined after consideration of the site survey of natural conditions, conditions of existing infrastructure, conditions of local construction, cargo handling method, efficiency of the equipment, equipment specification, conditions of maintenance, and structure of the handling operation, suitability to subsoil conditions, wave calmness, durability, and workability of construction, environmental impact, and cost. In the past three Sihanoukville Port projects have been executed by Japan's ODA Loan and a project is currently under construction. Those projects basically adopted the Japanese Port and Harbour design standard for the berthing structure and several applicable conditions. Based on the subsoil investigation results around the locations of the new container terminal, as the results of the soil investigation at the area of new container terminal, the hard rock layer is deeper than -32 m (about -36 m in average), the only landside area having 150 m in width is shallow about -18 m to -23 m. This means that the Mass Concrete Block Wall method necessitates the granite stone basement having about 20 m in thickness in order to support the heavy weight of the concrete block wall. In the area of Sihanoukville, huge quantities of the granite stone are expensive to utilize as construction material. The pile deck structure will have enough pile length to be stable standing on the hard layer stratum. Only the landside area that is 150 m in width needs to have its piles driven into the hard stratum with a large pile hummer.

8.2.1 Candidates for Quay Structures of New Container Terminal

Generally, structure of container berth deeper than -10 m in depth is divided into three types, such as the Gravity Type, Sheet Pile wall Type and Deck on Pile Type. Each type has several structures as described in following Table 8.2-1. In the table, candidates for the quay structure of this project are considered to select on the basis of the natural conditions surveyed in the study, and recommendable four structures are taken as the candidates to select the best.

Table 8.2-1 Features and Adoptability of Quay Structures

Type of Quay	Structural Method	Feature of the Structure	Adoptability to the Project	
1.Gravity Type Quay	Concrete Blocks Wall Method	Most simple and traditional method , adopted for the existing Sihanoukville container berth and multi-purpose berth. Rock foundation is based for the structure, so that the hard rock sub-soil layer shall be placed in shallow area under quay bottom. In case that the hard layer is deep, the structure will be expensive. Concrete Block is become the base of the crane rail, another foundation will be necessary for the land side crane rail.	In the Gravity Type Quay, Concrete Blocks Method is most economical and better for the aspects of workability and construction period. Cambodia is no dock and no floating dock. Floating dock mobilization from third country is much expensive than the Concrete Block method. In case to select the Gravity Type Quay, Sihanoukville port recommended the Concrete Blocks Method.	OK
	Concrete Caisson Method	Feature is same as Concrete Block method. However, fabrication dock or floating dock shall be necessary for the reinforced concrete caisson.		NG
	Concrete Cell Block Method	The conditions of the foundation is same as the Concrete Block and Caisson. In case the quay water depth is shallow, concrete cellar block is economical than the concrete blocks method. In case the quay water depth is deeper than 10m, concrete cellar block is much expensive than the Concrete Blocks Type.		NG
Feature of Gravity Type	Gravity Type Quay is most simple and traditional structure, Mass Concrete blocks or sand filed into the large concrete caisson sit on the rock foundation. Therefore, its keeping good stability and easy maintenance. The hard rock sub-soil layer shall be placed in shallow area under quay bottom. In case that the hard layer is deep, soil improvement under the quay bottom will be necessary, therefore the soil improvement is expensive and the stability of the structure is become to low.			

Type of Quay	Structure	Feature of the Structure	Adoptability to the Project	
2. Sheet Pile Wall Quay	Steel Pipe Sheet Pile Method	In order to load the container gantry crane on the rails set of the front wall and the buttress, both of wall shall be used steel pipe sheet piles. Both of the sheet piles shall be stand the weight of the gantry crane. Therefore, the steel pipe sheet pile is required large diameter in order to stand the heavy vertical load of the crane.	Based on the results of the soil investigation, this method is possible to be adopted.	OK
	Steel Sheet Pile Method	Specifications of the large size for the sheet pile is limited, therefore the method has not be utilized for the deep sea port more than -10m depth. This method is generally adopted as the -5m ~-10m depth of the berth structure. Moreover, gantry crane rail would not be set on the piles, therefore the another foundations will be necessary for the gantry crane of which is more expensive structure than others.	In this requirement of the project, the berth depth is planned as -14.5m. Therefore the method could not be adopted.	NG
	Sell Steel Sheet Pile Method	Cell sheet pile method is also same sub-soil requirement of the Steel Pipe Sheet Pile. Cell sheet pile method is also difficult to set the crane rail on the piles. Other foundations will be necessary to prepare for the gantry crane. This method is also more expensive than the steel pipe sheet pile method.	Additional foundations front and rear rails for the gantry crane is necessary to install, therefore this method is not adopted	NG
Feature of Sheet Pile Type	Sheet Piles wall are driven continuously along the berth line and a buttress is also made by sheet pipes or concrete walls at land side, tie-rods or tie-cables between the front sheet pile wall and a buttress are set and tighten the top of front wall to the back in order to stand the earth pressure. For using the economical section of the sheet piles, sub-soil conditions under the quay wall is generally required the good sandy layer having enough thickness to be stand the sheet piles. In case that the hard rock layer appeared in shallow area, sheet pile could not drive into the rock layer in order to keep necessary length of the piles driving under quay bottom.			
3. Deck on Pile Type	RC Deck on the Vertical Steel Pipe Piles	Horizontal force and vertical load are stand by all the piles. Therefore the diameter and dimension of each piles is bigger than the other methods, such as batter piles method, strut beam method and jacket method. However, workability is higher the the other methods due to simple piling works.	Based on the results of the soil investigation, this method is possible to be adopted.	OK
	RC Deck on the Batter Steel Pipe Piles	As the batter piles will be much utilized, in case the hard rock layer basement of the piles, batter piles are difficult to drive into the rock layer, which the method is more expensive than the other methods.	Based on the results of soil investigation, medium hard stratum was found at some area to be driven 4m into the layer. Therefore, the method is not adopted.	NG
	RC Deck on the Concrete Piles	For the deep sea port, concrete pile is required large size. Large size of the concrete pile is too heavy weight to handle and drive. The pile driving equipment is required to be large and expensive. Concrete pile has the risk to make clacks and difficult to maintain and repair the cracks. Therefore, the concrete pile method is generally used for the shallow sea port less than -10m depth.	In this requirement of the project, the berth depth is planned as -14.5m. Therefore the method could not be adopted.	NG
	RC Deck on the Vertical Steel Pipe Pile with Strut Beam	This method is basically same as Vertical Piles method. The pile dimension could be reduced by using the strut beam. The Strut beam shall be made in manufacture's factory. Therefore, in case that the factory is located the third country near by Cambodia, the construction cost will be cheaper than the Vertical pile method.	Based on the results of the soil investigation, this method is possible to be adopted.	OK
	Integrated Jacket Deck on the Steel Pipe Pile	Jacket Deck is required to assemble in the manufacture's factory. In case that factory is required to locate near by Cambodia. The special large floating crane barge is required to install the Jacket deck on the piles. The highest accuracy of the pile driving work is required. Construction period is much reduced by using the Integrated Jacket Deck.	In this project, the reduction of the construction period is not so required. Construction cost is clearly much higher the other method. Therefore, the method is not adopted.	NG
Feature of the Deck on Pile Type	Foundation is steel piles or concrete piles to stand the deck load. Piles and deck beams design arrangement are necessary to stand the berthing force and load on the deck. The piles are required the enough length to stand the vertical load and to resist for the force of pile pulling up. In case that the hard rock layer is in the shallow area, the piles are required to drive into the hard rock layer, which the construction cost is expensive. Corrosion protection for the steel piles and countermeasure for the cracks of the concrete piles and concrete deck is necessary to consider. therefore the maintenance cost will be higher than the other types			

Source: JICA Survey Tam

8.2.2 Criteria for Selection of Quay Structure of New Container Terminal

(1) Evaluation Items

After discussions with the PAS for the importance of the project, the criteria for the selection of the quay structure take into account the following order in priority.

1) **Construction Cost of the Structure** (To secure the project feasibility subject to the IPO planned by PAS , the initial construction cost shall need to be minimized)
2) **Secure the Structural Stability and Easy Maintenance** (To minimize the maintenance cost)
3) **Effectiveness for Wave Dissipation** (Due to the influence of wave reflection, the berth structure shall need to have the function of wave dissipation to secure the safety of vessel manoeuvring)
4) **Environmental care** (Vibration, Noise, Traffic Congestion and Water Pollution)
5) **Secure Temporary Construction Yard** (Difficulty to secure of temporary yard in the port area, a portion of the SEZ (less than 1.5 Ha) will be provided to the contractor as the temporary yard)
6) **Easy Material Procurement and Quality Assurance** (To contribute to the quality assurance and cost saving by the procurement materials at low cost and good quality)
7) **Construction Period** (Target year 2022 for starting operation, construction period shall meet with the schedule)
8) **Difficult Methodology and Workability** (High level difficulty and lack of workability of the construction will cause delays of the construction and quality deterioration)

(2) Evaluation Criteria

In accordance with the above priorities, each valuation item is evaluated on a weighted basis as follows

Base Point of the Items: 1) =20 points, 2) = 17 points, 3) = 15 points, 4) = 13 points, 5) = 11 points, 6) = 9 points, 7) = 8 points and 8) = 7 points. **Total 1) ~ 8) = 100 points**

Each item is divided into three evaluations: **Excellent = 1.0, Good = 0.8 and Poor = 0.5.**

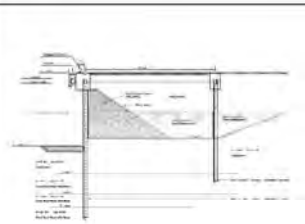
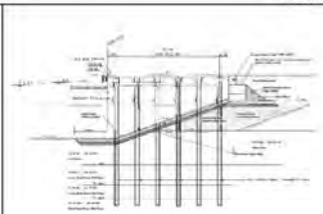
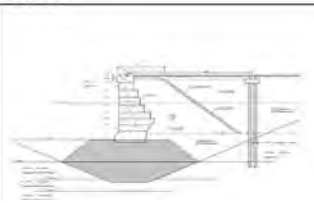
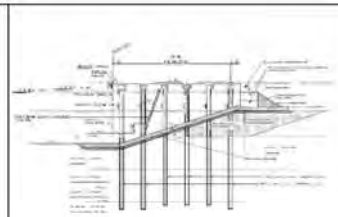
Therefore, evaluation of candidate structural methods is ; **Points of Items x Evaluation**

If a structure type received the best evaluation for each item it would have a score of 100 in total, if it received the lowest evaluation for each item it would score 50 in total which means the maximum is 100 points in total and the minimum is 50 points in total.

In accordance with the above criteria, the evaluation table and figure for each structural method is presented in Figure 8.2-1.

After considering the comparisons, Figure 8.2-1, Concrete Deck on the Steel Pipe Pile & Strut Beam is supposed to be appropriate. However, its disadvantages should be well-considered. It is noted that other quay structure types exceed the Concrete Deck on the Steel Pipe Pile & Strut Beam in some items. The Consultant suggests adopting the Concrete Deck on the Steel Pipe Pile & Strut Beam structural method based on the comprehensive evaluation results. Especially the maintenance issues for the steel piles and the concrete deck as is explained in Section 8.2.4.

In addition to the above, the planned new container berth could disturb the calmness by the waves reflected by the concrete wall of the existing container berth as was suggested in the calmness analysis of the previous projects. Therefore, the new container berth would require the wave dissipation facilities to be planned in the structural design. The Concrete Deck on the Steel Pipe Pile & Strut Beam structure could be planned to have the wave dissipation blocks installed in the wave affected area under the concrete deck.

Evaluation Item	Points	Structural Method			
					
Structural Method		**Steel Pipe Sheet Pile Method (Sheet Pile Wall Type)**	**RC Deck on Vertical Steel Pipe Pile Method (Deck on Pile Type)**	**Concrete Blocks Method (Gravity Wall Type)**	**R.C Deck on Steel Pipe Pile with Strut Beam (Deck on Pile Type)**
1) Construction Cost	Evaluation	Construction Cost (Approx.US$ 104, 000/m) (Poor)	Construction Cost (Approx. US$ 97, 000/m) (Good)	Construction Cost(Approx.US$ 106, 700/m) (Poor)	Construction Cost (Approx. US$ 95, 900/m) (Excellent)
	Point=Weight X Evaluated Point	20 x0.5=10	20x0.8=16	20x0.5=10	20x1.0=20
2) Stability and Maintenance Aspects	Evaluation	Good Structural Stability Necessary Maintenance for Steel Pile (Good)	Good Structural Stability Necessary Maintenance for Steel Pile and RC Deck (Good)	Good Structural Stability Basically Maintenance Free (Excellent)	Good Structural Stability Necessary Maintenance for Steel Pile and RC Deck (Good)
	Point=Weight X Evaluated Point	17x0.8=13.6	17x0.8=13.6	17x1.0=17	17x0.8=13.6
3) Effectiveness of Wave Dissipation	Evaluation	Wave Dissipation Block could not use Effectiveness : Low (Poor)	Protection by rocks under −1m is effective Wave Dissipation Block using above −1.0m (Excellent)	Wave Dissipation Block Could be used Effectiveness : Middle (Good)	Protection by rocks under −1m is effective Wave Dissipation Block using above −1.0m (Excellent)
	Point=Weight X Evaluated Point	15x0.5=7.5	15x1=15	15x0.8=12	15x1.0=15
3) Environmental Care	Evaluation	Refer to Table 8.2-2 (Good)	Refer to Table 8.2-2 (Good)	Refer to Table 8.2-2 (Poor)	Refer to Table 8.2-2 (Good)
	Point=Weight X Evaluated Point	13x0.8=10.4	13x0.8=10.4	13x0.5=6.5	13x0.8=10.4
4) Procurement of Materials and Quality Assurance	Evaluation	Steel Pipe Sheet Pile is imported from third country (Good)	Steel Pipe Pile is imported from third country (Good)	Almost materials using local made (Excellent)	Steel Pipe Pile is imported from third country (Good)
	Point=Weight X Evaluated Point	11x0.8=8.8	11x0.8=8.8	11x1.0=11	11x0.8=8.8
5) Space of Temporary Yard	Evaluation	Stockpile Yard for Steel Pipe Sheet Pile Necessary 1.0 Ha (Good)	Stockpile Yard of Steel Pipe pile and Precast Concrete beam yard Necessary 1.5Ha (Good)	Concrete Block fabrication yard and stockpile yard Necessary 4.0 Ha (Poor)	Stockpile Yard of Steel Pipe pile and Precast Concrete beam yard Necessary 1.5Ha (Good)
	Point=Weight X Evaluated Point	9x0.8=7.2	9x0.8=7.2	9x0.5=4.5	9x0.8=7.2
6) Construction Period	Evaluation	Due to construction Items are limited and small, Construction period is the shortest than others (Excellent)	Driving Piles and fabrication of Pre-cast concrete deck is progressed in parallel. Then, the Deck concrete work could be following after Piling works. Possibility to reduce the Construction Period is taken by the arrangement of each works schedule. (Good)	Concrete Block Fabrication is taken time. Foundation stone placing work, Block installation work Backing stone placing work and coping concrete work are difficult to work same time in parallel. Therefore construction period for this method is longest than others. (Poor)	Driving Piles and fabrication of Pre-cast concrete deck is progressed in parallel. Then, the Deck concrete work could be following after Piling works. Possibility to reduce the Construction Period is taken by the arrangement of each works schedule. (Good)
	Point=Weight X Evaluated Point	8x1.0=8	8x0.8=6.4	8x0.5=4	8x0.8=6.4
7) Difficulty Methodology and Workability	Evaluation	Driving of steel pipe sheet pile and installation of tie-rod is necessary experience. However, construction items is small and accuracy of the works are not influenced to the other works. (Excellent)	Driving of steel pipe pile and concrete deck construction is necessary experience high accuracy and experience. (Good)	For the deep sea berth, the installation of the concrete blocks are necessary high accuracy and experience. (Good)	Driving of steel pipe pile and concrete deck construction is necessary experience high accuracy and experience. (Good)
	Point=Weight X Evaluated Point	7x1.0=7	7x0.8=5.6	7x0.8=5.6	7x0.8=5.6
Total Point		72.5	83	70.8	87

Source: JICA Survey Tam

Figure 8.2-1 Quay Structure Comparison (1/2)

Comparison for Environmental Aspects and Construction Period

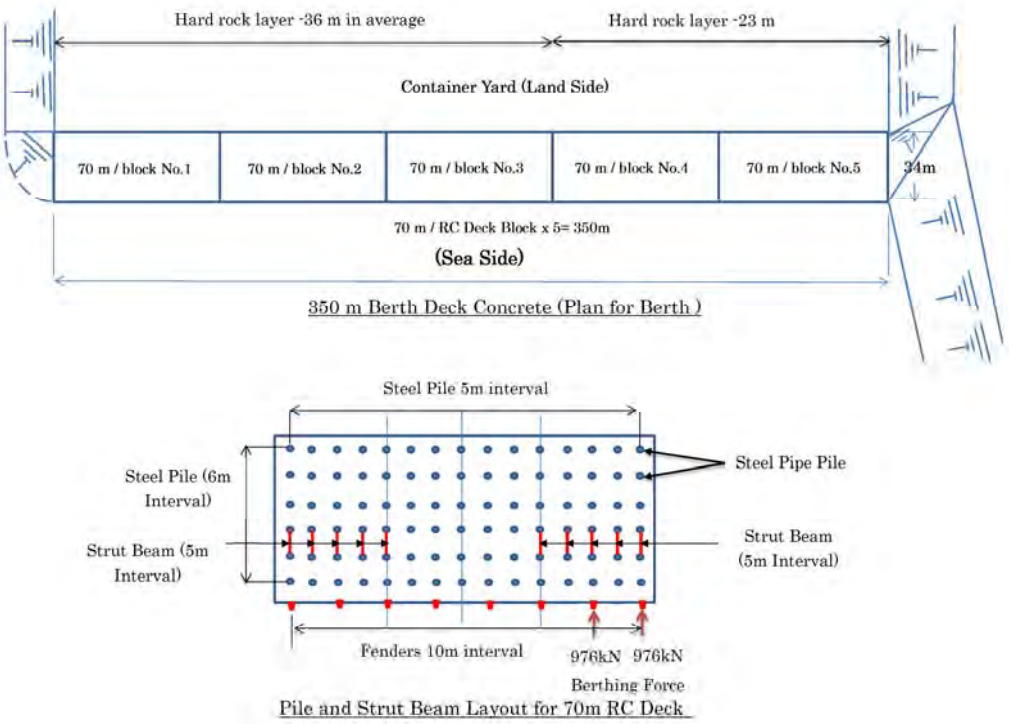
Item	Steel Pipe Sheet Pile Structure	Concrete Deck on Steel Pipe Pile	Concrete Block Method	Concrete Deck on Steel Pipe Pile & Strut beam
Noise	Pile driving will be used High Frequency Vibro-Hammer. Then, noise is not so large	Pile Driving work will be used Hydraulic drop hammer, Then, noise is highest	Noise is lowest level	Pile Driving work will be used Hydraulic drop hammer, Then, noise is highest
Vibration	Using Vibro-hammer is highest	Pile Driving work will be used Hydraulic drop hammer, Then, vibration is not so high	Vibration is lowest level	Pile Driving work will be used Hydraulic drop hammer, Then, vibration is not so high
Water pollution	Dredging work under the Quay is occurred a little muddy water	Dredging work under the Quay deck is occurred a little muddy water	Dredging and Stone placing work under the Quay is occurred muddy water	Dredging work under the Quay deck is occurred a little muddy water
Traffic Congestion	Traffic congestion is occurred a little for backing rock placing work	Traffic congestion is occurred a little for slope protection placing work	Large traffic congestion may occurred for Concrete work, Base Stone and Backing stone work	Traffic congestion is occurred a little for slope protection placing work
Constructio n Period	1	1.2	1.5	1.2
Evaluation	Construction site is far from the residential area , so Noise and Vibration is not influenced.	Construction site is far from the residential area , so Noise and Vibration is not influenced.	Water pollution and Traffic congestion is some problems	Construction site is far from the residential area , so Noise and Vibration is not influenced.
Results	**good**	**good**	**poor**	**good**

Source: JICA Survey Team

Figure 8.2-1 Quay Structure Comparison (2/2)

8.2.3 Quay Structural Plan and Structure Section of New Container Terminal

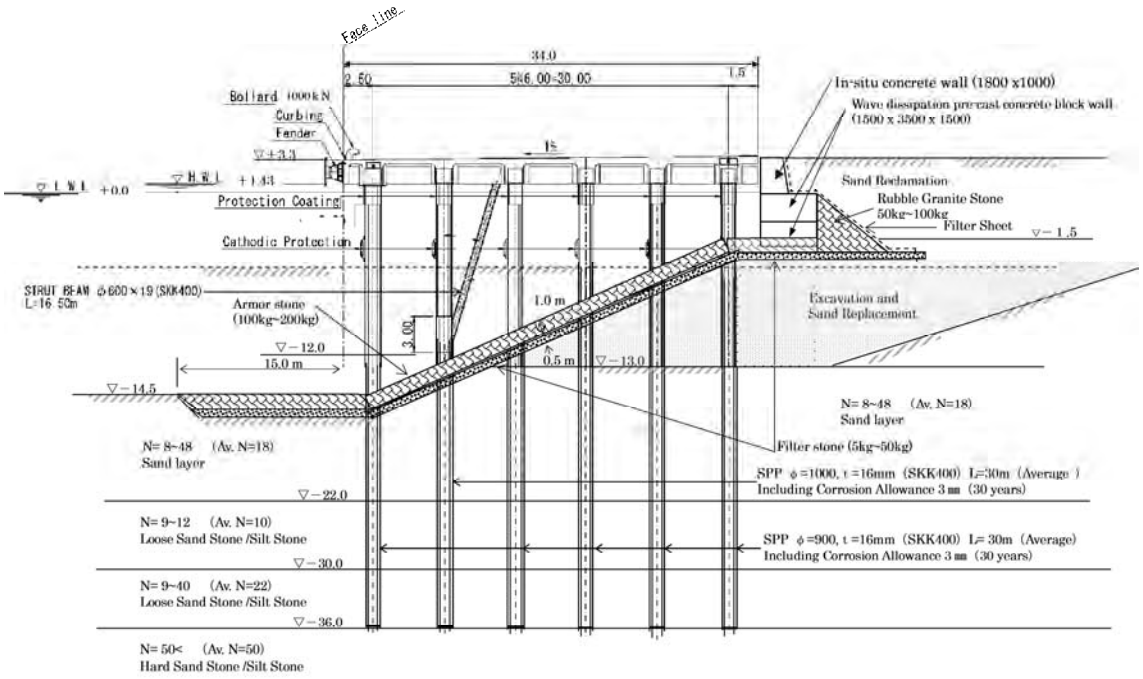
As the results of the soil investigation in the area of the new container terminal, the hard rock layer is deeper than -32 m (about -36 m in average), only in the landside area 150 m in width is it shallow, about -18 m to -23 m. In adoption of the Concrete Deck on the Steel Pipe Pile & Strut Beam structure, the berth RC deck construction for Phase I is planned 350 m in length and 34 m in with. In consideration of the shrinkage that occurred in the concrete deck in Sihanoukville, the RC deck is divided into five blocks each 70 m in length and 34 m in width, as shown in Figure 8.2-3.



Source: JICA Survey Team

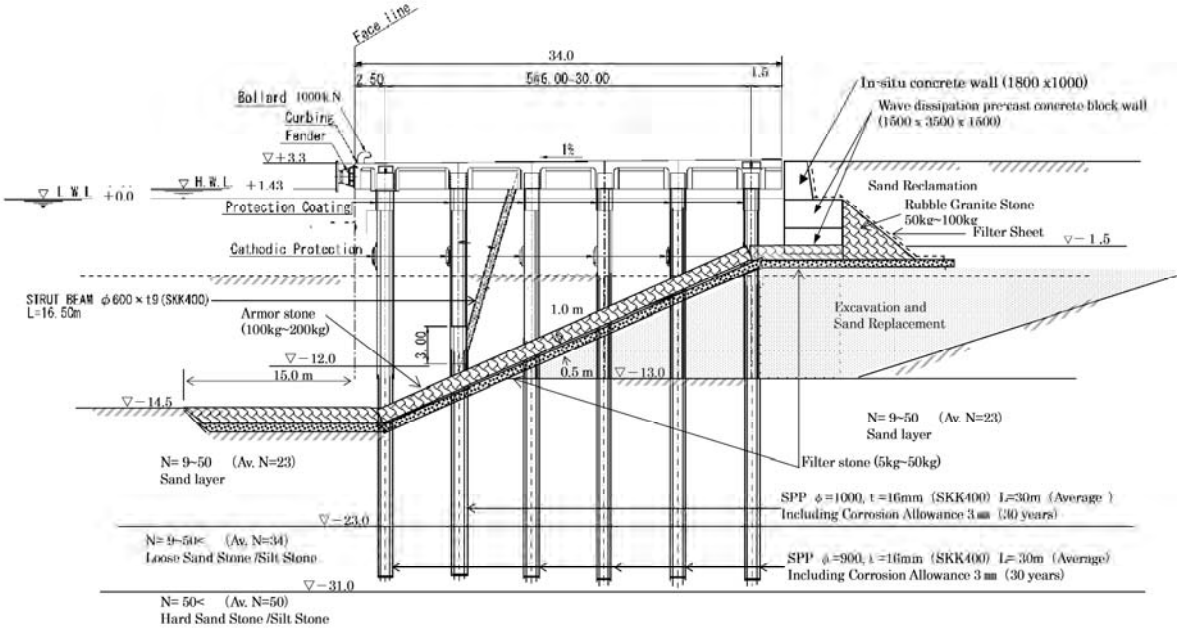
Figure 8.2-2 Berth Construction Plan (Phase I)

The typical section of quay structure for Block 1~Block 3 is shown in Figure 8.2-3 and typical section for Block 4~ Block 5 is shown in Figure 8.2-4. Wave dissipation blocks are planned to be installed as a retaining wall behind the Concrete Deck in order to secure the calmness for both structures.



Source: JICA Survey Team

Figure 8.2-3 Typical Section of Quay Structure (Block 1~Block 3)



Source: JICA Survey Team

Figure 8.2-4 Typical Section of Quay Structure (Block 4~Block 5)

8.2.4 Maintenance Plan and Design for Quay Structure

(1) Corrosion Protection for Steel Pipe Pile

Corrosion protection for the steel pipe piles employs Petrolatum Tapes with hard cover for 50 years protection in the splash zone (under the RC deck to -1 m). For the area below -1m to the seabed, the steel pile is also planned to have cathodic protection (Anode) welded to each pile as the corrosion protection for 30 years. Moreover, 3 mm additional thickness of the steel pipe pile will be applied for 30 years corrosion protection, which is more than 50 years protection in total. Those corrosion protections for the steel piles are considered into the basic design and the cost estimation.

This design of the corrosion protection could be applied as a maintenance free structure for more than 50 years. Only inspection for the cathodic protection (Anode) and the Petrolatum Tapes with hard cover are required to determine whether the protection is damaged or missing or functioning well at 5 year intervals. The inspection cost could be minimized and about 1,000 USD / 5 years is estimated for the cost.

(2) Reinforced Concrete Deck

In this basic design, the concrete cover of the reinforcing bars for the concrete surface and bottom of the deck and beam is recommended to be 150mm thick which is enough covering to avoid the corrosion of the reinforcing bars caused by the seawater permeation from the concrete hairline cracks.

Hairline cracks on the concrete surface are caused by the shrinkage of the concrete. For prevention of the shrinkage cracks, the pre-cast concrete beam and pre-cast concrete slab method are recommended in this study. In the experience with construction of RC decks, pre-cast concrete method has minimized the shrinkage cracks. However, it depends on the structural design, quality of the concrete and the contractor's workmanship to prevent the cracks. Therefore, the countermeasures shall be considered together with the cost performance in the detailed design stage and construction stage in order to minimize the maintenance works and maintenance cost.

Basically, the inspection for the bottom of the concrete deck is done 10 years after construction. If the countermeasures mentioned above have been done, the repair works will be minimized and estimated repairing cost is about 35,000 USD/ block of the deck.

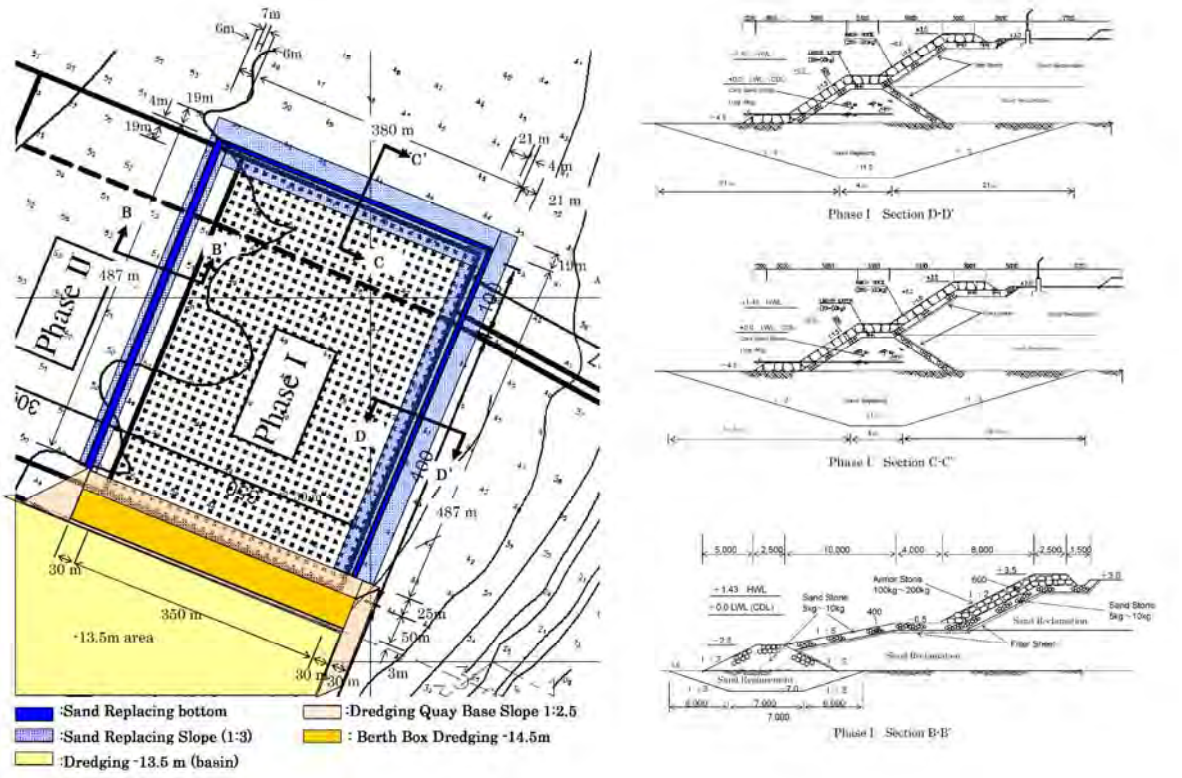
(3) Estimated Maintenance Cost

Maintenance cost of the Concrete Deck on the Steel Pipe Pile & Strut Beam for 350 m length is estimated at about 1.2 million USD for 50 years.

In the comparison of the quay structural method, Construction cost for 350 m of Concrete block structural method would be higher, at about 3.7 million USD, than the Steel Pipe Pile & Strut Beam structural method. Therefore, the Concrete Deck on the Steel Pipe Pile & Strut Beam is still economical in consideration of the maintenance cost for 50 years.

8.3. Reclamation and Soil Improvement

The comparatively good dredged materials such as rock layer and sandy layer will be used to fill in the reclamation area. The very soft layer in the reclamation area is about 6.5 m in thickness. However, the very soft layer is also confirmed to contain loose sandy materials as per the soil investigation results and its consolidation is not large, of which the settlement is evaluated to be about 0.6 m within three months after completion of the reclamation works. Therefore, the special soil improvement is not considered. However, for the seawall construction for the protection of the reclaimed area, the very soft layer is planned to be replaced with good sand to keep the stability of the seawalls. The plan for sand replacement for the soft layer having 6.5 m thickness at the seawall area and seawall structural section is shown in Figure 8.3-1.



Source: JICA Survey Team

Figure 8.3-1 Sand Replacement Plan and Seawall Structure

For the Customs inspection yard at the landside near the planned access bridge, a soil investigation boring about 50m from the planned area in the Port SEZ project was done in 2007 as shown in the results of borehole figure 8.3-2.

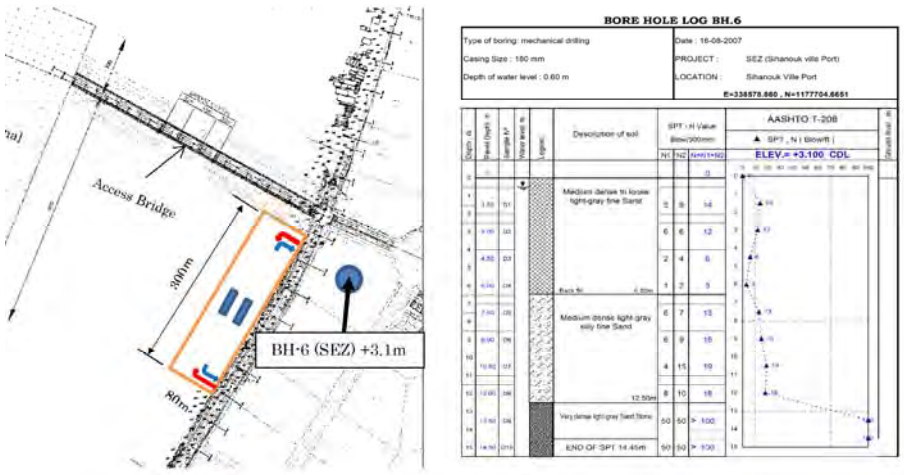


Figure 8.3-2 Soil Boring data for Customs Inspection Yard

Existing shoreline in the planned Customs Inspection Area is covered by a sand layer. Hence, the sub-soil condition of the area is considered almost the same as the Borehole Log BH-6 as shown above. Sub-soil condition from the top to12 m depth is sandy materials having N values (3~15) and hard stone layer (N>50) is below -10 m CDL. Therefore, the area would not be subject to consolidation settlement by the filling works.

8.3.1 Reclamation

(1) Consolidation settlement

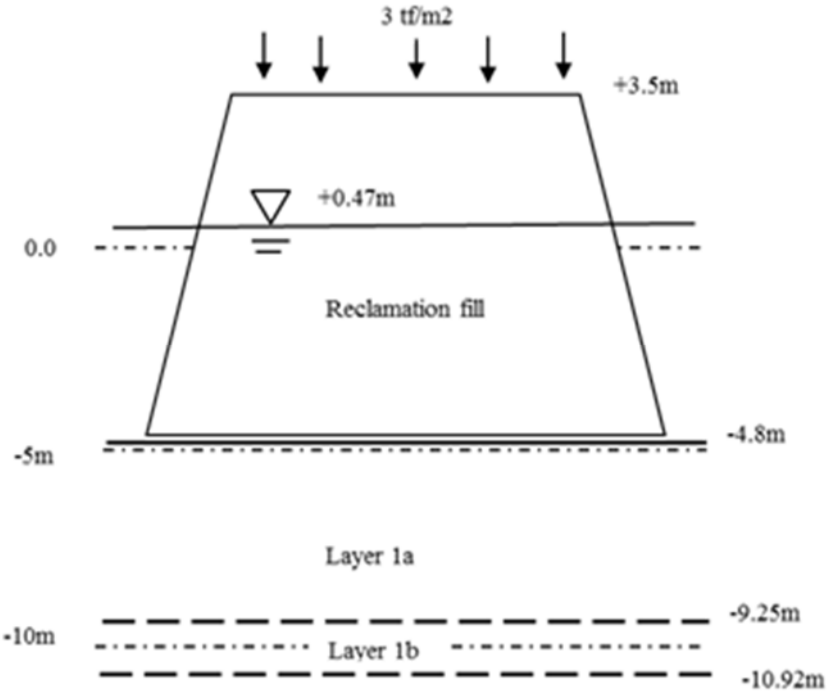
Reclamation work shall be carried out from the seabed level with averaged depth of CDL-4.8 m up to +3.5 m as shown schematically by Figure 8.3.3. Consolidation settlement would ensue during and post reclamation work. Presumed consolidation settlement could be calculated by Equation 4.2-2. Determination of parameters to compute the settlement has been already discussed in 4.2.4 (3).

Table 8.3.1 shows the computed consolidation settlement under two cases of load magnitude. Consolidation load for Case 1 is only the fill load from the sea bed to +3.5m and Case 2 considers future potential load, e.g. 3 tf/m^2, such as traffic load or piled-up containers in addition to the load for Case 1.

According to the results, settlement for both cases are 0.43 m and 0.49 m, respectively. Therefore, averaged consolidation settlement of the reclamation area in Phase I is approximately presumed as 0.5 m to 0.6 m, the volume of the extra-bank should be considered in the total volume of reclamation fill.

Some assumptions made in the calculation should be notified as following and reflected during the execution of reclamation work.

1) As shown by Figure 4.2-10, Section F-F', and Figure 4.2-11, Section G-G', total thickness of 1a and 1b tend to increase from landside to the breakwater side and the inner side to the wharf alignment. In spite of such difference of their thickness, single averaged thickness in the whole reclamation area is assumed for the calculation of settlement. Therefore, since actual fill volume for reclamation work can be different from the computed one, it seems necessary to monitor the settlement during fill work from the seabed to +3.5 m and to reflect the monitored data to the extra-banking work.
2) It is advised to wait before beginning the pavement work until the residual settlement would be expected to be lower than the allowable residual settlement.



Source: JICA Survey Team

Figure 8.3-2 Reclamation Model for Settlement Calculation

Table 8.3-1 Computed Consolidation Settlement

Soil parameters and Sf		Layer 1	
		1a	1b
H		4.45	1.67
E_0		1.25	1.04
Cc		0.2	0.2
Pv (tf/m2)		1.55	3.78
Case 1: Up to +3.5m	ΔP1	9.8	9.8
	Sf (m)	0.34	0.09
	Total sf	**0.43**	
Case 2: +3.5m+3 tf/m2	ΔP2	12.8	12.8
	Sf (m)	0.38	0.11
	Total	**0.49**	

Pv: Effective overburden pressure

Source: JICA Survey Team

(2) Settlement Rate

Layer 3 in Table 4.2-4 has sand content of approximately 80%, and yet its permeability could be estimated as 10-6 cm/sec by referring to Figure 4.2-15. Therefore layer 3 would not work as a drainage layer for consolidation above layer 1. Thus, it is concluded that drainage condition for consolidation is assumed as a single drainage. Time and consolidation degree is calculated by Equation 8.3-1.

$$t = H' \times T_v / C_v \quad \cdots\cdots\cdots\cdots \text{Equa.8.3-1}$$

Here, t; time, H'; Thickness of clay, Tv; Time factor, Cv; Consolidation coefficient

Consolidation coefficient (C_v) is assumed as 2 cm^2/min (=0.29 m^2/day) by the relationship of Ip and Cv as shown by Figure 4.2-16.

Table 8.3-2 shows time and Consolidation degree (U). It is realized that it would take only 3 months to attain the consolidation degree of 90%. It could be understood that since elapsed days to attain the consolidation degree of 90% is approximately 110 days, e.g. nearly 4 months, soil improvement techniques such as vertical drains seem not to be necessary.

Table 8.3-2 Consolidation Degree vs Elapsed Time

U (%)	T_v	$t = T_v H^2 / C_v$ (day)
10	0.008	1
20	0.031	4
30	0.071	9
40	0.126	16
50	0.187	24
60	0.287	37
70	0.403	52
80	0.567	73
90	0.848	109

Note: $t = Tv \times 6.12^2/0.29 = 129Tv$

Source: Design Practice of Soils and Foundations, Japan Geotechnical Engineer Society, p.343.

It seems very effective and useful to revise the parameters in Table 8.3-2 through analysis of monitored time vs. settlement during the execution of a Multi-Purpose Terminal Project.

(3) Reuse of Dredged Soil for the Reclamation Area

Dredging work is to be carried out for the turning basin and the berth box area with depth of -14m and the replacement method for building of the seawalls with depth of -7 m to around -12 m. Therefore, layer <1> to layer <3> could be the soils to be dredged. According to the sand content shown in Table 4.2-5, average sand content of those layers are:

Name of layers	Sand content (%)
1-a	65
-b	68
2-b	43
3	81

(Note; Layer 2-b is only at Bor. No. 01.)

It is realized that the sand content of only layer 3 is larger than 80 %, it could be reused as the reclamation material. However, as layer 3 is distributed mainly deeper than -14m, it seems impossible to reuse layer 3 as the reclamation material.

The possibility of reuse of layers 1a and 1b seem to be dependent on the dredging method, countermeasure against turbidity diffusion, transportation method of dredged soil and its dumping method, and filling method etc.

8.4. Access Channel and Turning Basin

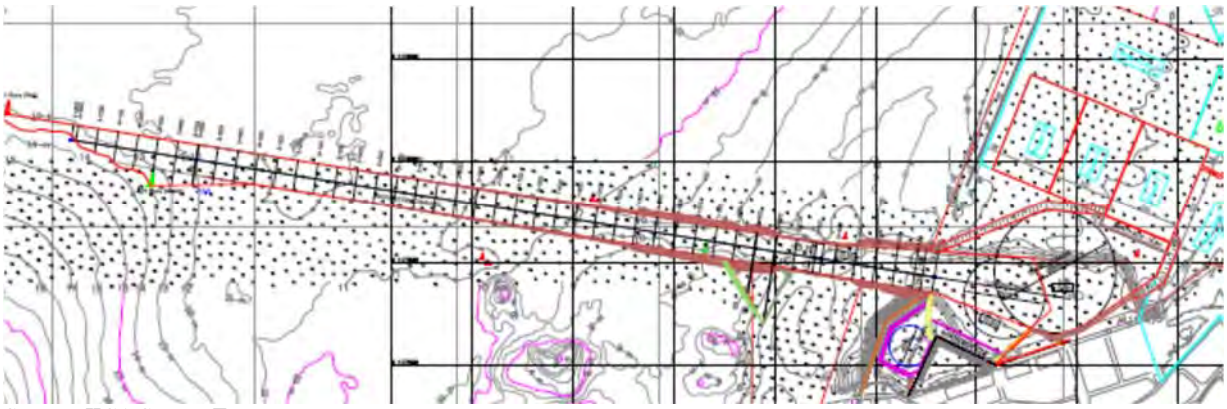
8.4.1 General

The preliminary design of Access Channel and Turning Basin was made based on the information given by following four previous study and survey:

1) The bathymetric and seismic survey and geotechnical information made by “Multipurpose Terminal (MPT) Study (JICA) “ in April 2011
2) Bathymetric survey made by SSCD in May 2012
3) Pre-construction bathymetric survey for the construction of MPT Project in December 2014
4) Bathymetric Survey for marine chart of “Sihanoukville Harbour” (JICA) in December 2014.

As for the seabed configuration, it was assumed that the on-going dredging and excavation works of MPT construction project was completed with -12 m water depth

Considering above mentioned condition, the general layout plan of dredging for the Survey is shown in Figure 8.4-1. The length of Access Channel is approximately 4.5 km from the port entrance as Sta.0+000 to seaward up to -13.5 m contour line. The Turning Basin covers the area between the new container berth (Phase I) and MPT with water area of approx. 49 ha (486,000 m^2)



Source: JICA Survey Team

Figure 8.4-1 General Layout Plan of Dredging

(1) Container Ships Dimension

The size of objective container ships, which is Panamax to Over-Panamax class, was determined as indicated in the Table 8.4-1.

The size of Access Channel and Turning Basin are planned based on the maximum LOA .

Table 8.4-1 Objective Container Ships Size for Channel and Basin

DWT	LOA (m)	Beam (m)	Draft (full) (m)	Remarks
60,000	285 to 300	37.2 to 40.0	12.7 to 13.8	Over Panamax

Source: JICA Survey Team

(2) Water Depth

The water depth of Turning Basin and Access Channel (as inner Channel) was determined to be -13.5 m with 10% of 12.3 m the ships maximum draft as Under Keel Clearance (UKC). The Berth Box with the water depth of -14.5 m was also considered for future expansion and for tidal window operation for coming Phases I and II.

As for the Outer Channel which means offshore channel between Kaoh Poah (Snake) Island and Kaoh Kaong Kang Island, offshore swell with the wave height of less than 1 m is considered, and 15 to 20% of ships' maximum draft (12.3 m) makes Outer Channel water depth to be 14.1 to 14.8 m.

Table 8.4-2 Port Water Depth and Maximum Operational Draft

Phase	Max. Draft	Water Depth			
		Berth	Basin	Inner Channel	Outer Channel
	(c)=(b)/1.1	(a)	(b)	(d)=(c)x1.1	(e)=(c) x(1.15 to 1.20)
I - II	12.3	-14.5	-13.5	-13.5	-14.1 to - 14.8
Future Exp.	13.2	-14.5	-14.5	-14.5	-15.2 to -15.8

Source: "Harbour Approach Channels Design Guidelines, PIANC Report No.121-2014"

(3) Sub-surface Layers of Access Channel and Turning Basin

Four (4) sub-surface layers are also shown in the cross sections, namely (1) Soil Layer (upper), (2) Soil Layer (lower), (3) Weathered Rock, and (4) Rock. Those locations and depth of layers were investigated by the seismic survey conducted by "Multipurpose Terminal Study (JICA) in 2011". As the dredging and excavation works of MPT Project were in progress it was revealed that the actual location and depth of soil layers are similar to that indicated in the study report.

The characters of the 4 sub-surface layers are summarized in the Tables 8.4-3 and 8.4-4.

Table 8.4-3 Classification of Sub-Surface Layers

Geological Classification of the sub-surface layers	Characteristics of the layers	Hardness level for Dredging works	Name of the layer for Design and Construction of the Project
Holocene	**Very soft/soft** Holocene **sediments** which are silt Clays or clayey Silts with some sand and broken shells contents (in dredged areas, some samples were logged as 'very very' soft Clays having an almost watery appearance	**Soft soil**	**Soil layer/Upper**
Pleistocene to Paleocene	Sediments of Pleistocene down to (perhaps) Paleocene age, These will be **firm, stiff or hard if cohesive, and compact, dense or very dense if granular**, Boulders, gravels, sands, silts, clays, may be encountered during drilling.	**Soft to hard soil**	**Soil layer/Lower**
Top of rock in some state of decomposition	Triassic **sedimentary rocks in any state of decomposition** (Any grade for the top of the rock)	**Highly weathered rock**	**Weathered Rock**
Top of Grade III rock	Moderately (or less) **weathered sedimentary Rocks** (Grade III to I)	**Moderately to slightly weathered rock**	**Rock**

Source: JICA Survey Team

Table 8.4-4 Conditions of Sub-Surface Layers

Geological Classification of the sub-surface layers	Name of the layer for Design and Construction of the Project	Hardness level for Dredging works	N-value (Standard Penatration Test)	RQD (Rock Quality Designation)	Shear Strength (qu) (Mpa)
Holocene	**Soil layer/Upper**	**Soft soil**	**0 to 5**		
Pleistocene to Paleocene	**Soil layer/Lower**	**Soft to hard soil**	**5 to 50**		
Top of rock in some state of	**Weathered Rock**	**Highly weathered rock**	**> 50**	**0 to 90**	**40 to 80**
Top of Grade III rock	**Rock**	**Moderately to slightly weathered rock**	**> 50**		

Source: JICA Survey Team

The area of hard strata are limited at around CH 0+400 to CH 0+700 of Access Channel and in front of MPT berth areas as indicated in Figure 8.4-2.

Source: MPT Study Report 2011

Figure 8.4-2 Extent of Hard Stratum (Weathered Rock and Rock)

8.4.2 Access Channel

(1) Direction and Dimension of the Access Channel

The bearing direction of the Channel center line is similar to that of MPT project which is 99° from the true north. The Channel bottom width was determined to be half of LOA (300 m x 1/2=150 m) since the short length of the Channel and the number of ship calls makes one way navigation to be affordable for the meantime.

Two Channel side slopes of 1;5 and 1:10 are considered. 1:10 slope will be applied at the area with high siltation rate.

Table 8.4-5 Direction and Dimension of the Access Channel

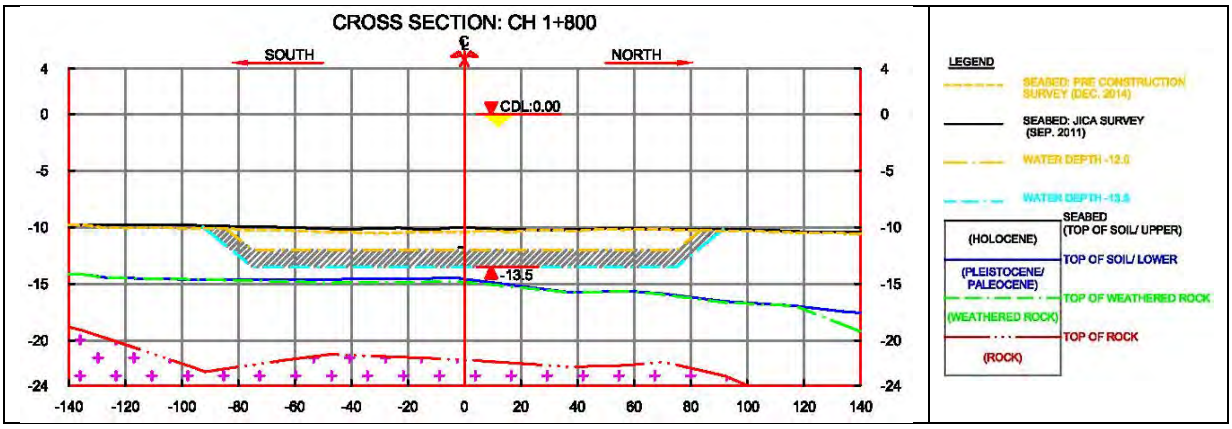
Bearing direction of Channel center line	N-99°
Water depth	CDL -13.5m
Channel bottom width	150 m
Side slope	1:5 to 1:10
	Note: CDL: Construction Datum Level

Source: JICA Survey Team

(2) Cross Sections

The cross sections of Access Channel were made at intervals of every 100 m for approximately 4.4 km long Channels. The cross sections are shown in the Appendix 8.4-1.

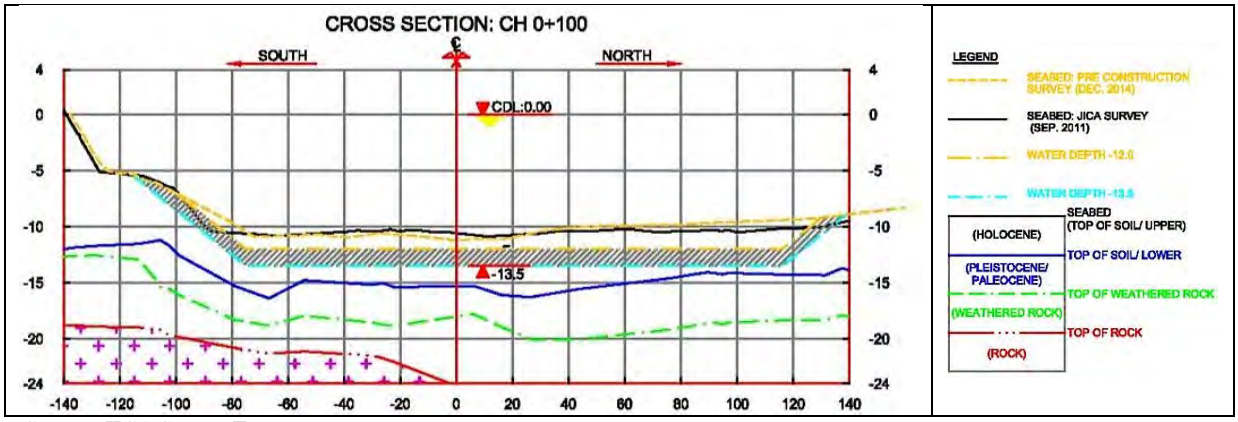
The water depth comparison along the proposed Access Channel area was made for last three and half (3.5) years from April 2011 (indicated with broad black line) to December 2014 (indicated with broken orange line). A typical section of the Access Channel among above cross sections at CH 1+800 is shown in Figure 8.4-3 below. The objective dredging area for the Survey is indicated by hatching which is between -12 m and -13.5 m area.



Source: JICA Survey Team

Figure 8.4-3 Typical Cross Section of Access Channel

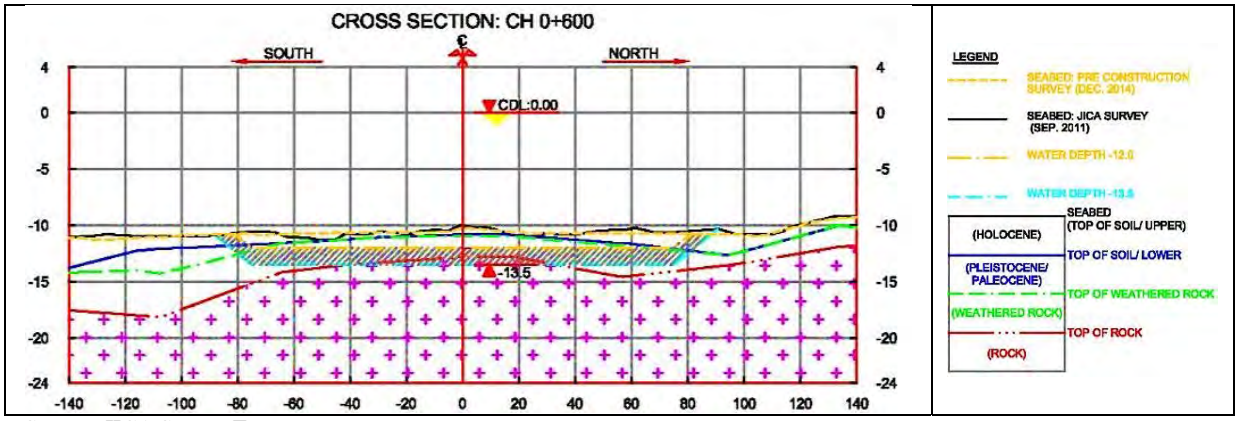
There is no significant change of water depth in the entire length of existing channel, except for the area between CH 0+000 m (at port entrance) and CH +400 m (400 m seaward) where siltation of 0.3 m to 1.1 m thick was occurred particularly northern half of the channel width while southern half were rather scoured. A cross section at CH 0+100 is shown in Figure 8.4-4 where siltation and scouring were occurred simultaneously.



Source: JICA Survey Team

Figure 8.4-4 Cross Section of Access Channel at CH 0+100 with Siltation

The cross section at CH-0+600 with shallow hard stratum such as weathered rock and rock layers is indicated in Figure 8.4-5.



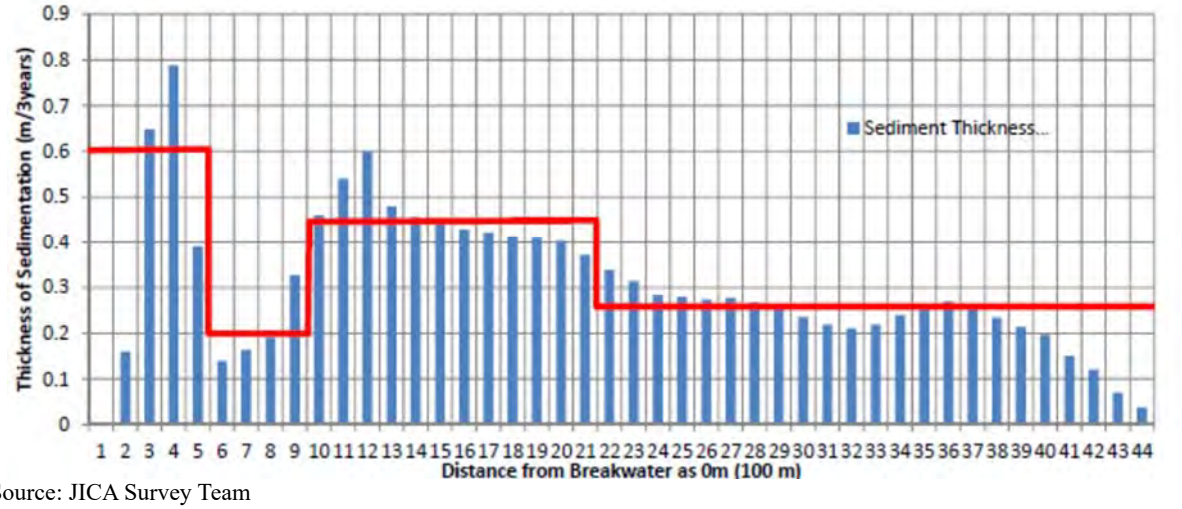
Source: JICA Survey Team

Figure 8.4-5 Cross Section of CH-0+600 with Rock Layer

(3) Sedimentation of the Access Channel

The sedimentation of the Access Channel is considered for the period of three (3) years as determined in the study of MPT (JICA) in 2011. The study (2011) was made applying the E.W. Bijiker model (1980, ICCE). The model simplified to determine the process of the suspended solid, cross current and waves.

Using the output of the study (2011), the thickness of the sedimentation and relevant extra depth for 3 years period for each cross station of -13.5 m Access Channel at intervals of every 100 m were predicted as indicated in Figure 8.4-6. The predicted thickness of sedimentation and volume of extra depth dredging of each layer are shown in Appendix 8.4-2.



Source: JICA Survey Team

Figure 8.4-6 Predicted Sedimentation Thickness and Extra Depth of Channel

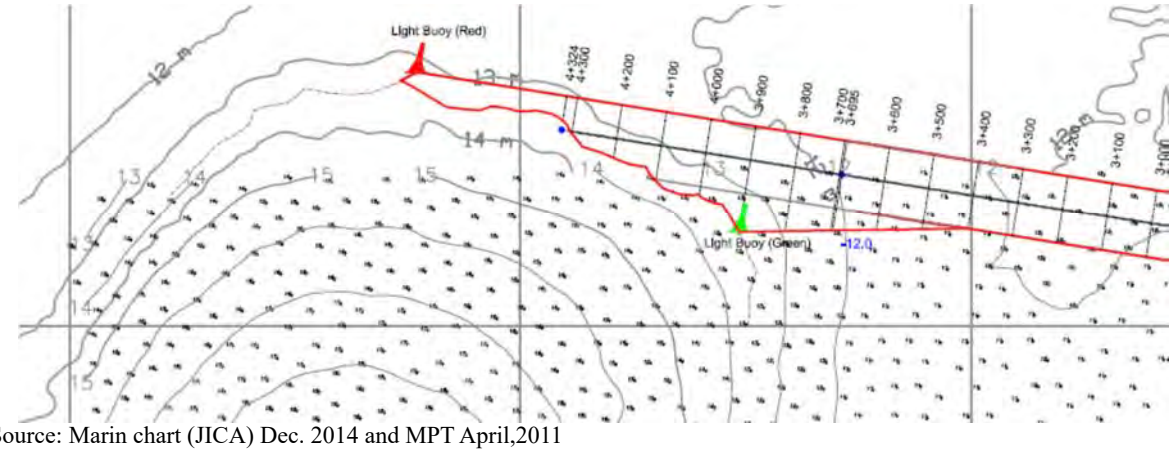
(4) Dredging volume

The dredging volume of Access Channel is summarized together with that of Turning Basin in subsequent Section. The volume calculation of Access Channel is shown in Appendix 8.4- 3

(5) Widening of the Channel entrance and Navigation Aids

Figure 8.4-7 shows the entrance of Access Channel. The incoming ships from southern outer sea (Gulf of Thailand) have to turn the helm to starboard to enter the Access Channel. In order to secure safe maneuvering, the entrance of the Channel was planned to widen from 150 m to 220 m as shown in the Figure.

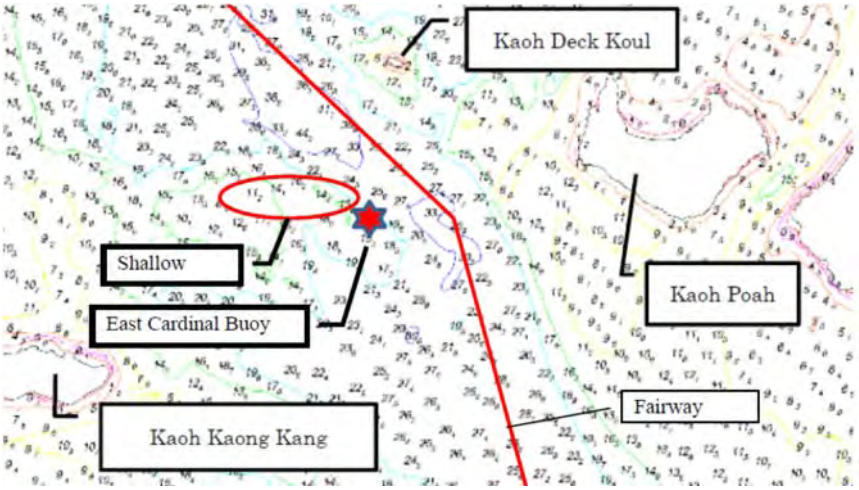
Two (2) sets of Lateral light buoy are also provided at the entrance along -13.5 m contour line.



Source: Marin chart (JICA) Dec. 2014 and MPT April,2011

Figure 8.4-7 Widening of the Access Channel Entrance and Location of Lateral Light Buoys

An East Cardinal buoy is planned to show the fairway of Outer Channel. This buoy will be installed in the vicinity of shallows in between Kaoh Poah and Kaoh Kaong Kang Island.



Source: Marine Chart "Sihanoukville Harbour, (JICA) December 2014"

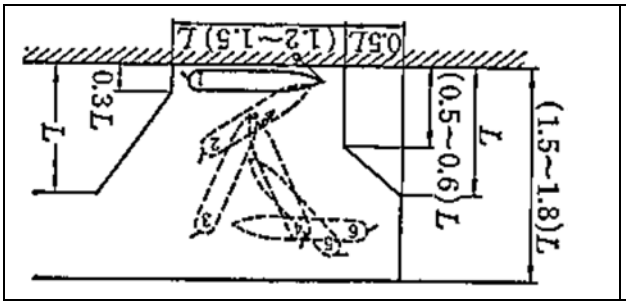
Figure 8.4-8 Outer Channel and East Cardinal Light Buoy

8.4.3 Turning Basin

(1) Dimension of Port Basin Facilities

The size of the turning circle, with assistance of tug boats(s) or thruster, is determined to be two times of LOA which makes 600 m of the circle diameter.

As for the berth box, the width is determined to be 1.5 times of ship beam size.



In case that the ship berthed head-in, the ship will depart by maneuvering as indicated in the left sketch.
The head space will be 0.5 to 0.6 of LOA.
For the Project, 180 m of head space is considered for the maximum size of objective ships.

Source: "Technical Standards and Commentaries for Port and Harbour Facilities in Japan"

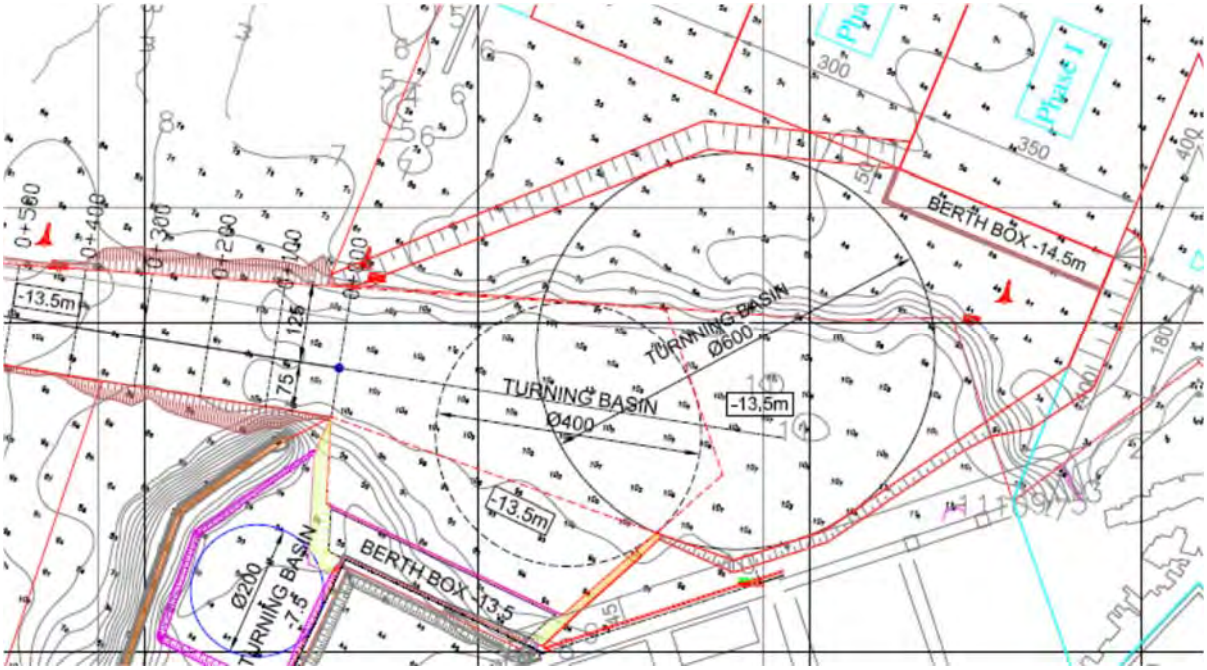
Figure 8.4-9 Berthing Head Space

The dimensions of port Basin is summarized in Table 8.4-6. The layout plan of Port Basin is shown in Figure 8.4-10

Table 8.4-6 Dimensions of Port Basin

Water depth (Basin)	CDL -13.5 m
Water depth (Berth Box)	CDL-14.5 m
Turning Circle	600 m (Diameter)
Berth box (width)	50 m
Head space of Turning Basin	180 m
Side slope	1:5

Source: JICA Survey Team



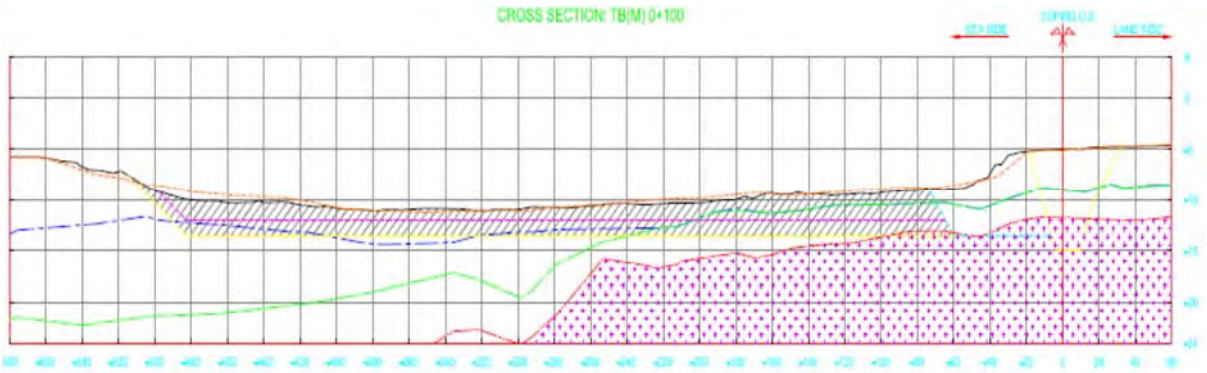
Source: JICA Survey Team

Figure 8.4-10 Layout Plan of Port Basin and Seabed Depth Map

(2) Comparison of Water Depth of Port Basin

The comparison of water depth of MPT port basin was made between the bathymetric surveys made in 2011 by MPT Study (JICA) in April 2011 and pre-construction survey for MPT construction project in December 2014. Above two bathymetric surveys were made by 3.5 years time lag.

The two seabed configurations have not much significant difference except for some of the side slope bottom of the turning basin. The typical section is indicated in the Figure 8.4-11 below and Appendix 8.4-4 In the Figure 8.4-11, at the left side end of the basin slope bottom, limited sediment can be recognized.



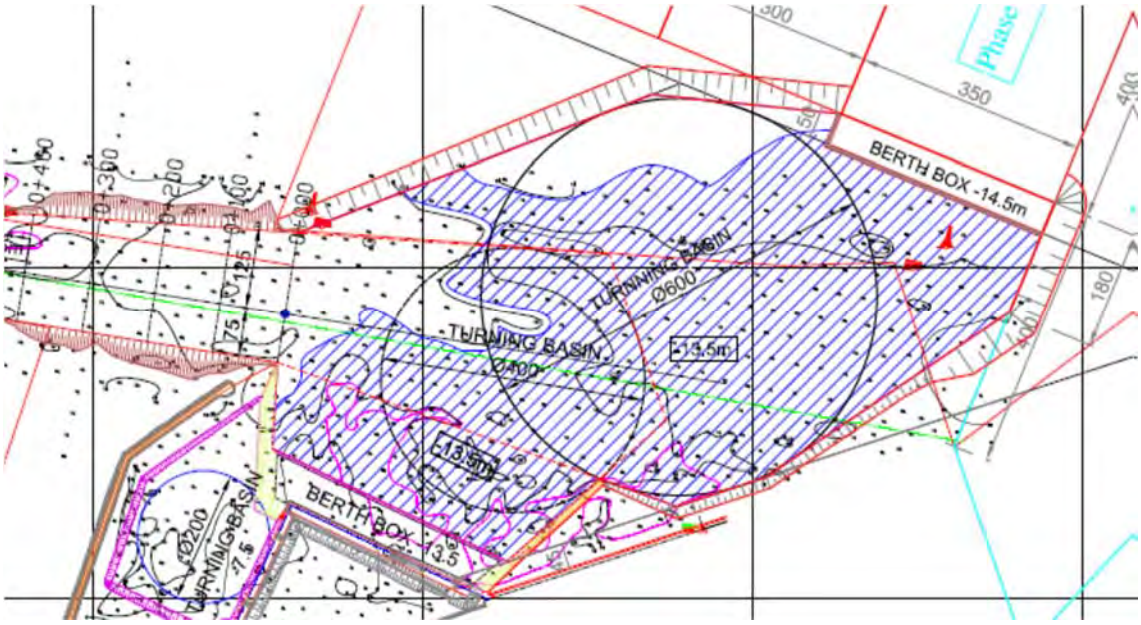
Source: JICA Survey Team

Figure 8.4-11 Typical Cross Section of Port Basin

(3) Extent of Subsurface Layers and Relevant Dredging Volume Calculation

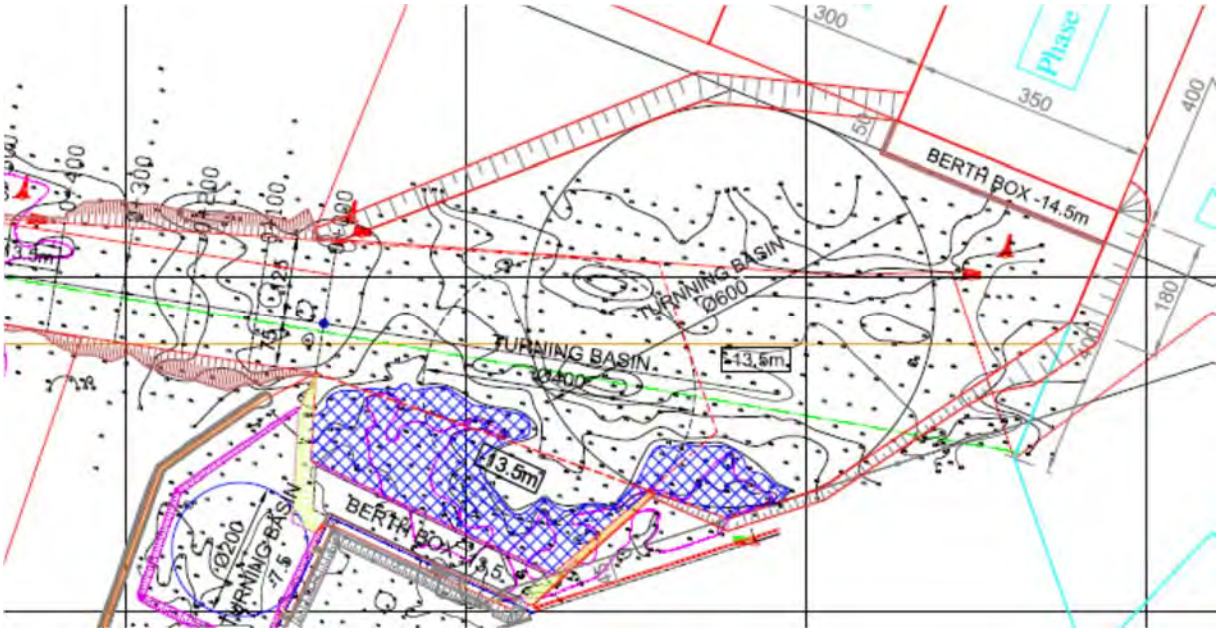
The seabed depth of Port Basin area is shown in Figure 8.4-10, in which the dredging works for MPT basin (-12 m) and berth box (-13.5 m) were on-going as of this reporting period and, therefore, assumed as built water depth of MPT project. The extents of individual layers were indicated in the following Figures:

Figure 8.4-12: Contour Map of Top Elevation of the 2nd Layer (Paleocene)
Figure 8.4-13: Contour Map of Weathered Rock Layer
Figure 8.4-14: Contour Map of Rock



Source: JICA Survey Team

Figure 8.4-12 Contour Map of Top Elevation of the 2nd Layer (Paleocene)



Source: JICA Survey Team

Figure 8.4-13 Contour Map of Weathered Rock Layer

Source: JICA Survey Team

Figure 8.4-14 Contour Map of Rock

The dredging volume for (1)-13.5 m CC Turning basin and (2) front area of MPT berth area (-13.5 m) in between MPT Berth box and edge of CC Turning Circle are calculated separately for four sub-surface layers respectively by segment area and average thickness method for relevant soil layers. The layouts of segment area and soil volume calculation tables are shown in Appendix 8.4-5.

8.4.4 Summary of Dredging Volume

Summary of dredging volume is shown in Table 8.4-7. The total volume of 3.98 million m^3 is separated to Access Channel and Turning Basin with classification of four (4) sub-surface soil types. The detail volume calculation and relevant calculation segments are shown in Appendix 8.4-5

Table 8.4-7 Summary of Dredging Volume

Case 1 MPB Multi-purpose berth basin not included						(Unit: x 1,000 ㎥)	
	Channel	**Channel extra depth**	**Sub total**	**Port Basin**	**Berth Box**	**Sub total**	**Total**
Upper Layer (Holocene)	918	232	1,149	1,911	0	1,911	3,060
Lower Layer (Pleistocene/Paleocene)	45	14	59	613	18	631	689
Weathered Rock	71	22	93	19	0	19	112
Rock (Grade III Rock)	8	8	16	0	0	0	16
Total	**1,041**	**275**	**1,316**	**2,543**	**18**	**2,561**	**3,876**
Case 2 MPB Multi-purpose berth basin only						(Unit: x 1,000 ㎥)	
	Channel	**Channel extra depth**	**Sub total**	**Port Basin**	**Berth Box**	**Sub total**	**Total**
Upper Layer (Holocene)			0	14		14	14
Lower Layer (Pleistocene/Paleocene)			0	14		14	14
Weathered Rock			0	61		61	61
Rock (Grade III Rock)			0	12		12	12
Total	**0**	**0**	**0**	**100**	**0**	**100**	**100**
Case 3 (Case 1 + Case 2) Total Volume						(Unit: x 1,000 ㎥)	
	Channel	**Channel extra depth**	**Sub total**	**Port Basin**	**Berth Box**	**Sub total**	**Total**
Upper Layer (Holocene)	918	232	1,149	1,924	0	1,924	3,073
Lower Layer (Pleistocene/Paleocene)	45	14	59	627	18	645	703
Weathered Rock	71	22	93	80	0	80	173
Rock (Grade III Rock)	8	8	16	12	0	12	27
Total	**1,041**	**275**	**1,316**	**2,643**	**18**	**2,661**	**3,977**

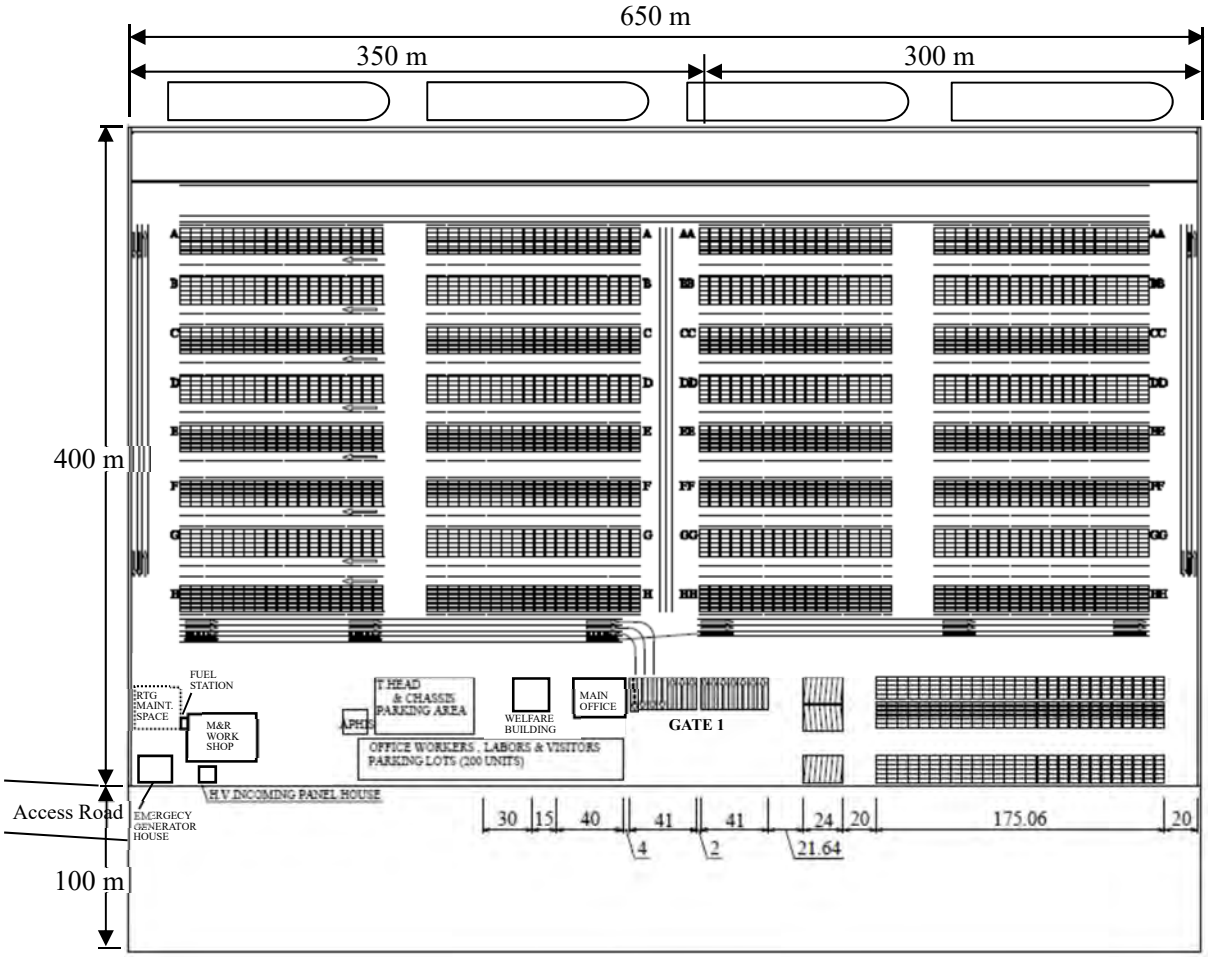
Source: JICA Survey Team

8.5. Yard Layout of New Container Terminal

8.5.1 Estimated Cargo Handling Capacity of New Container Terminal No. 1 and No. 2

(1) Estimated Yard Layout of New Container Terminal No.1 (Phase I) and No. 2 (Phase II)

The yard layout of Container Terminal No. 1 and No. 2 after completion of Phase II of Sihanoukville Port is shown in Figure 8.5.1.



Source: JICA Survey Team

Figure 8.5-1 Yard Layout of Container Terminal No. 1 and No. 2 after Completion of Phase II

(2) Container Handling Capacity of New Container Terminals NO.1 and NO. 2

Effective utilization ratio, Dwell Time (in general, the number of days) and Peak ratio of the container yard are assumed as follows.

- Effective utilization ratio of Yard: 0.75
- Peak ratio of annual or monthly handling amount: 1.4
- Average Dwell time of a container: 5 days
  Here, CT: Container Terminal, CY: Container Yard

It is assumed that the stacking number of containers of two lanes for export on the seaside is 5.0, while it is 4.3 on average for the seven lanes on the landside. The annual container handling capacity of No. 1 and No. 2 New Container Terminals is calculated and shown in the following table.

Table 8.5-1 Annual Container Handling Capacity of No. 1 and No. 2 New Container Terminals

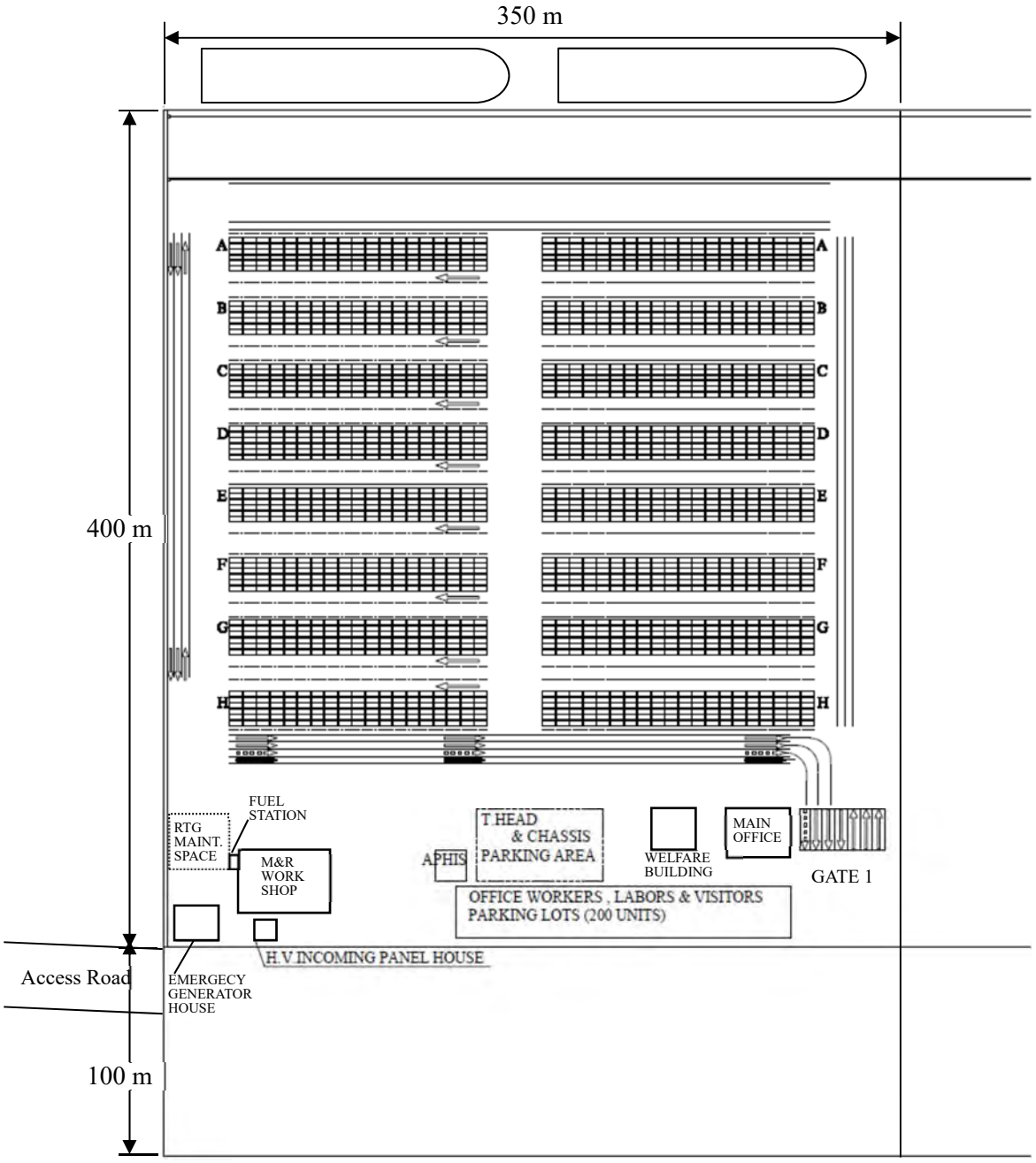
Item	Unit	Phase I	Phase II
		No. 1 CT	No. 2 CT
Total Ground Slot of Existing CT	TEU	5.0 or 4.3 Tiers	5.0 or 4.3 Tiers
Dead Maximum CY Capacity/time	TEU	1,872	1,824
Effective utilization ratio of Yard		8,377	8,160
Peak ratio (of annual or monthly handling amount)		0.75	0.75
Average Dwell time of a container	Day	1.4	1.4
Workable Maximum CY Capacity/time	TEU	5	5
Sustainable Maximum CY Capacity/time	TEU	6,283	6,120
Sustainable CY Capacity/Year	TEU/year	4,487	4,371
Sustainable CY Capacity/Year	TEU/year	327,551	319,083
Total Sustainable (CY + Off-dock CY) Capacity/Year	TEU/year	646,634	

Source: JICA Survey Team

8.5.2 Cargo Handling Capacity of New Container Terminal No. 1 without Off-dock Container Yard

(1) Estimated Yard Layout of New Container Terminal No.1 (Phase I)

The Yard Layout of No. 1 Container Terminal, which is planned in Phase I, is shown in Figure 8.5.2.



Source: JICA Survey Team

Figure 8.5-2 Yard Layout of Container Terminal No. 1 (Phase I)

(2) Container Handling Capacity of New Container Terminal No.1

Effective utilization ratio, Dwell Time (in general, the number of days) and Peak ratio of container yard are assumed as follows.

- Effective utilization ratio of Yard: 0.75
- Peak ratio of annual or monthly handling amount: 1.4
- Average Dwell time of a container: 5 days
  Here, CT: Container Terminal, CY: Container Yard

It is assumed that the stacking number of containers of two lanes for export on the seaside is 5.0, while it is 4.3 on average for the seven lanes on the landside. The annual container handling capacity of No. 1 New Container Terminal is calculated and shown in the following table.

Maximum container storage volume of New Container Terminal will be 8,377 TEUs, and as a result, Annual Handling Capacity will be about 330,000 TEUs when the "Off-Dock CY (i.e." Dray Terminal ") is not included as a part of the storage yard of CT No.1

Table 8.5-2 Annual Container Handling Capacity of No. 1 New Container Terminal

Item	Unit	Value
Total Ground Slot of Existing CT	TEU	1,872
Dead Maximum CY Capacity/time	TEU	8,377
Effective utilization ratio of Yard		0.75
Peak ratio (of annual or monthly handling amount)		1.4
Average Dwell time of a container	Day	5
Workable Maximum CY Capacity/time	TEU	6,283
Sustainable Maximum CY Capacity/time	TEU	4,487
Sustainable CY Capacity/Year	TEU/year	327,551

Source: JICA Survey Team

8.5.3 Cargo Handling Capacity of New Container Terminal No. 1 with Consideration of Off-dock Container Yard

As the annual handling capacity of the new container terminal No.1 is to be 400,000 TEUs, the Off-dock CY requires a cargo handling capacity of about 70,000 TEUs as mentioned in the previous section. Assuming that the number of ground slots of the Off-dock CY is 720 TEUs, and that reach stackers will stack containers in 4 tiers, the annual container handling capacity of the Off-dock CY will be 112,566 TEUs, and as a result, the total annual container handling capacity of the New Container Terminal will be 440,000 TEUs.

Table 8.5-3 Total Annual Container Handling Capacity of the New Container Terminal

Item	Unit	CY	Off-dock CY About 3 ha (120 m x 250 m)
		4.5 Tiers	4 Tiers
Total Ground Slot of Existing CT	TEU	1,872	720
Dead Maximum CY Capacity/time	TEU	8,377	2,880
Effective utilization ratio of Yard		0.75	0.75
Peak ratio (of annual or monthly handling amount)		1.4	1.4
Average Dwell time of a container	Day	5	5
Workable Maximum CY Capacity/time	TEU	6,283	2,160
Sustainable Maximum CY Capacity/time	TEU	4,487	1,542
Sustainable CY Capacity/Year	TEU/year	327,551	112,566
Total Sustainable (CY + Off-dock CY) Capacity/Year	TEU/year	440,117	

Source: JICA Survey Team

After Cargo Handling Equipment is installed in the Existing Container Terminal and the Off-dock CY is secured, the Annual Container Handling Capacity of the Existing Container Terminal will be 800,000 TEUs, and the Annual Container Handling Capacity of the New Container Terminal including Off-dock CY will be around 450,000 TEUs.

8.6. Administration Building, Maintenance Building, Gate, Inspection Facility and Required Facilities

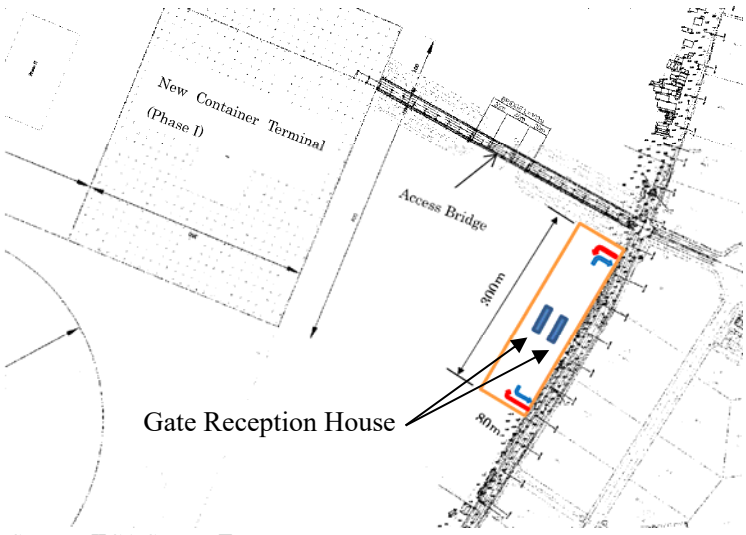
The importance of the following facilities and equipment for the New Container Terminal is considered. The each scale of the facilities and equipment should be determined at the stage of the Detailed Design.

The arrangement of the facilities and equipment installed in No.1 CT shall be planned in consideration of the relationship between the Container Terminal No. 2 (No.2 CT) that has been planned in Phase II.

- Main Office (Administration Building)
- Workers building
- Gate (Truck Scale (each one installed in IN-Gate)
- Maintenance Shop and Maintenance Space
- Fuel Station
- Sub-Station (including Generator House, High-Voltage Incoming and Distribution Panels House)
- Parking Place for In-yard Cars (Tractor head & Yard Chassis)
- Animal, Plant and Health Inspection Station
- Dangerous Goods Temporary Storage Plant (installed in the container storage area)
- Waiting Space for Road-chassis
- Over-height Maintenance Space
- Parking Area for Terminal-use Vehicles
- Night Lighting Tower
- Container Freight Station (CFS) (installed outside of Container Terminal)

8.7. Customs Inspection Yard

Non-destructive inspection facilities such as the X-ray inspection facility should be installed outside of the Gate of the New Container Terminal together with the Gate Reception). A building which will house the Police, Customs and CAM-CONTROL, in order to shorten the waiting time of Trailers at gates of the New Container Terminal. These inspection equipment and facilities are provided by Customs, PAS will be provided the inspection yard only at the designated location as shown in the following Figure 8.7-1. The scale of facilities and equipment should be determined at the detailed design stage.



Source: JICA Survey Team

Figure 8.7-1 Location and Area of Customs Inspection Yard

8.8. Cargo Handling Equipment

8.8.1 Selection Criteria of Cargo Handling Equipment

The main specifications of object container ship wharf and waterway channel are shown below.

Table 8.8-1 Main Specifications of Object Container Ship, Berth and Channel

	Ship Size					Berth		Channel
	DWT (ton)	TEU	LOA (m)	Beam (m)	Draft (m)	Length (m)	Depth (m)	Depth (m)
Object Container Ship	60,000	4,000 - 4,600	300	32.3	13.4	350	14.5	13.5

Source: JICA Survey Team

The main particulars of the quayside container cranes installed in the wharf will be determined on the assumption Over-Panamax-type ships of 5,000 to 6,000 TEUs-class will call at the port as shown in Table 8.8-2.

Table 8.8-2 Main Specifications of Target Container Ships

	Ship Size				
	DWT (ton)	TEU	LOA (m)	Beam (m)	Draft (m)
Container Ship (Over-Panamax)	-	5,000 - 6,000	275 - 300	32.2 - 40	12.5 - 14.5

Source: JICA Survey Team

(1) Selection of Quayside Container Crane (QC)

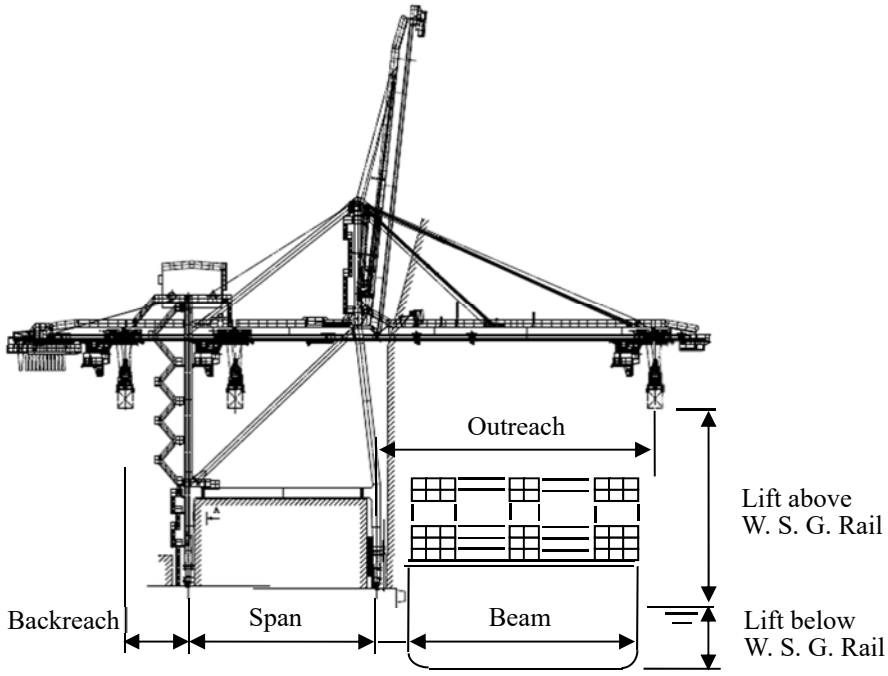
The main particulars of the Quayside Container Cranes (QC) that will be installed in the New Container Terminal are shown in Table 8.8-3.

The quayside container cranes with outreach response to the Over-Panamax-type container ships of 40 m beam (16 rows on deck) stacking 6,000 TEU containers must be selected.

Table 8.8-3 Main Particulars of Quayside Container Crane (QC)

Main Particulars	Unit	Value	Remarks
Rated Load	ton	40.6	(for container)
		40.6	(for Hatch Cover)
		50	(for Cargo)
Lifting Height Under Spreader	m	31.7	(above Seaside rail top)
		16.0	(below Seaside rail top)
		47.7	Total Lifting Height
Span	m	30	
Outreach		44.2	
Back reach		11	
Main Hoist Speed	m/min	70	with rated load
		160	without load
Boom Hoist Speed	min/one cycle	8	
Trolley Traverse Speed	m/min	210	
Gantry Travel Speed	m/min	45	
Supply Power	A.C. 6.6kV, 50Hz, 3 Phase		

Source: JICA Survey Team



Source: JICA Survey Team

Figure 8.8-1 Outline of Quayside Container Crane (QC)

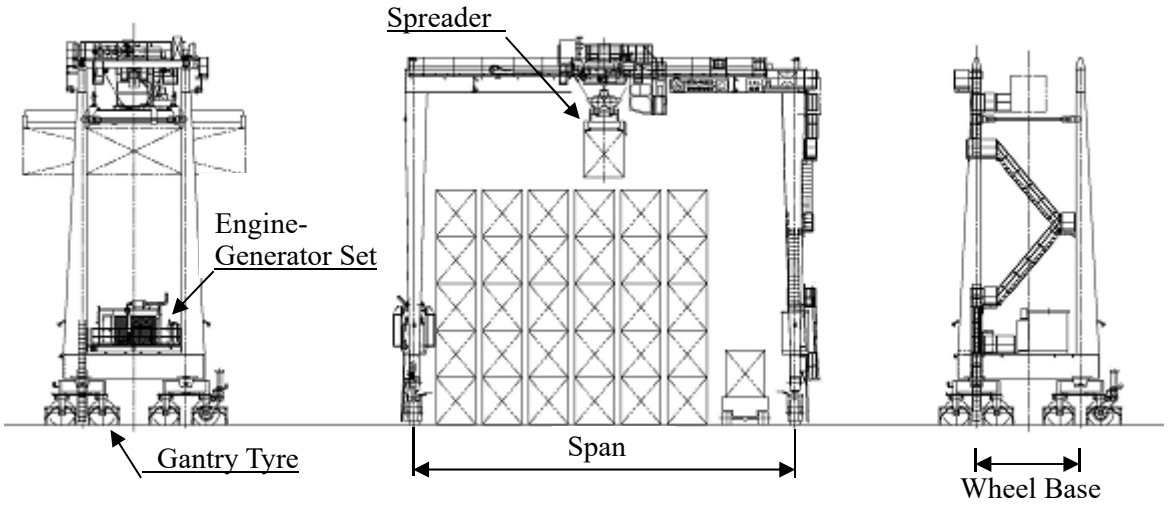
(2) Selection of Rubber Tired Transfer Crane (RTG)

The main specification of the rubber tired gantry crane is that it has the capability to stack containers over 5 high.

Table 8.8-4 Main Particulars of Rubber Tired Gantry Crane

Items	Unit	Value/Remarks
Rated Load	LT	40
Type of Spreader	m	Single lift (20/40 FT) Telescopic Spreader
Span	m	23.47
Container Arrangement	row	6 (0 + 6) Arrangement
No. of Tiers	tier	5 (1 over 5)
No. of Tires	wheel	8
Wheel Base	m	2.5
Power Source		Diesel-Engine Generator Sets

Source: JICA Survey Team



Source: JICA Survey Team

Figure 8.8-2 Outline of Rubber Tired Gantry Crane (RTG)

8.8.2 Container Handling Capacity of Quay

(1) Prerequisites for Calculating the Cargo Handling Capacity of the Quay

1) The theoretical cargo handling capacity of QC is 30 Boxes / Hour.
2) The wharf cargo handling capacity is calculated assuming that the number of QCs per ship engaged in the loading and unloading of the container ship is two units on average.
   Furthermore, when 3 units of QC per ship are engaged in loading/unloading works of containers, the "Work Share Ratio" is taken into account when calculating the cargo handling capacity.
3) Target ship is assumed to be a "Over-Panamax type container ship".

(2) Container Handling Capacity of Berth

The annual container handling capacity of the berth of the New Container Terminal is shown in Table 8.8-5.

Table 8.8-5 Annual Container Handling Capacity of Berth of New Container Terminal

Items	Unit	Value		
Berth Length	m	350		
QC No.		No. 1 QC	No. 2 QC	No.3 QC
Number of QC	Unit	1	1	1
Annual Working Hours	Hour	8,760	8,760	8,760
Theoretical Handling Capacity of QC	Box/Hour	30	30	30
Operation Availability of QC		0.833	0.833	0.833
Handling Capacity of QC		25	25	25
Gross Working Hours		16	16	16
Operation Availability of Berth		0.75 (16/24)	0.75 (16/24)	0.75 (16/24)
Work-share Ratio of QC		1.0	1.0	0.5
Annual Handling Quantity / QC		164,250	164,250	82,125
Conversion Rate from Box to TEU	TEU/Box	1.6	1.6	1.6
Annual Handling Volume (TEU)	TEU	262,800	262,800	131,400
Annual Container Handling Volume per Berth	TEU	525,840		–
	TEU	657,240		

Source: JICA Survey Team

As stated in section 8.5.2, the annual container handling capacity of the New Container Terminal including the Off-dock CY is about 440,000 TEUs. The required number of QC installed in the wharf will be 2 units in order to achieve the cargo handling capacity of the New Container Terminal.

The annual container handling capacity of the berth using 2 QC is about 520,000 TEUs.

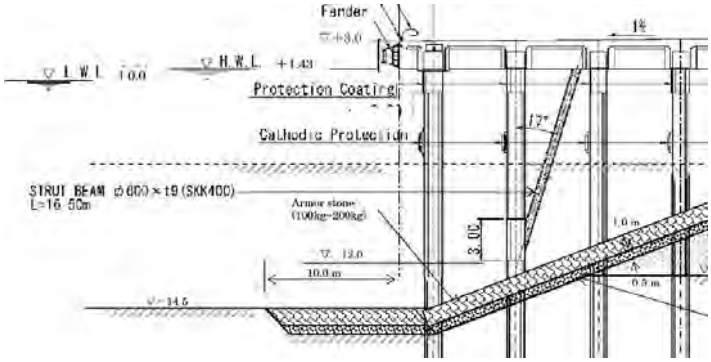
However, since the theoretical productivity of a QC is 25 boxes/hour, the annual handling capacity will be less than the 420,000 TEUs, and also less than the cargo handling capacity of the New Container Terminal if the actual productivity were only 20 boxes/hour. Therefore, to ensure that demands can be met, a total of 3 QC will be installed in the New Container Terminal No.1.

8.9. Examination of the Advantage of Japanese Construction Technology

In this project Japan's engineering technique is being considered for the construction as the recommendation for the berth structure introduced in the previous chapter 8.4 " RC Deck on Steel Pipe Pile with Strut Beam" method and the concrete retaining wall would be utilized as the wave dissipation blocks which is also Japan's special technique. The wave dissipation concrete block wall has also been applied to the multipurpose berth as Japan's technique in the previous project.

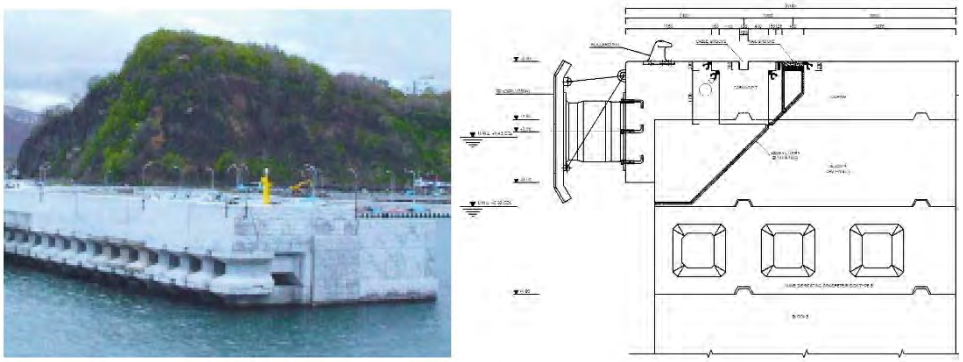
Both of Japan's techniques could be more economical structures than other methods in order to secure the structural stability and operational calmness of the port. The Steel Pipe Strut Beam Method has the advantage that it can use smaller piles than the butter pile structural method. The Wave Dissipation Concrete Wall is only the berth structure to secure the calmness under the conditions of the proposed construction area.

In addition to the above, the steel pipe piles and the strut beam pipe are covered with a urethane elastomer at the factory to provide for an anti-corrosive function which is also Japan's special techniques that prevents the steel pipes and steel strut beams in its splash zone from corroding by seawater. The urethane elastomer lining is mainly provided at the steel mill factory as the products. Therefore, they have excellent anti-corroding for the long life (more than 30 years) and are stable quality produced at the factory. In this project, the length of the steel pipe piles could not be fixed, the length is much difference depending on the elevations of base rock sub-soil layer at the each piling positon. Hence, the area of the corrosion protection in the piles of which the positions to be splash zone in the piles could not be identified. Therefore, the urethane elastomer lining method is only available for the strut beams which are identified the splash zone in the beams previously.



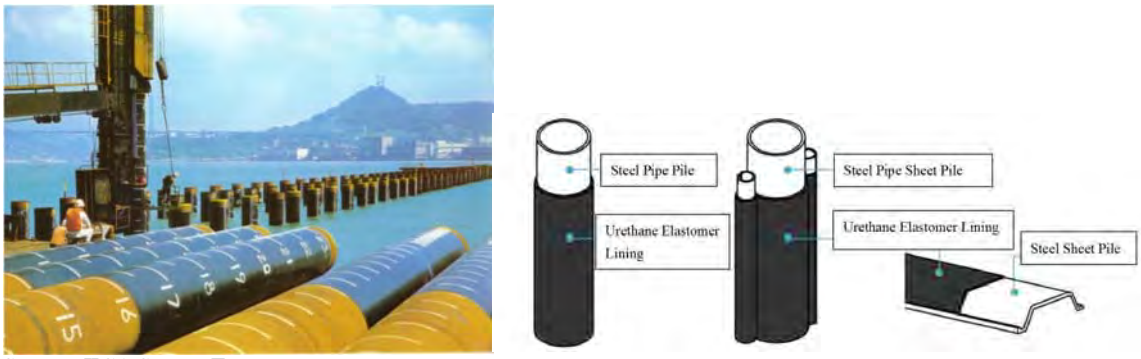
Source: JICA Survey Team

Figure 8.9-1 Steel Pipe Strut Beam Method



Source: JICA Survey Team

Figure 8.9-2 Wave Dissipation Concrete Block Wall



Source: JICA Survey Team

Figure 8.9-3 Heavy-duty Anticorrosion Lining (Urethane Elastomer)

8.10. Adaptation of Climate Change by the Project

8.10.1 Vulnerability due to Climate Change

Asia is believed to be highly vulnerable to climate change with the highest vulnerability in the world. According to research on the risks of climate change to development in South Asia which was commissioned by the World Bank and carried out by the Potsdam Institute for Climate Impact Research and Climate Analytics, Asia is already experiencing a warming climate and it was confirmed as having the world's largest population exposed to coastal flooding. Moreover, its rapid and unplanned urbanization further increases the risks of sea water intrusion.

8.10.2 Scenario of Climate Change

The IPCC (UN Intergovernmental Panel on Climate Change) has postulated global warming projections for various scenarios. The common scenarios are shown in Table 8.10-1.

Table 8.10-1 Scenarios of Global Warming postulated by IPCC

Scenarios	Assumptions	Temperature Change (degrees Celsius)		Sea Level Rise (cm)
		Most likely value	Most likely Range	Most likely Range
Scenario A1B (A balanced emphasis on all energy sources)	General Considerations: * Rapid economic growth. * A global population that reaches 9 billion in 2050 and then gradually declines. * The quick spread of new and efficient technologies. * A convergent world - income and way of life converge between regions. Extensive social and cultural interactions worldwide.	2.8 °C	1.7 to 4.4 °C	21 to 48 cm
Scenario A1F1 (An emphasis on fossil-fuels)		4.0 °C	2.4 to 6.4 °C	26 to 59 cm
Scenario A1T (Emphasis on non-fossil energy sources)		2.4 °C	1.4 to 3.8 °C	20 to 45 cm
Scenario A2	General Considerations: * A world of independently operating, self-reliant nations. * Continuously increasing population. * Regionally oriented economic development. * Slower and more fragmented technological changes and improvements to per capita income.	3.4 °C	2.0 to 5.4 °C	23 to 51 cm
Scenario B1	General Considerations: * Rapid economic growth as in A1, but with rapid changes towards a service and information economy. * Population rising to 9 billion in 2050 and then declining as in A1. * Reductions in material intensity and the introduction of clean and resource efficient technologies. * An emphasis on global solutions to economic, social and environmental stability	1.8 °C	1.1 to 2.9 °C	18 to 38 cm
Scenario B2	General Considerations: * Continuously increasing population, but at a slower rate than in A2. * Emphasis on local rather than global solutions to economic, social and environmental stability. * Intermediate levels of economic development. * Less rapid and more fragmented technological change than in A1 and B1.	2.4 °C	1.4 to 3.8 °C	20 to 43 cm

Source: JICA Survey Tam

8.10.3 Need for Adaptation Options

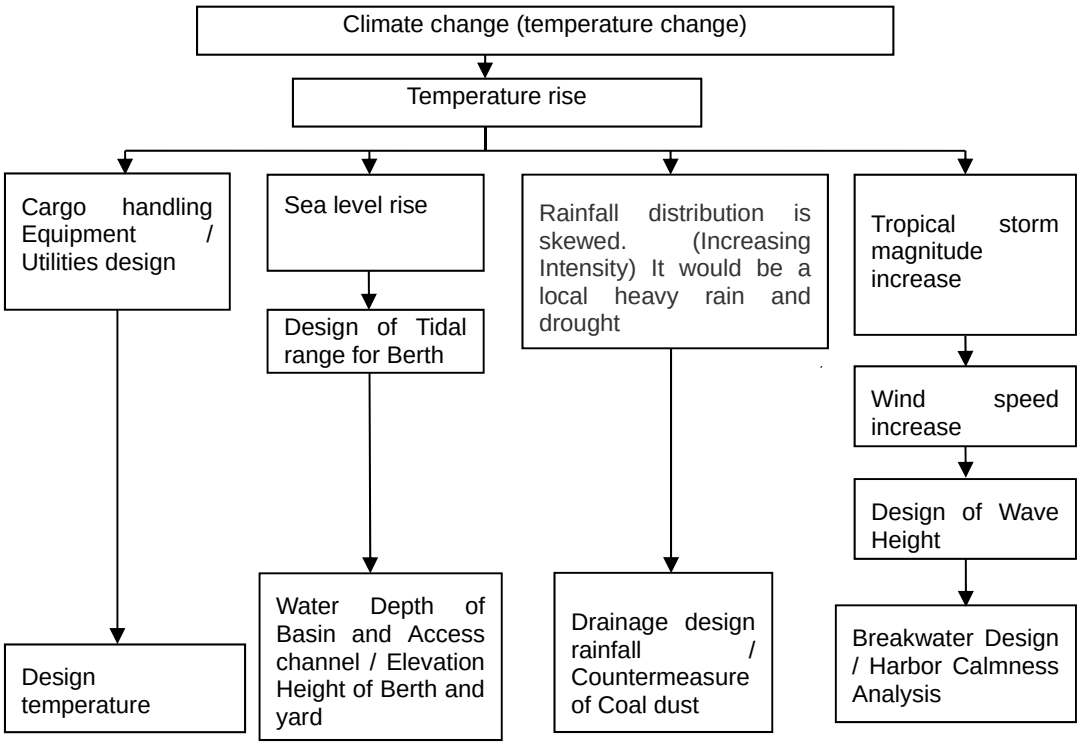
The Project is for newly constructing a container terminal at the north east side of the existing container terminal in Sihanoukville port. About 17 ha of new reclaimed land will be constructed and a container berth 350 m in length will be constructed. The container terminal is planned on the reclaimed area. Necessary container handling equipment would be procured for the terminal as well. The container berth is designed the + 3.3 m CDL height and the depth will be -14.5 m. For the container terminal, an access channel and basin -13.5 m in depth will be expanded. Moreover,

widening and new paving of the existing access road is planned from the National Road No4 to the terminal and a new access bridge is to be constructed between the terminal and the access road in this project. The Project comprises of the following components:

1) Construction of new container terminal (approximately 17.5 ha, berth 350 m long),
2) Construction of access road including access bridge, (20 m width)
3) Dredging of channel and basin, (-13.5 m)
4) Construction of major terminal building,
5) Construction of customs inspection yard,
6) Procurement of cargo handling equipment and terminal operation system, and
7) Consulting services.

It is therefore necessary to consider the safety of the harbour operation and all related structures so as to ensure vessel traffic safety from the effects of climate change.

While there are various types of climate change in the global climate system, the most significant influence of global climate change for this Project which is located in Sihanoukville is global warming, its related temperature rise, its related sea level rise and rainfall rise, and drought and tropical storm magnitude which are not independent climate phenomenon. The consideration of the effects of climate change as they impact this project is as follows Figure 8.10-1.



Source: JICA Survey Tam

Figure 8.10-1 Scope of Consideration

8.10.4 Adaptation Options

Adaptation options are mainly for the design considerations. The adaptation options for climate change in Cambodia due to the above mentioned causes are selected as follows;

- Consideration of harbour design for depth and berth height due to Sea level rise
- Consideration of drainage and pavement design due to rain fall and storm water increasing
- Consideration for the design of harbour calmness due to wave height increasing in storm magnitude due to the temperature rise

In the last decades, the sea level has not so changed much and about 6mm / year rising is projected for the region. Therefore, about 30cm for 50 years is considered in this project

(1) Storms and Cyclones

The recent climate changes will impact the port. Large scale storms or cyclones might strike the Sihanoukville region. In the most recent decades cyclones have brushed Sihanoukville. To cope with the high waves that hit the port, the existing breakwater, especially the north breakwater, shall be improved for about 200 m in length from the port entrance. This countermeasure is not directly concerned with the new container terminal. Therefore, this countermeasure is not included in this project scope. However, it is an effective countermeasure to ensure the calmness of the port. Hence, the additional armour stone with concrete parapet repairing works for the north breakwater is recommended if enough budget allocation for this repairing work is secured in the detailed design stage.

This project will create a large reclamation area in front of the fishing village and residential area. Therefore, in case a large wave strikes the village and residential area, the reclaimed area of the project is expected to protect them.

(2) Rising Sea Tide

In the most recent decades, the sea level has not changed in the region. However, the reclamation area of the project is recommended to be filled to + 3.5 m (in average) which is about 30 cm higher than the existing container yard. The access road is also recommended to be filled to + 4.3 m. This countermeasure is expected to protect the residential area from the flood sue to a strong storm.

8.11. Confirmation of Required Approval

8.11.1 Approval for Construction Facility

Basically the approval for the construction facilities such as common facilities, housings, buildings and factories shall be given by Ministry of Public Works and Transport (MPWT).

For this project, the implementation agency is the Port Authority of Sihanoukville (PAS). Therefore, PAS shall submit an application form for the approval of the construction to the MPWT. After the loan agreement is exchanged, PAS will prepare the application form for describing the project facilities, coordinates of the facilities and EIA approval letter. Upon the approval, the consultants will assist in preparing the application form.

8.11.2 Contract for Electrical Power Supply

In this project, the electrical power will be provided by EDC. PAS shall enter into a contract with EDC to supply the necessary electrical power for the project. The consultants shall assist in evaluating the power demand and discuss necessary systems to install the power lines between the EDC's sub-station and the Project's sub-station.

8.11.3 Approval Regarding Environmental and Social Considerations

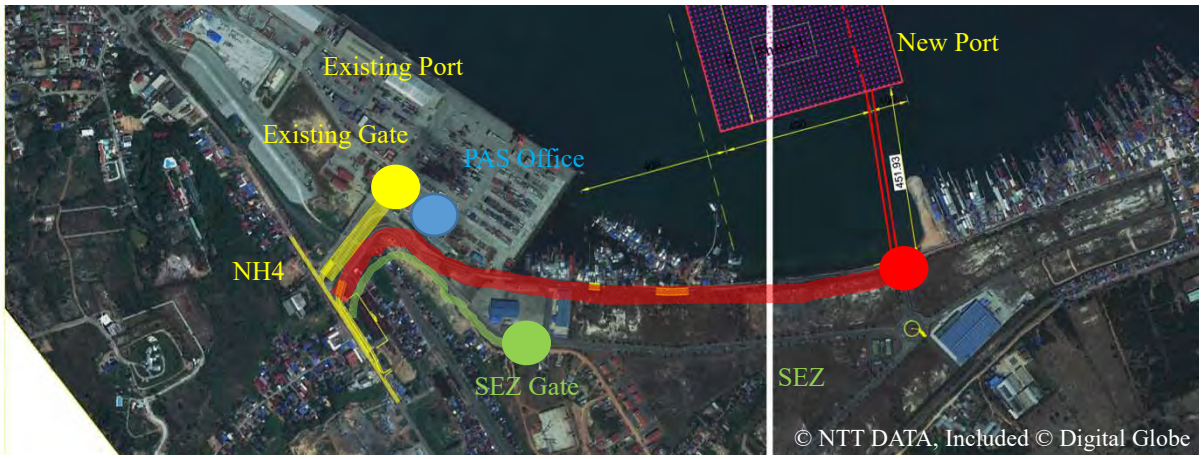
All port construction projects and projects involving dredging work of more than 50,000 m^3 are required to provide an EIA report according to the MOE guidelines. Details of the procedure are described in Chapter 11.

9. BASIC DESIGN OF ACCESS ROAD AND BRIDGE

9.1. Outline Scope of Road and Bridge Design

The existing access road traffic capacity to the new port construction site is inadequate. For that reason, the construction of a new road is indispensable for the new port. Therefore, a new road plan was taken into consideration in this chapter.

For a clearer understanding of the current situation, the interconnecting road positions around the new port construction site are described below.



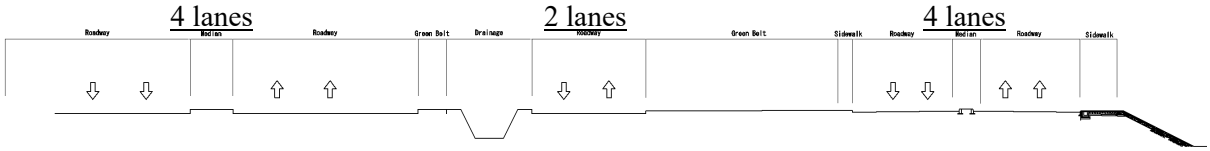
Source: JICA Survey Team

Figure 9.1-1 Current Situation around the Planned Area

As indicated above, most cargo vehicles are gaining access to the port via the NR4. Hence, NR4 needs to be improved in order to accommodate the increasing traffic in the years to come. Hence, before the overall implementation can take place, the JICA Survey Team has pointed out that the following points should be taken as a principal during the design stage.

- The road design must be implemented without affecting the current right of way.
- Traffic for the new port and current traffic have to be separated as much as possible.

The JICA Survey Team has explained the matter to PAS and SHV Department of MPWT regarding the above mentioned route and its principal and it was agreed upon by both governing authorities. Hence, the opinion by the JICA Survey Team will be approved by the SHV Department of MPWT in the next survey.



Source: JICA Survey Team

Figure 9.1-2 Access to the Existing Gate

9.2. Validity of the Number of Lanes for the Access Road

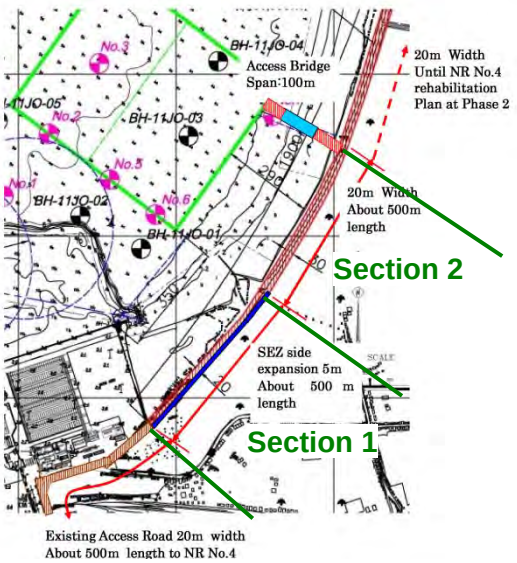
9.2.1 Current Situation

(1) Existing Coastal Road Area

The existing seaside road has been constructed along the SEZ fence towards the land direction instead of towards the sea direction. Moreover, the illegal resident's housings were also seen to have occupied some portion of the road.

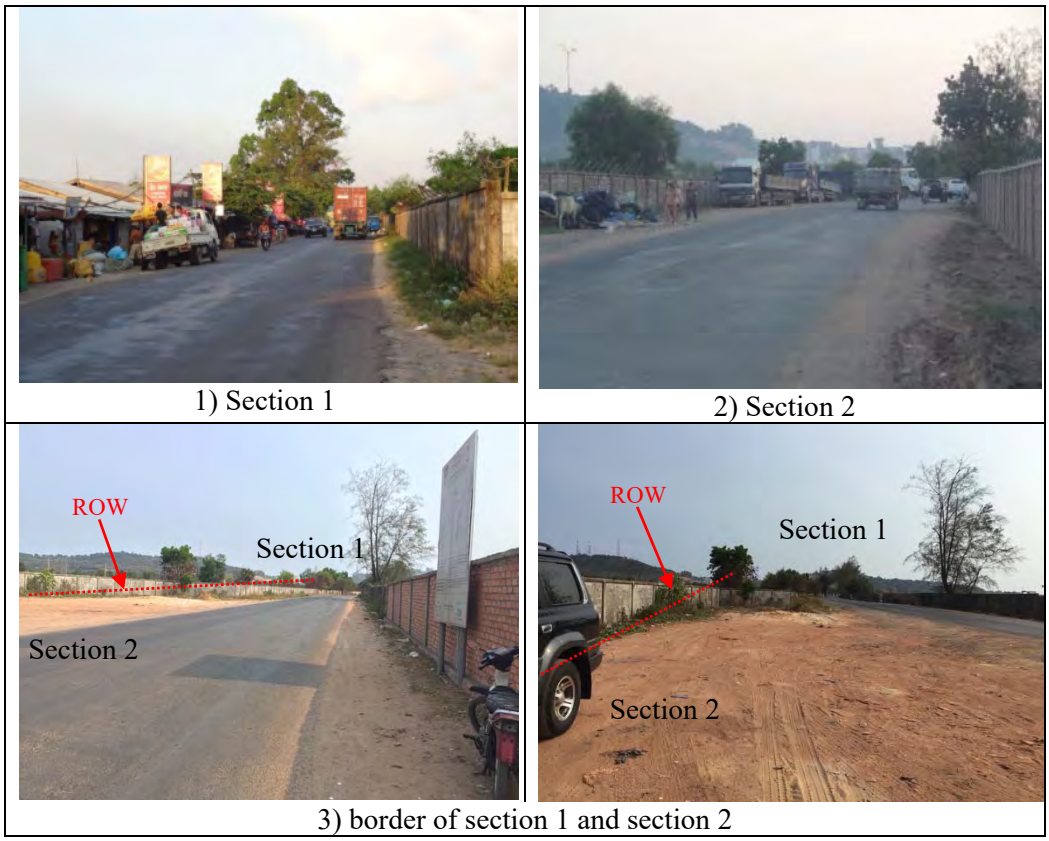
Section 1: Therefore, the road (about 500 m long) could only be widened in the inland direction instead of towards the sea. The team could be considered quite fortunate, since the existing SEZ fence has a space 5m wide measured from the factory's boundary. Hence, subject to the PAS approval, the SEZ fence could be move backwards, in order to secure the 20 m width road.

Section 2: The remaining length (about 500 m) of the access road leading to the new container terminal has no problem in acquiring the 20 m width between the existing fences of the land and sea sides. The condition of the planned access road is shown in Figure 9.2-1.



Source: JICA Survey Team

Figure 9.2-1 Access Road Plan



Source: JICA Survey Team

Figure 9.2-2 Photo of Current Road

(2) Around Existing Gate Intersection Area

The front lane of the current port gate two-lane access road has a distance of only 300 m from the intersection of NR4 and the number of vehicles that can be parked in this section appears to be eighteen cars at the most.

During the traffic processing study conducted during last year, almost 100 car spaces are justified as necessary, in order to avoid affecting the current traffic movement on NR4 which is already congested.

Source: JICA Survey Team

Figure 9.2-3 Parking Lane Section to the Current Gate

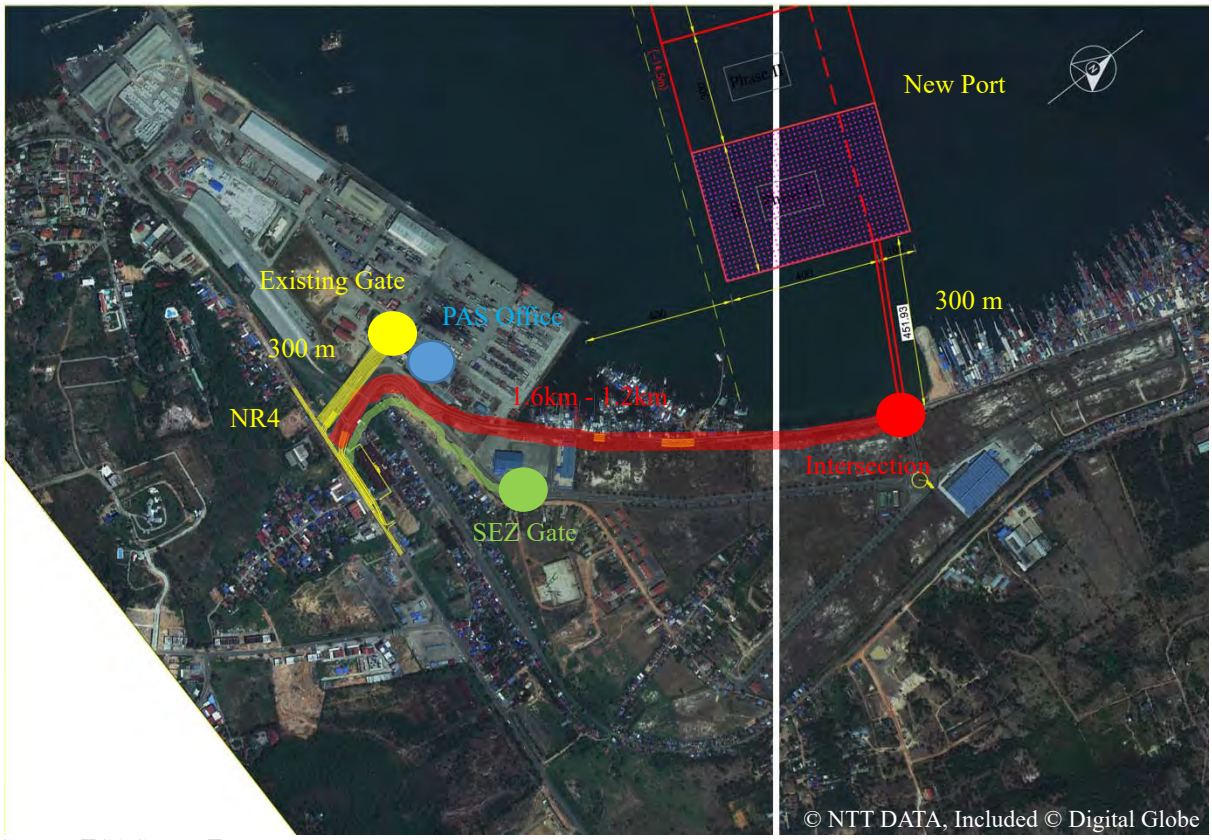
9.2.2 Vehicle Storage on the Access Road in this Project

The distance from the new port gate of this project to the intersection of NR4 is almost 1.6 km, excluding the access bridge portion. The traffic condition worsens when only the two current lanes to the new port are available. Maintenance is scheduled in the section of the planned access road.

The gate to the current port, which also serves as the entrance to the PAS office and the gate to SEZ, is located in the new access road section. There is also a lane to provide access to each facility in addition to the two-lane road to the new port. Therefore, the new access roads to the new port could serve as a parking lane without adversely affecting other facilities.

Hence, the possible parking area could be calculated as 3200 m (1600 m × 2 lanes) ÷ 17.0 m = 188 cars.

A total of 94 vehicles will be able to be parked if one lane has been regulated as an available parking lane.



Source: JICA Survey Team

Figure 9.2-4 Layout of New Port Gate Access Road

After further consideration was given to the impact to the facilities, a subsequent section from the roundabout to the separate SEZ gates (1.2 km) could serve as a parking section. This is due to the fact that, in this section, vehicles may only enter into the new port based on the below figure,

2,400 m (1,200 m × 2 lanes) / 17.0 m[1] = 141 Cargo Vehicles

[1] Length of cargo vehicle is 17.0 m (16.7 m+α) in order to meet the Criteria of Cambodia

9.2.3 Verification of Peak Time Traffic Volume

As a result of the traffic surveys in previous years, the cargo truck volume at the maximum peak time had been measured to be at 54 vehicles during the peak hour.

Cargo volume is assumed to be about 1.5 times or 2 times of the current cargo truck volume when the new port has been developed in this project. Therefore, the necessary cargo truck volume is expected to also increase.

As a result, the maximum concentration in traffic volume can be calculated as below;

54 cargo vehicles / hour × 2 = 108 cargo vehicles / hour

When the gate processing capacity is assumed to be 3 min. / vehicle

Subsequently, when the second gate is opened, processing volume in 1 hour can be calculated as below.

60 minutes ÷ 3 min. / vehicle × 2 gates = 40 vehicles / hour

at the volume of 40 vehicles / hour, we realized that it is impossible to process all the centralized traffic volume during peak time. Therefore, a parking lot for vehicles is necessary.

Hence, the necessary number at that time can be calculated as below.

108 vehicles /hour - 40 vehicles / hour = 68 vehicles / hour

From the results described above, the available parking time when the access road is utilized from a centralized number and the gate entry capacity is shown below.

When the shortest section was utilized: 144 vehicles ÷ 68 vehicles / hour = 2.11 hours

When the longest section was utilized: 188 vehicles ÷ 68 vehicles / hour = 2.76 hours

However, the situation such as peak time where the traffic volume is continued for 3 hours or more is difficult to imagine. Hence, the number of parked vehicles is reduced when the parking time exceeds two hours.

9.2.4 Consideration

Based on the above calculation, the number of lanes needed for the access road to the new port is planned at 4 lanes in this project. We view that by having a 4 lane access road, it is possible to avoid traffic congestion at National Highway Route 4 intersection.

Major consideration results are shown below;

- According the SSCD (by JICA 2012), the congestion queue ended near the Sihanoukville Railway Station after implementing the countermeasure against traffic congestion. Newly generated traffic at the New Container Terminal will be handled separately from current traffic at the existing container terminal. Taking the exclusive lane to the New Container Terminal into account, newly generated traffic will not affect the current traffic.
- The impact on vehicle transportation is expected to be reduced due to an increase in railway transportation.
- Traffic volume will not increase more than the current traffic volume due to full occupancy of the container berth during weekends. The current traffic volume could be regarded as the peak.
- Traffic congestion is supposed to be alleviated by the reduction of the gate processing time.

9.3. Access Road Design for Phase I

9.3.1 Major Design Criteria

The scope of this project implementation is widening of the existing road and improvement of the current road. Both of the existing roads and the widening part will be improved as the access road in the project. The design was implemented with reference to the design criteria of Cambodia "CAM PW 03-1-1-99 Road Design standard (2003)". Moreover, the Japan Road Construction Ordinance was also referenced when needed.

Major design criteria used in this project are shown in the table below.

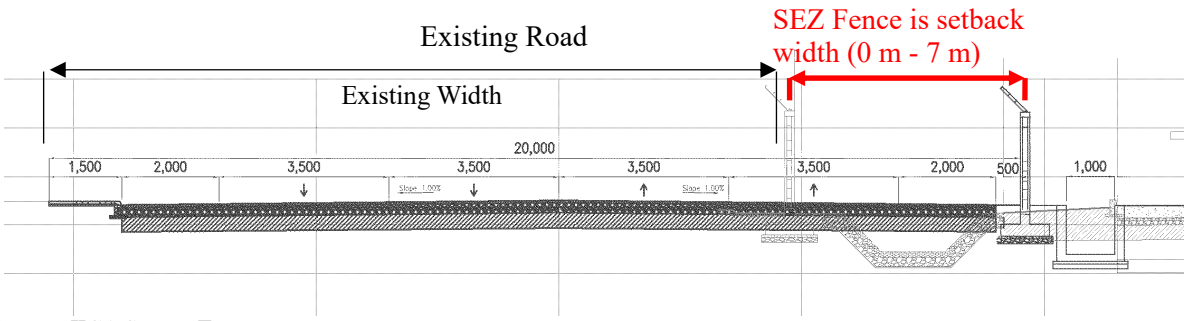
Table 9.3-1 Major Design Criteria

Design Speed	40 km/hr
Number of lanes	2×2 = 4 lanes
Minimum curve radius	R=100 m
Maximum longitudinal slope	4% (Bridge Approach)

Source: JICA Survey Team

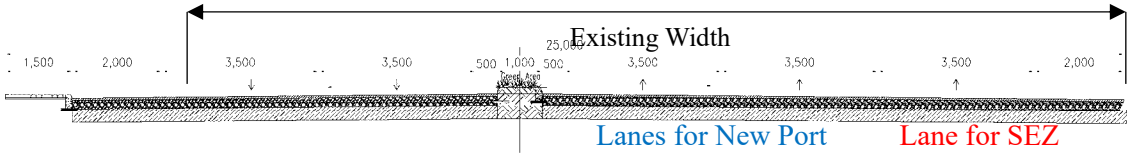
9.3.2 Typical Cross Section

Typical cross section of this road plan is shown below.



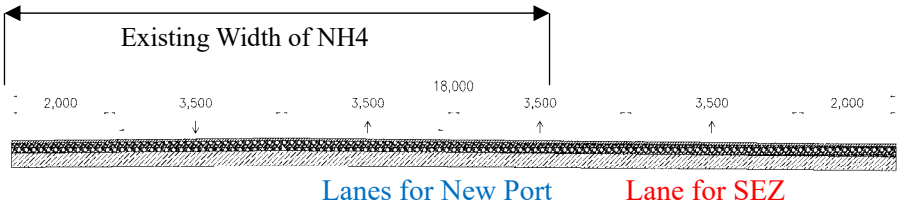
Source: JICA Survey Team

Figure 9.3-1 A-A Typical Cross Section



Source: JICA Survey Team

Figure 9.3-2 B-B Typical Cross Section (Gate Area)



Source: JICA Survey Team
* Refer to Figure 9.3-4 all position of cross section

Figure 9.3-3 C-C Typical Cross Section (NR4 Widening)

9.3.3 Access Road Alignments

The road alignment has been planned to take advantage of the minimum amount of land between the road site and SEZ. Additionally, the current roadside housing and stores are not affected by this road plan.

The road alignment plan is shown below.

Source: JICA Survey Team

Figure 9.3-4 Alignment Plan of Access Road to New Port

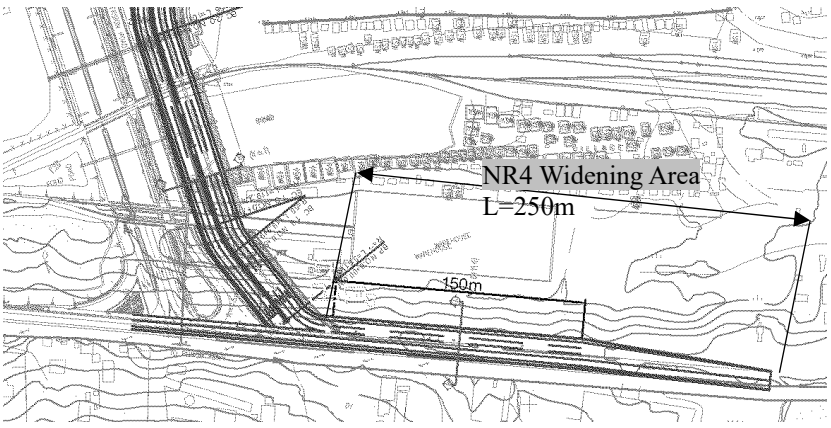
9.3.4 Intersection of NR4

The National Highway Route 4 intersection is selected as the starting point for the access road since it has minimal impact caused by traffic increase from the new port.

At the intersection of NR4, traffic congestion arises when the traffic towards the port is concentrated due to traffic from Phnom Penh taking a right turn.

Therefore, the plan to add two more lanes for the right turn towards the New Port and SEZ has been decided upon in order to alleviate NR4 traffic. The plan is to widen the 250m length lane and the 150m divergent lane.

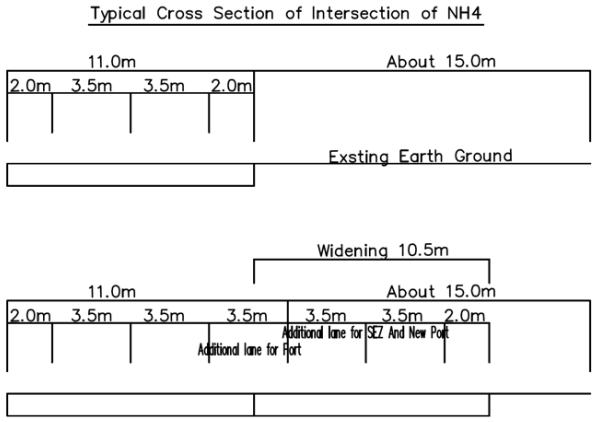
Intersection plan of NR4 is shown below;



Source: JICA Survey Team

Figure 9.3-5 Intersection Plan of NR4

The cross section of the divergent lane is shown below. The divergent lane will encroach into the existing ROW area. That area is currently used as a waiting area when the traffic towards the port is concentrated.

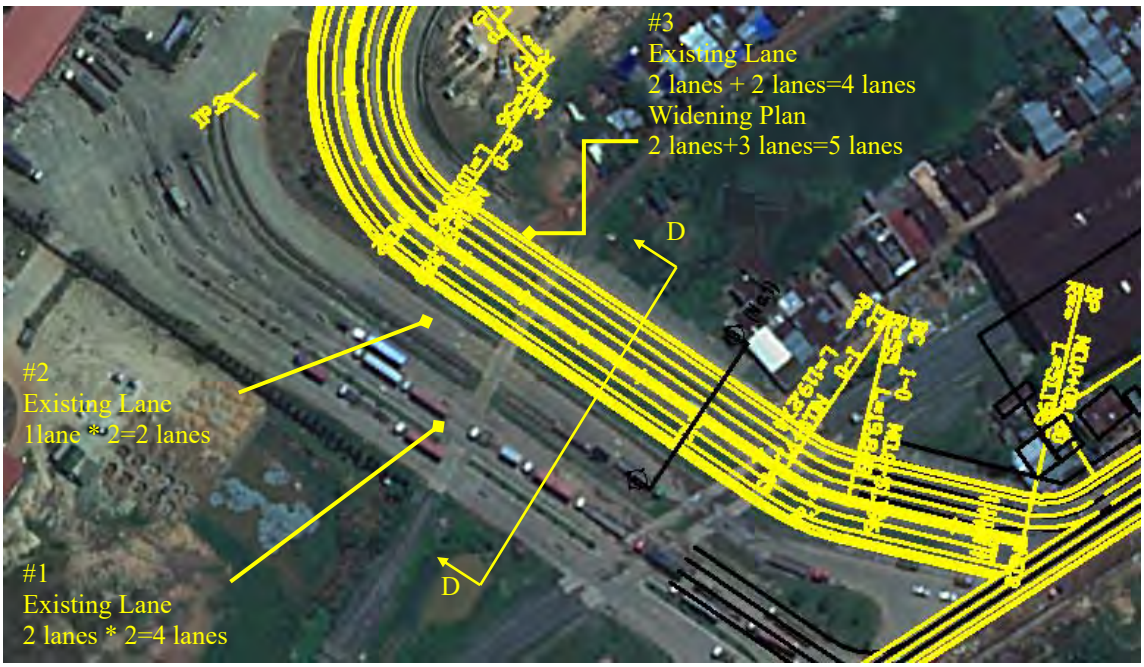


Source: JICA Survey Team

Figure 9.3-6 Typical Cross Section of Intersection of NR4

When widening the area between NR4 and the existing port entrance to cater for the additional lane the existing green belt will be modified.

The plan is shown below.

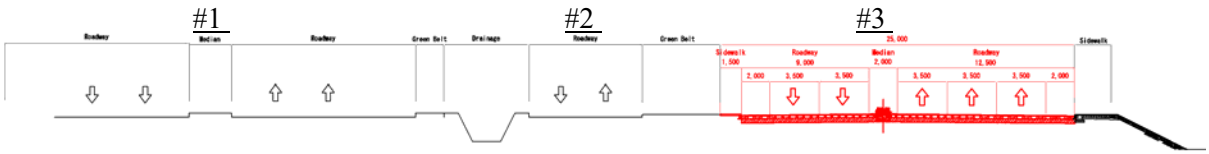


Source: JICA Survey Team

Figure 9.3-7 Intersection of the National Highway Route 4

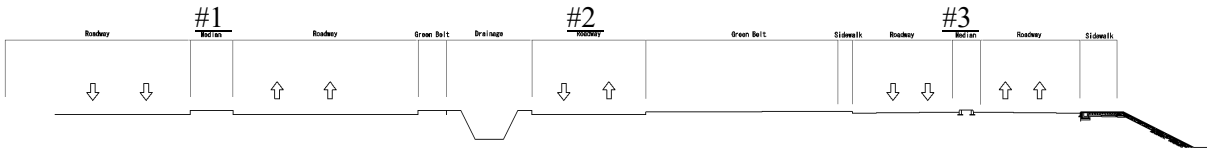
The current lane configuration is composed of # 1, # 2 and # 3 as indicated below. The area between # 2 and # 3 shall be treated as green belt. The green belt is aimed at reducing the cost impact as much as possible to the project because widening maintenance has been carried out in the project of SEZ development during 2015. For this purpose, the existing 4 lane road shall be upgraded to a 5 lane road by changing the green belt to roadway. We foresee that it shall facilitate the traffic flow by this option.

Existing cross section and plan cross section is shown below.



Source: JICA Survey Team

Figure 9.3-8 Plan Cross Section (D-D)



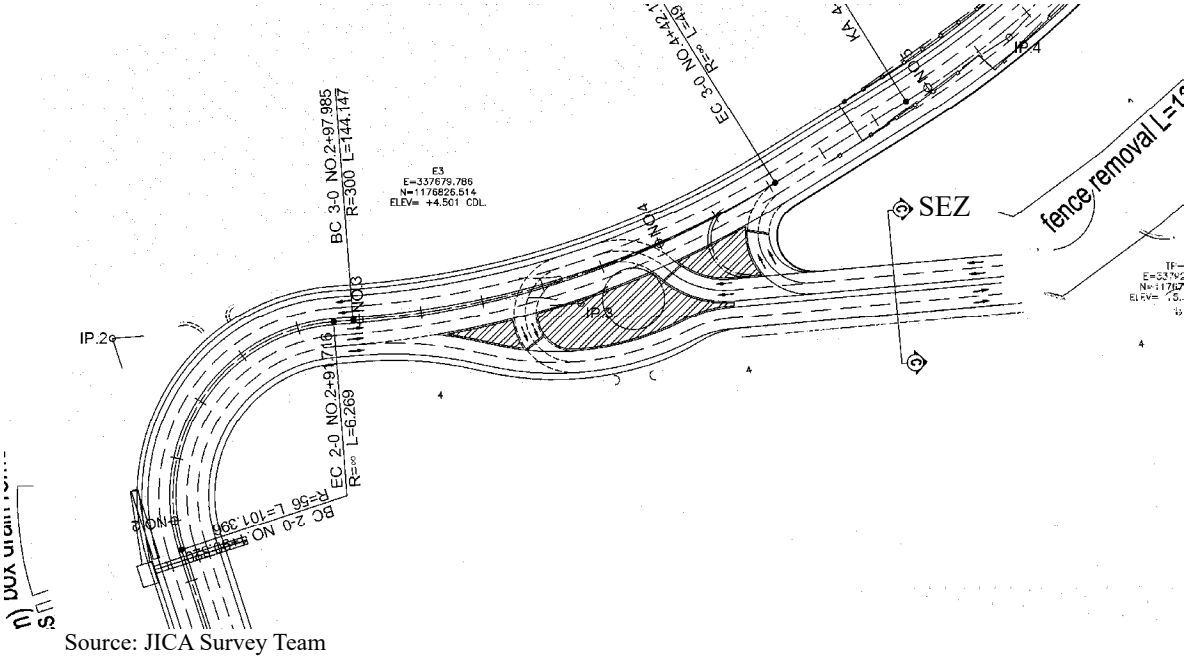
Source: JICA Survey Team

Figure 9.3-9 Existing Cross Section (D-D)

9.3.5 Intersection of the Existing Round About

At the moment, the existing traffic is being handled by the roundabout. However, an intersection to separate access traffic to the new port and access traffic to the SEZ is proposed in this project.

The intersection plan of the existing roundabout is shown below;



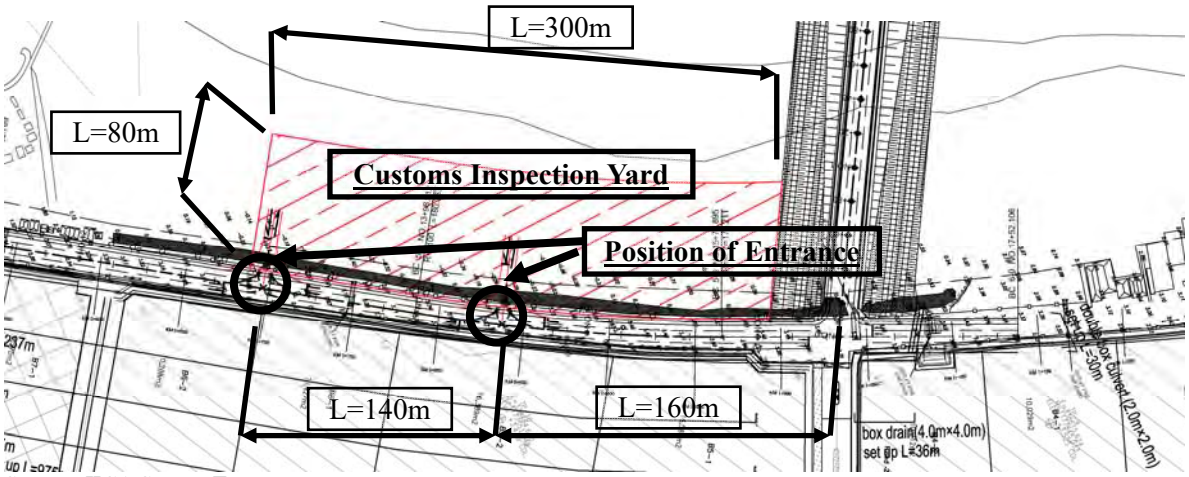
Source: JICA Survey Team

Figure 9.3-10 Intersection Plan on Existing Round About Intersection

9.3.6 Design of Customs Inspection Yard Entrance

The entrance to the customs inspection yard is planned to be positioned in front of the bridge. In the road plan, the access plan from the access road to the yard is implemented in this project.

Customs Inspection Yard will be located as shown below.



Source: JICA Survey Team

Figure 9.3-11 Customs Inspection Yard Entrance

As shown above, the interval between the two entrances of the customs inspection yard is 140 m, and the interval between one entrance and the intersection is 160 m. By implementing this, we view that it is possible to reduce the transportation impact to the access road.

And, two entrances into the yard are planned to be full access intersections.

9.3.7 Design Criteria - CAM PW 03-1-1-99 Road Design Standard (2003)

Major Criteria in "CAM PW 03-1-1-99 Road Design Standard (2003)" is shown below:

Table 9.3-2 Design Vehicle Dimensions

Design Vehicle		Dimensions (m)						Turning Radius (m)
Type	Symbol	Wheel Base	Overhang		Overall Length	Overall Width	Height	
			Front	Rear				
Passenger Car	P	3.4	0.9	1.5	5.8	2.1	1.3	7.3
Single Unit Truck	SU	6.1	1.2	1.8	9.1	2.6	4.1	12.8
Truck Combination	WB-15	7.9	0.9	0.6	16.7	2.6	4.1	13.7

Source: CAM PW 03-1-1-99 Road Design Standard (2003)

Table 9.3-3 General Design Speed

Design Speed (Rural)

Design Standard	Design speed (km/hr)		
	Flat Terrain	Rolling Terrain	Mountainous Terrain
R6	120	100	80
R5	100	80	60
R4	90	70	60
R3	70	60	50
R2	60	50	40
R1	40	30	20

Design Speed (Urban)

Design Standard	Design Speed (km/ hr)		
	Area Type I	Area Type II	Area Type III
U6	100	80	60
U5	80	60	50
U4	70	60	50
U3	60	50	40
U2	50	40	30
U1	40	30	20

Source: CAM PW 03-1-1-99 Road Design Standard (2003)

Table 9.3-4 General Lane Width

Design Standard	Lane Width (m)	Marginal Strip Width (m)
R6/U6	3.50	0.50
R5/U5	3.50	0.50
R4/U4	3.25	0.25
R3/U3	3.00	0.25
R2/U2	2.75	0.00
R1/U1	(5.00)	0.00

NOTE: ( ) denotes the total two-way lane width.

Source: CAM PW 03-1-1-99 Road Design Standard (2003)

Table 9.3-5 General Shoulder Width

Shoulder Width (Rural)

Design Standard	Useable Shoulder Width (m)		
	Flat Terrain	Rolling Terrain	Mountainous Terrain
R6	3.00	3.00	2.50
R5	3.00	3.00	2.50
R4	3.00	3.00	2.00
R3	2.50	2.50	2.00
R2	2.00	2.00	1.50
R1	1.50	1.50	1.50

Shoulder Width (Urban)

Design Standard	Useable Shoulder Width (m)		
	Area Type I [1]	Area Type II [1]	Area Type III [1]
U6	3.00	3.00	2.50
U5	3.00	3.00	2.50
U4	3.00	2.50	2.00
U3	2.50	2.00	1.50
U2	2.00	1.50	1.50
U1	1.50	1.50	1.50

Source: CAM PW 03-1-1-99 Road Design Standard (2003)

Table 9.3-6 General Maximum Grades

Design Speed (km/h)	Flat Terrain	Rolling Terrain	Mountainous Terrain
60	6-8	7-9	9-10*
80	4-6	5-7	7-9
100	3-5	4-6	6-8
120	3-5	4-6	-
Note: *Grades over 10% should be used with caution. Values closer to the lower figures would be aimed for on primary highways. Higher values may be warranted to suit local conditions.			

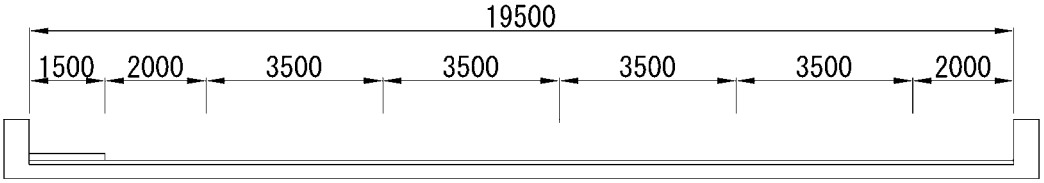
Source: CAM PW 03-1-1-99 Road Design Standard (2003)

9.4. Bridge Design

9.4.1 Design Policy

An access bridge for the terminal is planned from the access road to the new container terminal, where small fishing vessels can pass beneath the bridge. The bridge is planned at 19.5 m in width (two lanes for each way with one walkway), the bridge is 100 m in length and made of R.C. structural piers and P.C. structural beams.

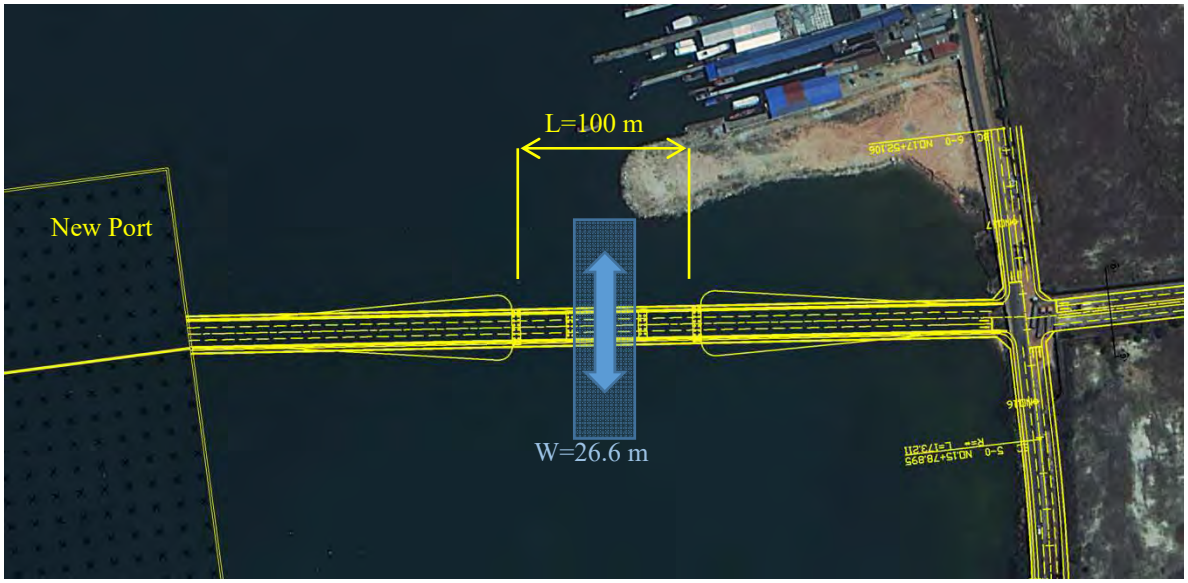
1) Bridge Cross Section



Source: JICA Survey Team

Figure 9.4-1 Typical Cross Section (Bridge)

2) Bridge Length: 100.0 m



Source: JICA Survey Team

Figure 9.4-2 Bridge Length and Clearance Width

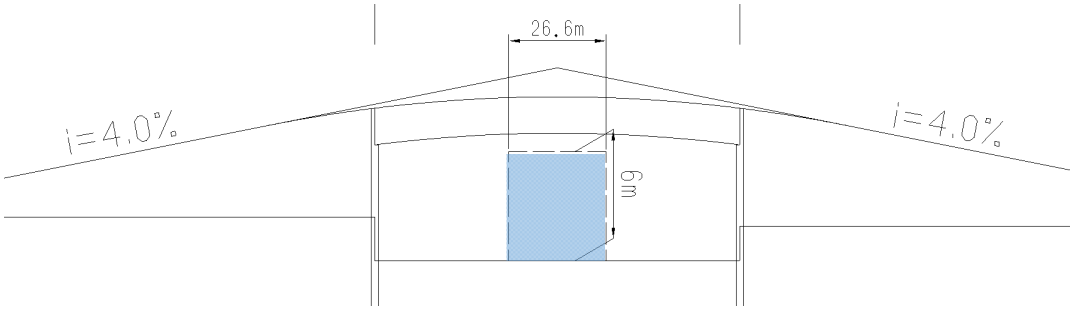
3) Design Criteria: Specifications for Highway Bridges (Japan Road Association)

4) Approach Slope Grade: 4.0%

Due to the fact that the majority of traffic is large trailers, a low-gradient has been adopted in the planning.

5) Clearance height under Bridge: H=6.0 m

Clearance of 6.0 m has been adopted for small fishing boats to pass after considering the consultation with PAS.

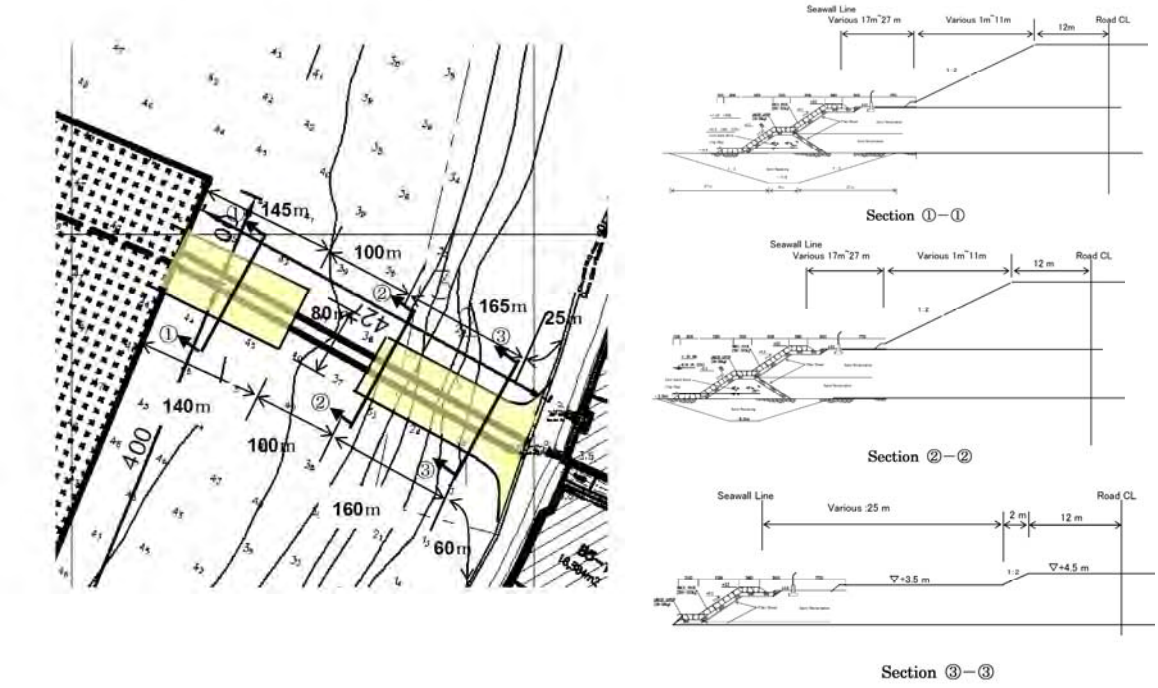


Source: JICA Survey Team

Figure 9.4-3 Passage Clearance Height Under Bridge

9.4.2 Embankment Fill, Sand Replacement and Seawall

The length between the access road and the new terminal is about 470 m. About 165 m from each end the longitudinal profile of the centreline will be raised to 3% in order to gain the elevation which will secure the 6.5 m clearance during high water level at the bridge center so as to enable fishing vessels to pass beneath the bridge. The embankment shall be protected by the seawalls. Prior to the construction of the seawall and sand fill, the soft seabed layer shall be replaced with good quality sand. The sand replacement plan and seawall structure is shown in Figure 9.4-4.



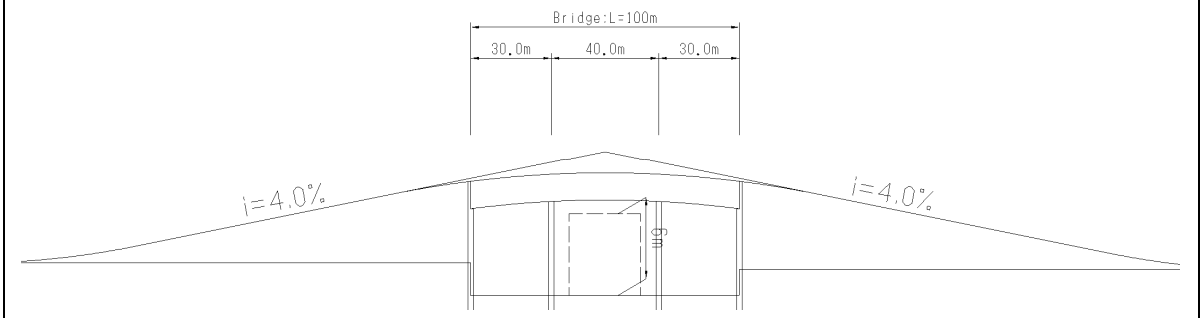
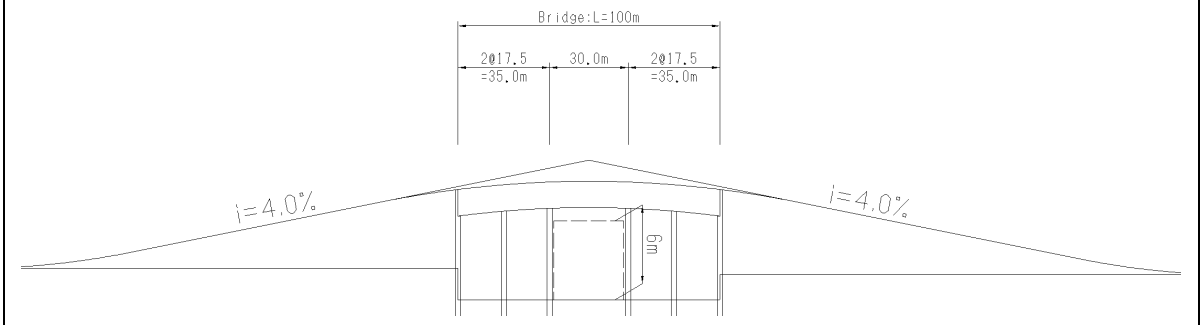
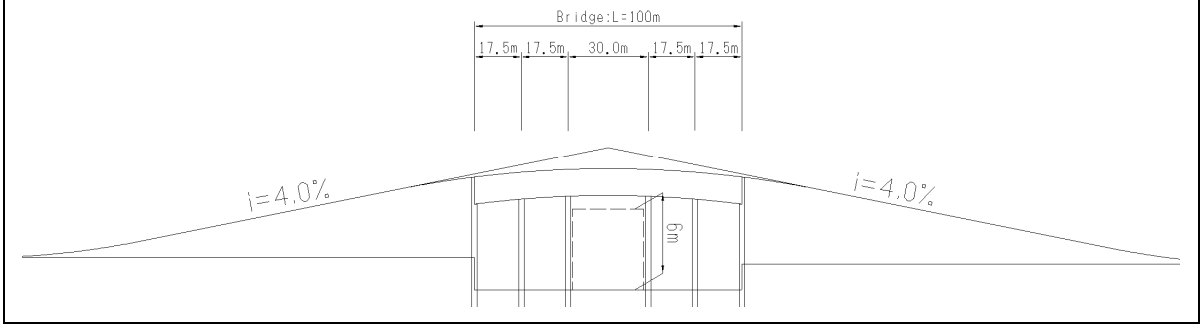
Source: JICA Survey Team

Figure 9.4-4 Sand Fill Plan and Seawall Structure

9.4.3 Selection of Alternative Plan for Bridge Span Split

The span split of the bridge is selected among the following three alternatives.

Table 9.4-1 Alternative Plans of the Bridge Span Split

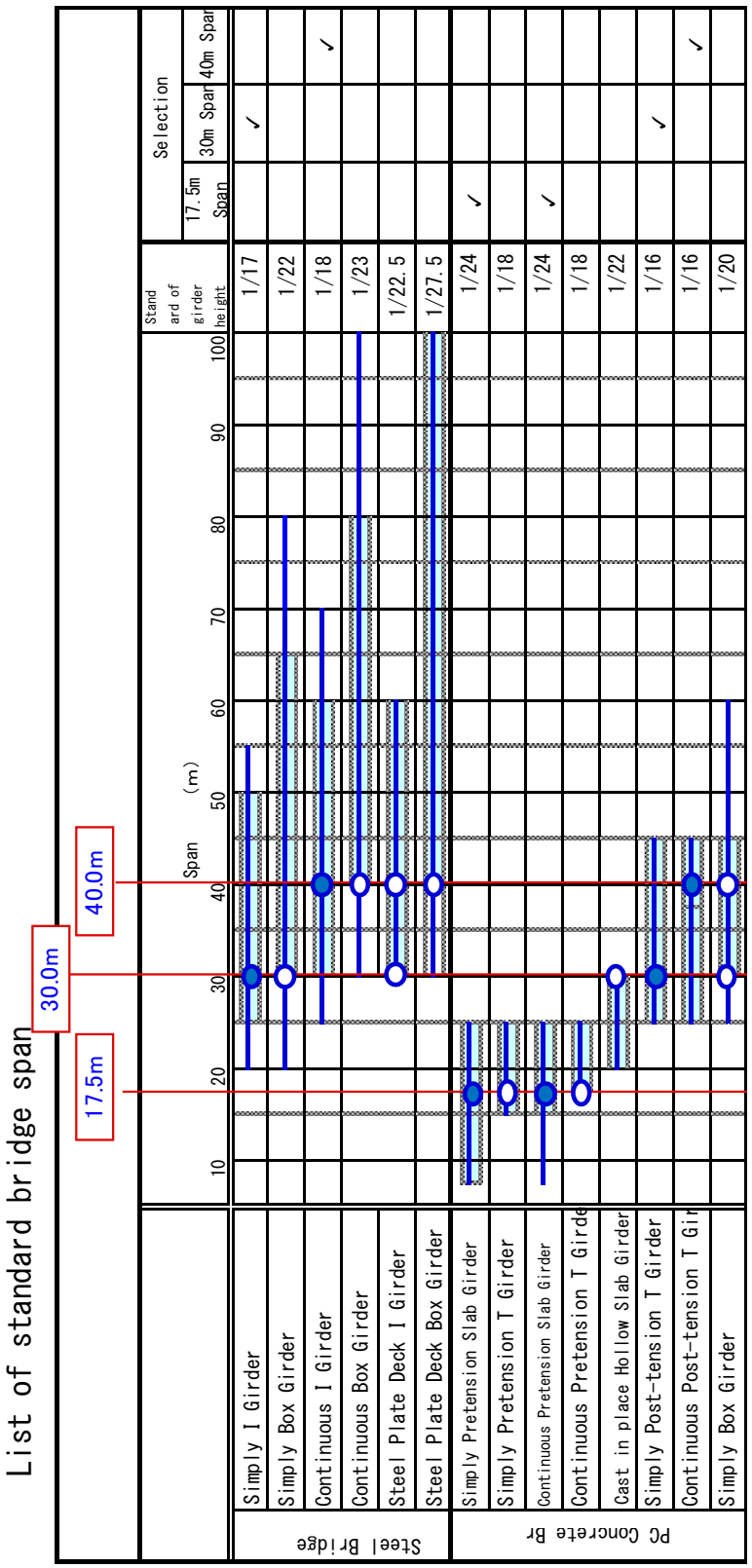
Alternative -A : Continuous three span

Alternative -B : Continuous two span + Simple one span + Continuous two span

Alternative -C : Simple span


Source: JICA Survey Team

9.4.4 Selection of Bridge Type

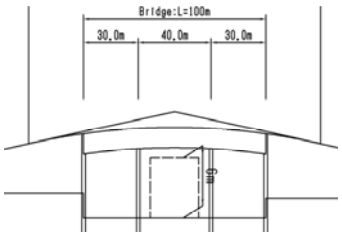
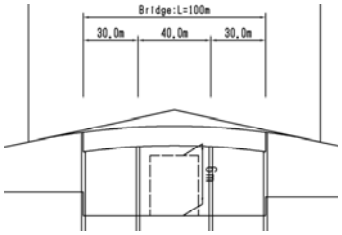
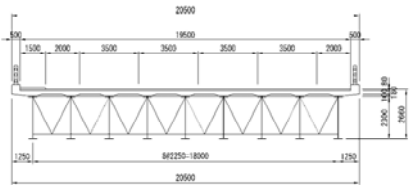
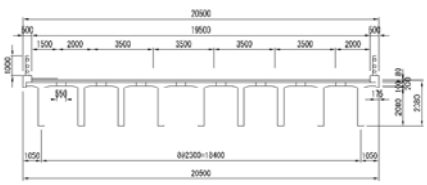
The bridge type was selected based on the list for this project shown below.

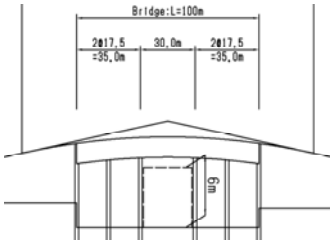
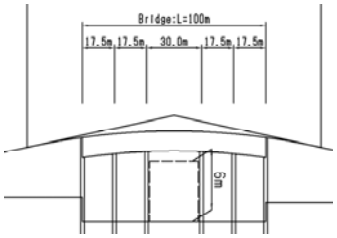
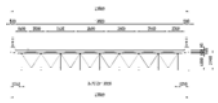
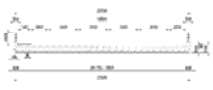
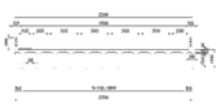
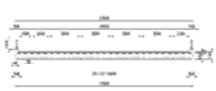
Table 9.4-2 List of Standard Bridge Span Length



Source: JICA Survey Team

Table 9.4-3 Selection of Bridge Type

	Alternative 1			Alternative 2		
Profile	Bridgelength L＝100m Span l＝30m+40m+30m 			Bridge Length L＝100m Span l＝30m+40m+30m 		
Cross Section	3 spans continuous non-composite RC deck slab steel plate girder bridge  Maximum hanging weight＝ 8.0 ton Structure height＝ 2.660 m			2 spans continuous post-tensioning PC T- section girder bridge  Maximum hanging weight＝ 119.0 ton Structure height＝ 2.380 m		
Evaluation	Constitutive property	This type is the application of a span and a common bridge types.	✓	Constitutive property	This type is the application of a span and a common bridge types.	✓
	Workability	Weight of steel girder is lighter than PC girder.		Workability	Weight of PC girder is heavier than Steel girder.	
	Runnability	It is advantageous than other alternative.	✓	Runnability	It is advantageous than other alternative.	✓
	Maintenance	This bridge type is needed repainting of coating.		Maintenance	This bridge type is not needed repainting of coating.	✓
		Superstructure : 472,000 JPY Substructure : 223,000 JPY Foundation : 27,000 JPY Total : 722,000 JPY (1.205)			Superstructure : 369,000 JPY Substructure : 203,000 JPY Foundation : 27,000 JPY Total : 599,000 JPY (1.000)	
					Recommend	

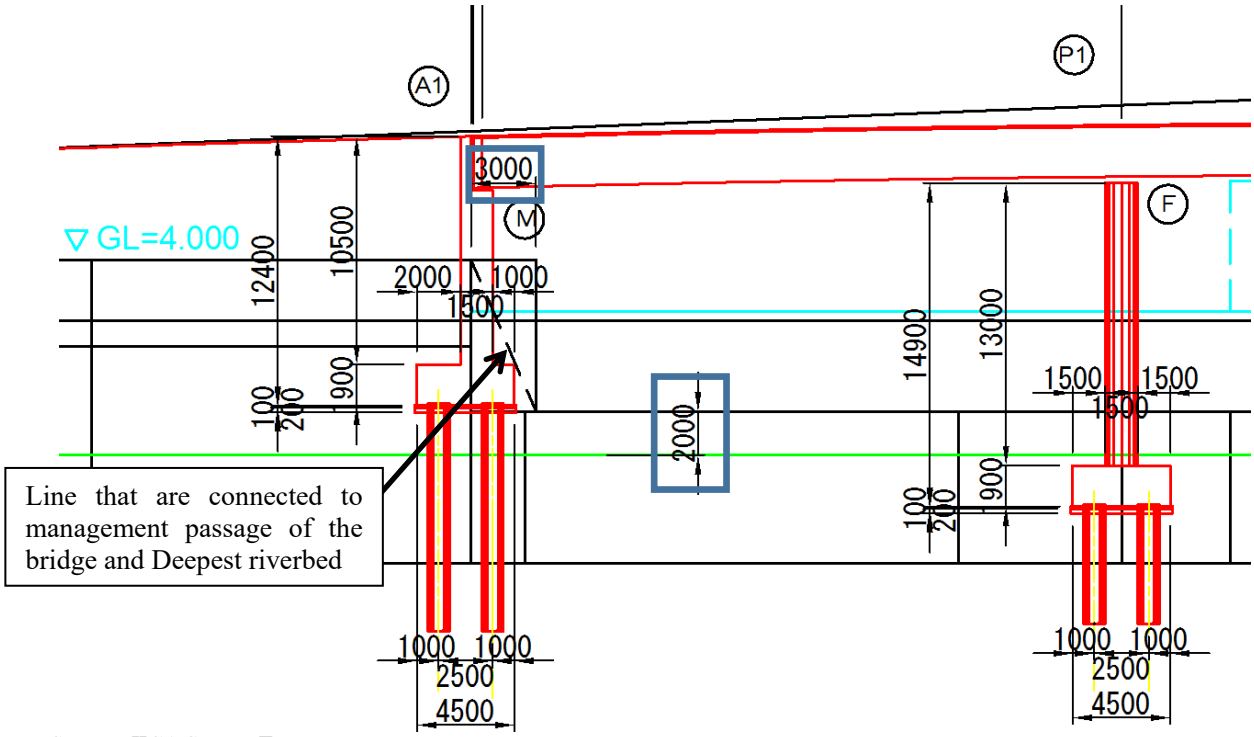
	Alternative 3			Alternative 4		
Profile	Bridge Length L＝100m Span l＝2@17.5m+30m+2@17.5m 			Bridge Length L＝100m Span l＝17.5m+17.5m+30m+17.5m+17.5m 		
Cross Section	spans connected pre-tensioning PC hollow-slab bridge  Maximum hanging weight＝ 13.0 ton Structure height＝ 0.730 m	Single span non-composite RC deck slab steel plate girder bridge  Maximum hanging weight＝ 8.0 ton Structure height＝ 2.160 m		Single span post-tensioning PC T-section girder bridge  Maximum hanging weight＝ 69.0 ton Structure height＝ 1.880 m	ingle span connected pre-tensioning PC hollow slab bridge  Maximum hanging weight＝ 13.0 ton Structure height＝ 0.730 m	
Evaluation	Constitutive property	This type is the application of a span and a common bridge types.	✓	Constitutive property	This type is the application of a span and a common bridge types.	✓
	Workability	The number of substructure is two more than the other alternative.	✓	Workability	The number of substructure is two more than the other alternative.	
	Runnability	It is disadvantageous than the other alternative.		Runnability	It is disadvantageous than the other alternative.	
	Maintenance	Steel girder of his bridge type is needed repainting of coating.But, PC girder of his bridge type is not needed repainting of coating.		Maintenance	This bridge type is not needed repainting of coating.	✓
		Superstructure : 323,000 JPY Substructure : 281,000 JPY Foundation : 40,000 JPY Total : 644,000 JPY (1.075)			Superstructure : 305,000 JPY Substructure : 300,000 JPY Foundation : 39,000 JPY Total : 644,000 JPY (1.075)	

Source: JICA Survey Team

9.4.5 Selection of Bridge Substructure

(1) Height of Substructure

Abutment and pier height will be set according to the rivers Construction Ordinance in Japan.



Source: JICA Survey Team

Figure 9.4-5 Position of Bridge Footing

※As a result, the height of abutment is planned at 12.4 m and the height of the pier is planned at 14.9 m.

(2) Type of Substructure

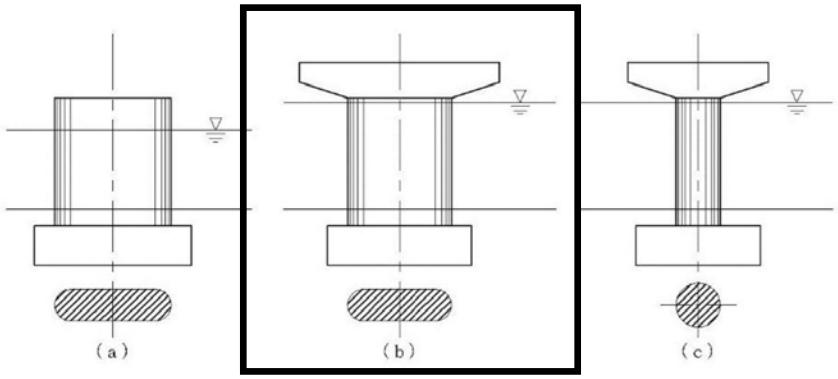
From our vast experience the "Reverse T type bridge abutment" was adopted after reference was made to the table below when the abutment height is at 12.4 m.

Table 9.4-4 Abutment Type and Adopted Height

Height / Type	12.4m				
	5	10	15	20	
Rahmen Type (15-25m)					
Box Type (12-20m)					
Reverse T-type (5-17m)			Adopt		
Gravity Type (5m 以下)					

Source: JICA Survey Team

Pier shape is the Oval shape (overhang shape) since H.W.L is low.



Source: JICA Survey Team

Figure 9.4-6 Position of Bridge Footing

(3) The Selection of the Foundation Type

At this stage, the Foundation type was adopted since it is most often accepted when the "cast-in-place pile φ1000 is being used. However, this should be considered again at the time of detailed design.

9.5. Future Road Plan for Connection to the New Container Terminal

9.5.1 Background of the Study

Currently, cargo trucks travels between Phnom Penh City and Sihanoukville Port via NR4.

The State Road (Tomnup Rolork Rd) is connected with an intersection as shown below. Its width is at about 4-5 m, and the pavement is constructed of DBST. Hence, it is inadequate for cargo trucks.

Source: JICA Survey Team

Figure 9.5-1 Current Major Road Map

Various discussions amongst Sihanoukville's MPWT and the JICA Study Team have taken place regarding the State Road shown above. The need for widening has been recognized by MPWT. However, the prospect to develop the State Road is impractical due to lack of budget. As a result of the

discussion, MPWT has stated that, they are only capable of performing maintenance if the budget is available.

Roadside commercial and residential areas will not be affected in most of the road sections when widening is carried out.

The possibility of new access road development for the purpose of increasing the dispersion of processing cargo vehicles will be considered in this project.

9.5.2 Policy of Future Road Plan

The majority of the sections will not be affected by the road widening. The only affected area is the Residential Area located on the existing road, in a section stretching a few kilometres closer to Sihanoukville Port.

Based on the above reasons, a bypass development plan is the policy for this section as a result of the improvement when the ease of maintenance is considered.

The bypass section with a major impact is shown below:

Source: JICA Survey Team

Figure 9.5-2 Section of Bypass Road

Considerations of carrying out the bypass plan are shown below.

- In order to implement the road development as early as possible, the road design has to be considered to minimize environment and social impacts.
- Adequate geometric configuration will be secured for the increasing number of cargo vehicles.
- A more effective connection will be made for access to the new port.
- National land which is parallel with the existing railway will be exploited as much as possible.

The bypass road development plan will be proposed on the basis of the considerations above.

9.5.3 The Proposed Design of the Future Road

(1) Design Criteria

Major design criteria are shown below:

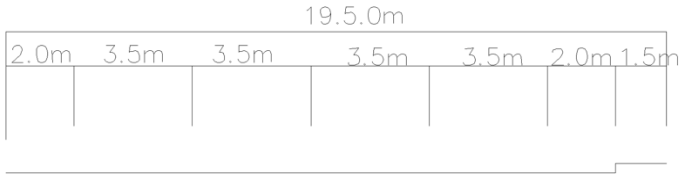
Table 9.5-1 Major Design Criteria

Road Class	R4
Design Speed	80 km/hr
Number of lanes	2×2 = 4 lanes
Width of Vehicle Lane	3.5 m
Maximum longitudinal slope	6%

Source: JICA Survey Team

(2) Proposed Cross Section

Width configuration required based on MPWT criteria is shown below:



Source: JICA Survey Team

Figure 9.5-3 Typical Cross Section of Future Road Plan

9.6. Design Drawings

9.6.1 Access Road and Bridges

(1) Plan Drawings

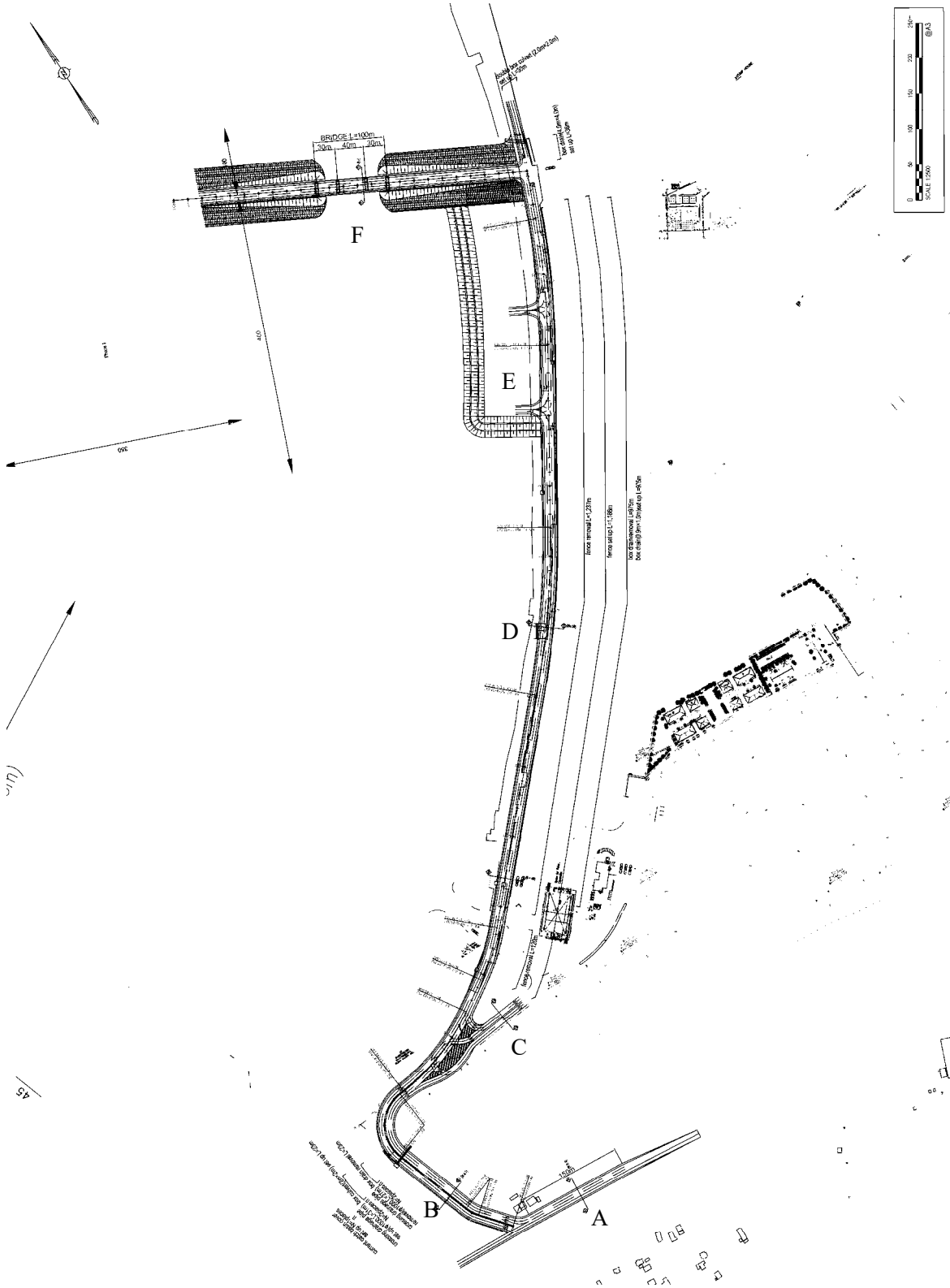


Figure 9.6-1 Plan Drawing

Source: JICA Survey Team

(2) Typical Cross Section Drawings

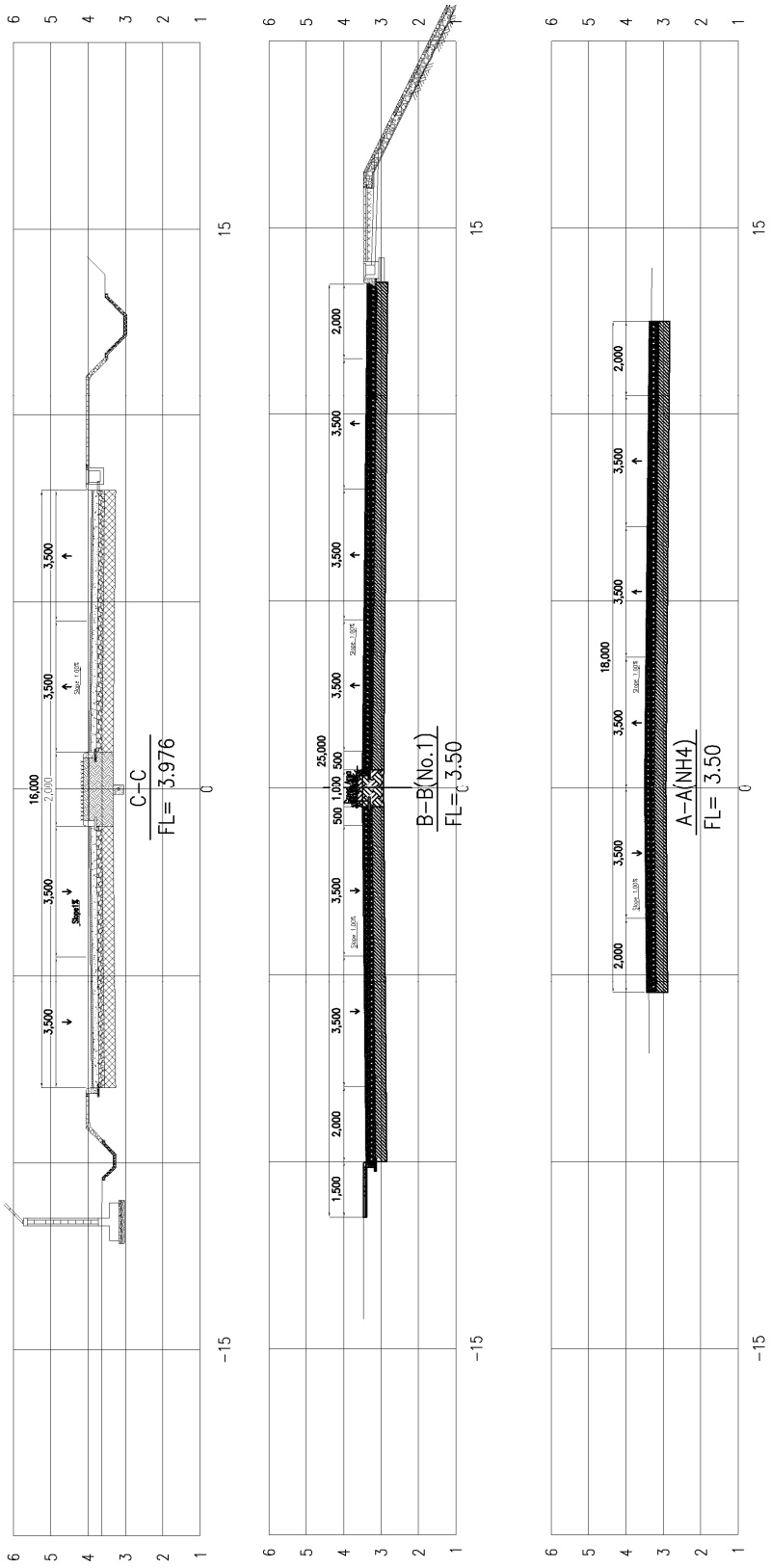


Figure 9.6-2 Typical Cross Section Drawings

Source: JICA Survey Team

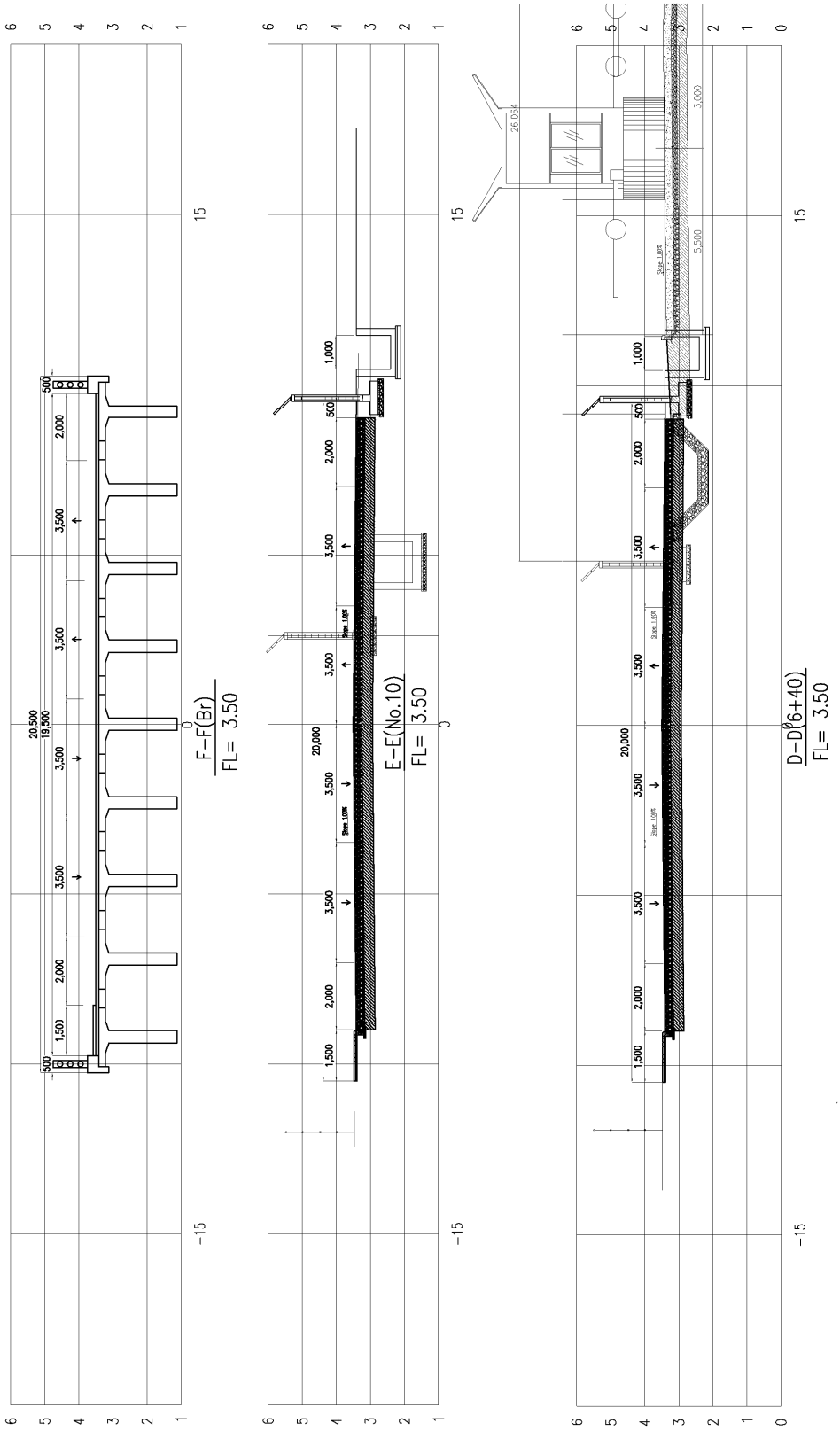


Figure 9.6-3 Typical Cross Section Drawings

Source: JICA Survey Team

(3) Profile Drawings

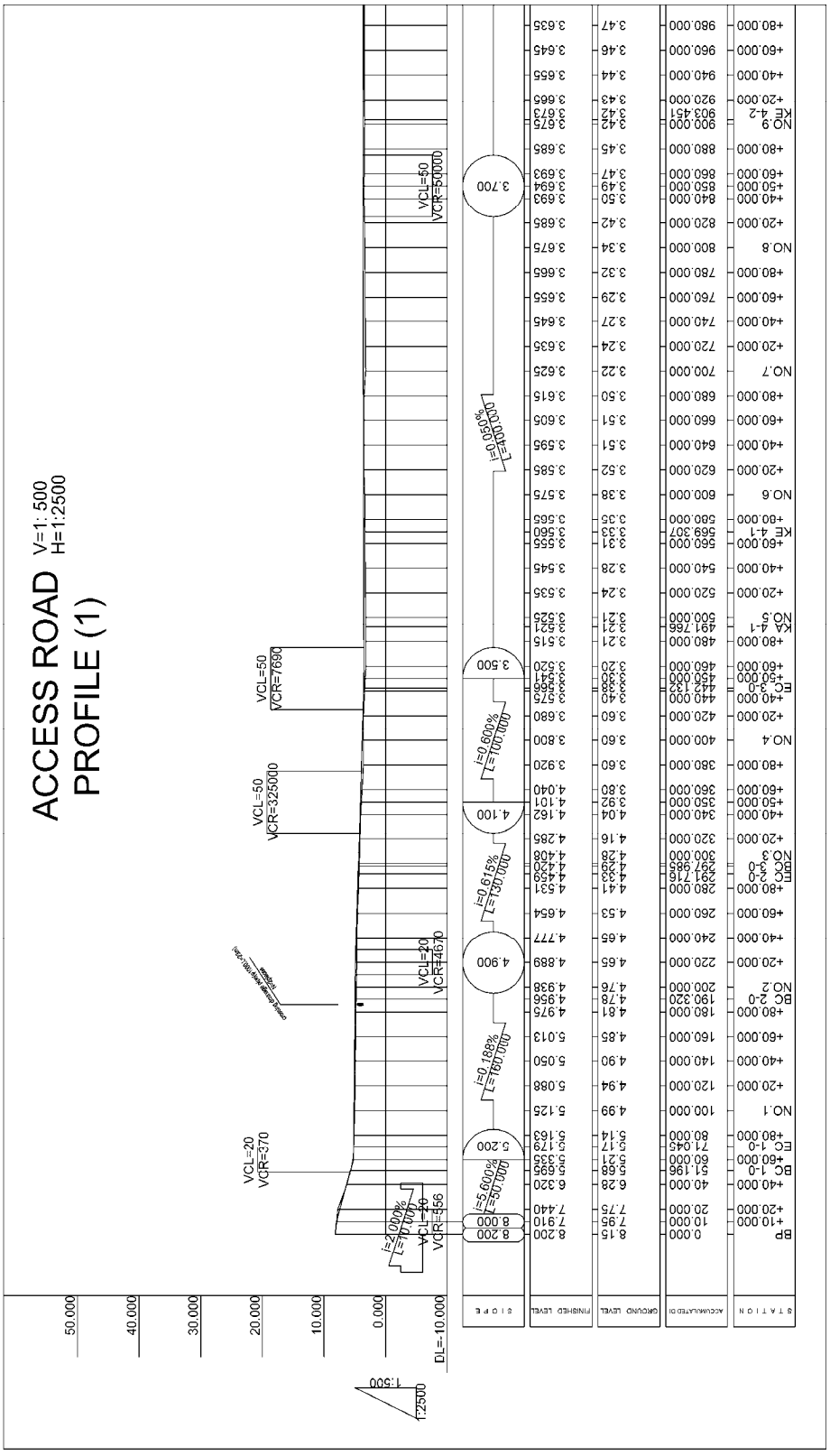


Figure 9.6-4 Access Road Profile (1)

Source: JICA Survey Team

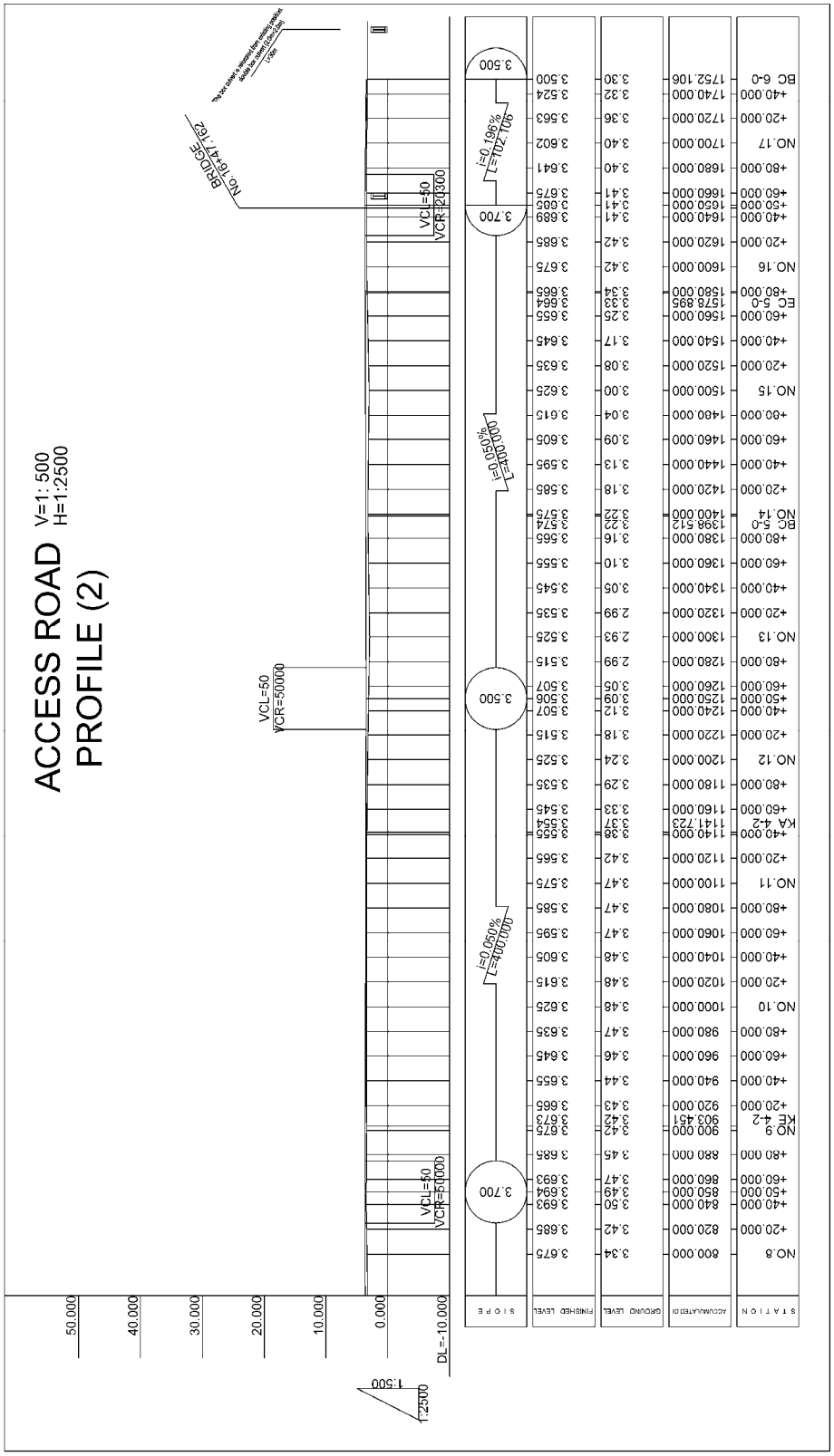


Figure 9.6-5 Access Road Profile (2)

Source: JICA Survey Team

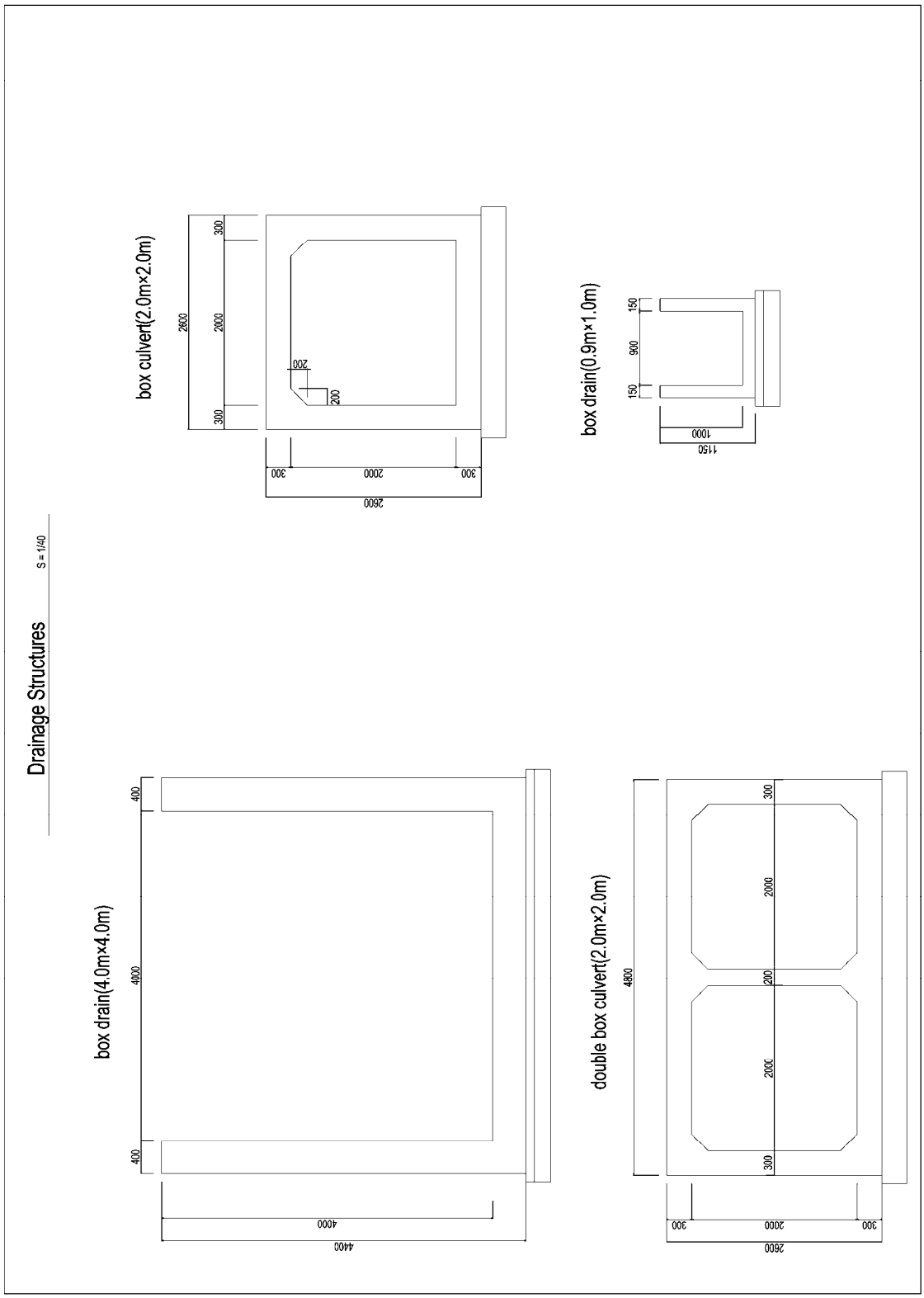


Figure 9.6-6 Drainage Structures

Source: JICA Survey Team

(4) Bridge General Drawings

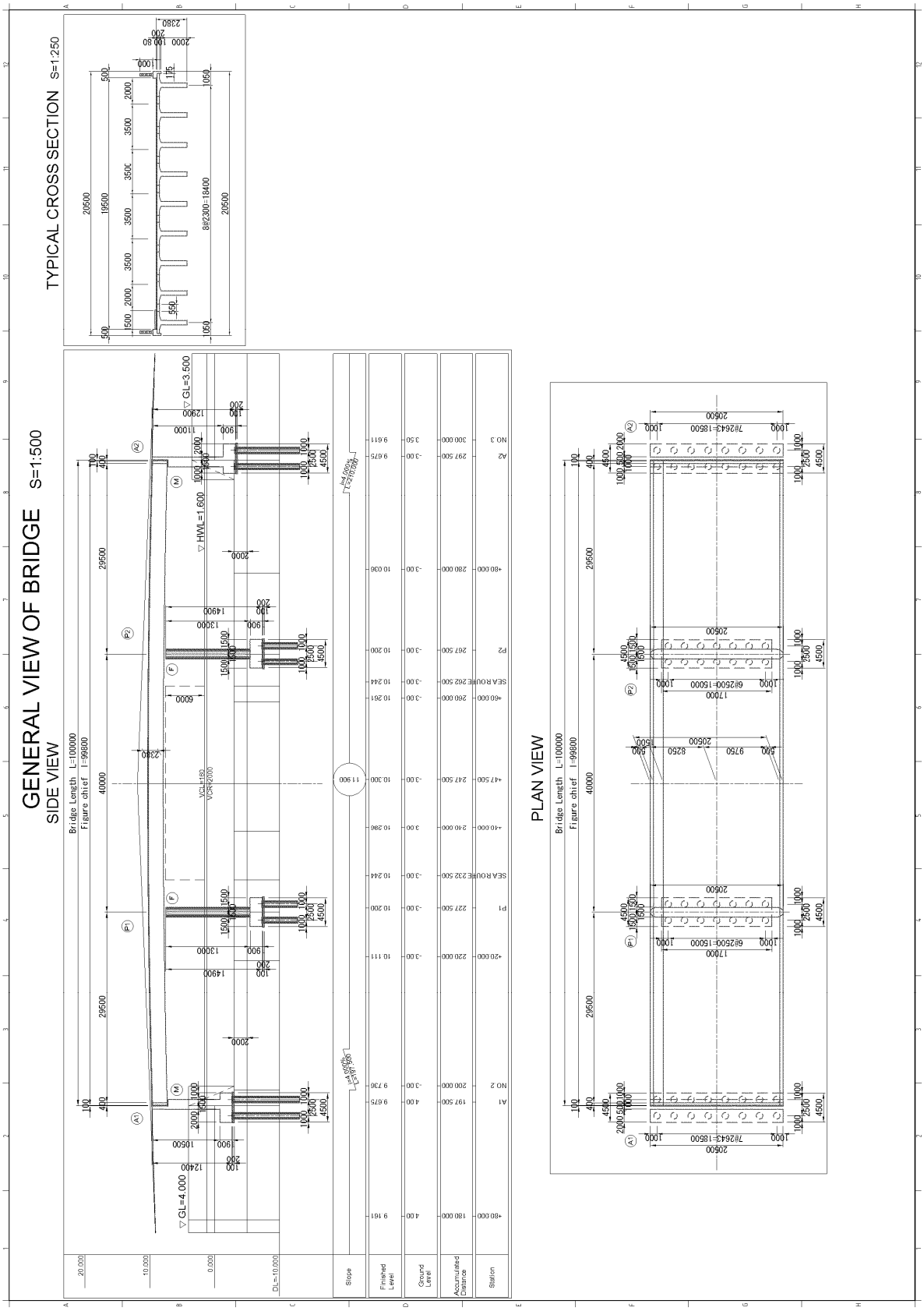


Figure 9.6-7 General View of Bridge

Source: JICA Survey Team

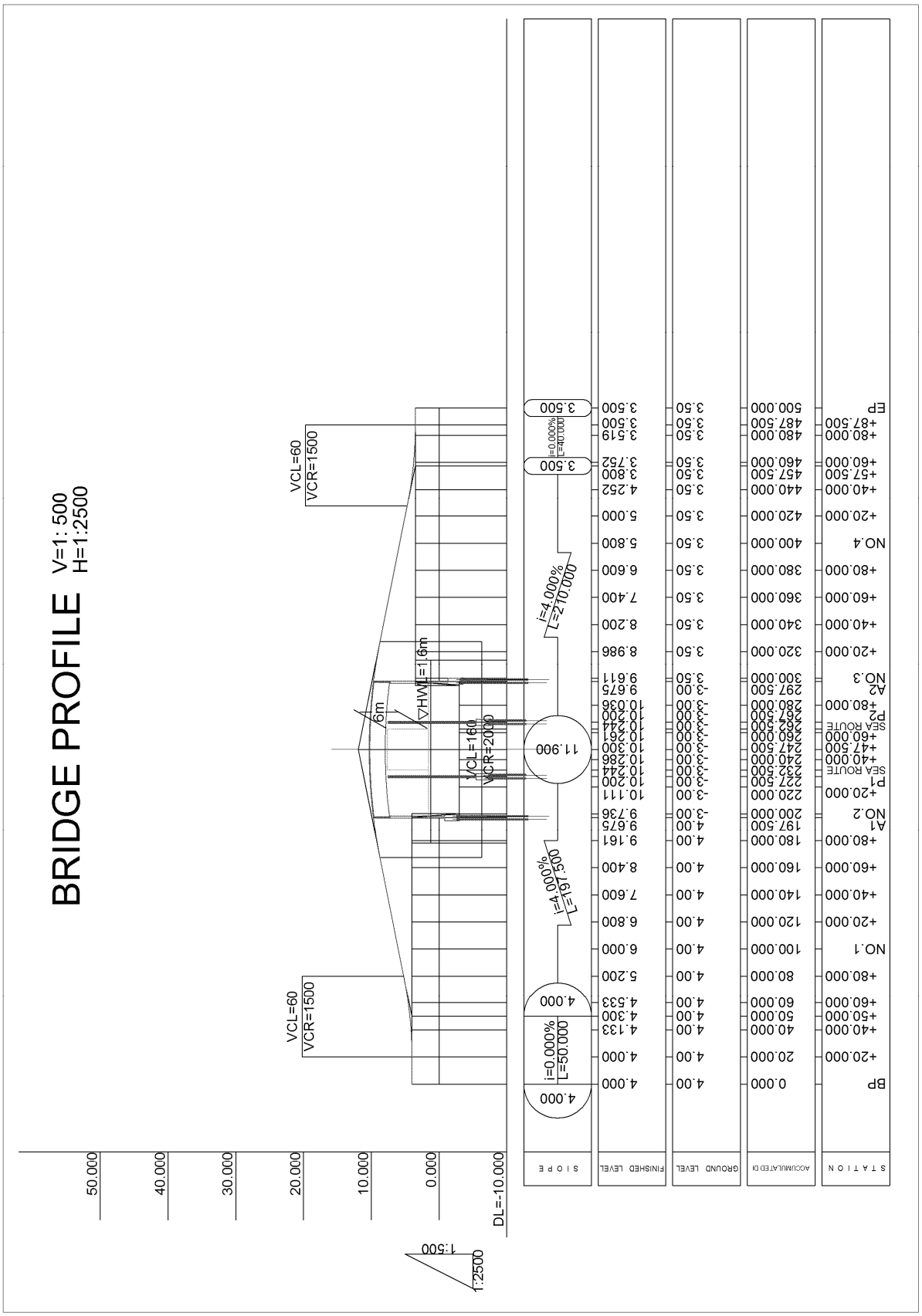


Figure 9.6-8 Bridge Profile

Source: JICA Survey Team

10. CONSTRUCTION PLAN AND COST ESTIMATE

10.1. Construction Plan

10.1.1 Construction Supervision Policy

A supervision policy for the construction is necessary for smooth construction progress by the comprehensive management as follows.

(1) Safety

According to "the Guidance for the Management of Safety for Construction Works in Japanese ODA Projects (September 2014)" by JICA, the basic principles of safety management during the construction works are the following 8 principles.

- Basic principle 1: Safety is a top priority

  All Project Stakeholders shall put top priority on safety and use their best endeavours to eliminate the occurrence of accidents.

- Basic principle 2: Elimination of causes

  The Contractor shall identify every possible danger in each process of construction work, and examine, analyse and eliminate the causes of such danger and take appropriate action to ensure the safe execution of the work.

- Basic principle 3: Thorough precautions

  The Contractor shall give consideration in advance to the inherent risk of accidents at each stage of construction work, review appropriate measures to cope with such risks, and commence work once these preventive measures have been implemented.

- Basic principle 4: Thorough compliance with relevant laws and regulations

  Relevant Laws and Regulations shall be complied with.

- Basic principle 5: Thorough prevention of public accidents

  All Project Stakeholders shall implement safety management measures taking the interests of third parties duly into consideration in order to prevent public accidents.

- Basic principle 6: Thorough implementation of PDCA cycle for safety management

  PDCA for Safety Management shall be complied with.

- Basic principle 7: Thorough sharing of information

  All Project Stakeholders shall share all safety-related information they possess in a manner and at times as appropriate in the circumstances.

- Basic principle 8: Thorough participation of all Project Stakeholders

  All Project Stakeholders shall actively participate in activities related to safety management at construction sites.

Moreover, in the Guidance, the Contactor shall prepare and implement a "Safety Plan" in the pre-construction stage and "Method Statements on Safety" in the construction stage.

(2) Quality (Management Based on the Specifications)

In the Package I, the Technical Specifications contain the materials, equipment, workmanship and quality control to cover major items of work contained in the Bill of Quantities of the contract. The Contractor shall conduct the quality control based on the Technical Specifications.

In the Package II, the Contractor shall fabricate the cargo handling equipment and provide customized software modules of the Terminal Operation System (TOS), based on the Contractor's technical design in the Contract.

The Contractor shall prepare and maintain a Quality Assurance Programme which is developed as appropriate to conform to ISO 9001 or equal approved.

The Quality Control Plan must contain a valid Quality Statement (signed by the Engineer) and set out the Bidder's organizational structure for the Contract, including the quality assurance and quality control organizational structures. The Quality Control Plan shall also contain specific quality procedures for all activities to be carried out during the execution of the Contract, together with specific work procedures that are necessary to fulfill the requirements of the Contract.

(3) Social Environment

There are three main environmental impacts to villager's lives during the implementation of the project as follows.

- Impact to Local Residents Living in the Coastal Area along the Access Road

  In the construction method of the access road expansion works, it is necessary for reducing traffic congestion as follows.

  1) Reclamation filling, a volume of 700,000 m^3 of purchased sand material is estimated to require more than 50,000 truckloads for transport to the reclamation area. In the case of land transport by trucks, serious traffic congestion would occur on the existing roads around Sihanoukville Port. Therefore, the sea transport instead of the land transport must be the method for the reclamation works.
  2) During the access road works, a traffic road (2 lanes) at least 7 wide is necessary for the solution of the traffic congestion problem. Therefore, in the construction of the road expansion works (20m of width), a half road width (10m) shall be constructed for first stage work, and then, the remaining half of the road width (10m) shall be conducted in the second stage work

- Impact to Small and Medium Type Boats Utilizing the Existing Port

  For safety management, during the access road and bridge works, small and medium type cannot be allowed to pass through the construction area for the access road and bridge works.

- Impact to Aquaculture in the Port Area

  Countermeasures to reduce the burden on the environment to minimize the impact to aquaculture during the dredging/reclamation works are:

  1) Due consideration to environmental monitoring systems of turbidity must be paid for the dredging/reclamation works in view of minimizing the effects on the environment.
  2) One of the popular methods of pollution and turbidity prevention is to set up steel frames in front of the dredger, attach silt curtains to the frames and then conduct dredging inside the curtains. The curtain length shall be determined by considering the turbidity spread in neighboring waters.

(4) Construction Schedule

Based on efficient construction methods, the Contractor shall prepare a comprehensive construction schedule to indicate major work activities for the execution of the works in their sequence order and expected duration, sequence and inter-relationships of all major operations or construction activities.

The construction schedule shall clearly show, but not be limited to the following views and work activities and shall be supported by a time schedule for equipment and manpower utilization and other relevant supporting data or statements, etc.

1. Mobilization and Demobilization Schedule
2. Procurement and Delivery of Major Construction Materials
3. Sequence Order and Duration of Major works
4. Indication of Works executed by Joint Venture Partners and Sub contractors.
5. Critical Construction Operations or Activities
6. Timing for Site Delivery of Materials.
7. Timing ready for connection of utilities.
8. Time for Sectional Completion, if any.
9. Testing and Commissioning Schedule
10. Time Completion of the Whole of works

The Contractor shall prepare his proposed equipment and manpower utilization schedule as supporting documents in separate forms. The utilization schedule shall be prepared in the time frame schedule, fully describing the number required for each piece of equipment for each type and/or capacity to be utilized and the number of workforce for each category of manpower with identification of foreign/local and skilled/unskilled utilized in major work activities.

The Construction Schedule shall be prepared in the form of an arrow diagram by adoption of the Critical Path Method (CPM) or Program Evaluation and Review Technique (PERT) or other appropriate system proposed by the contractor with necessary indications of milestones for construction activities as enumerated above.

10.1.2 Examination of Technical Issues of Construction

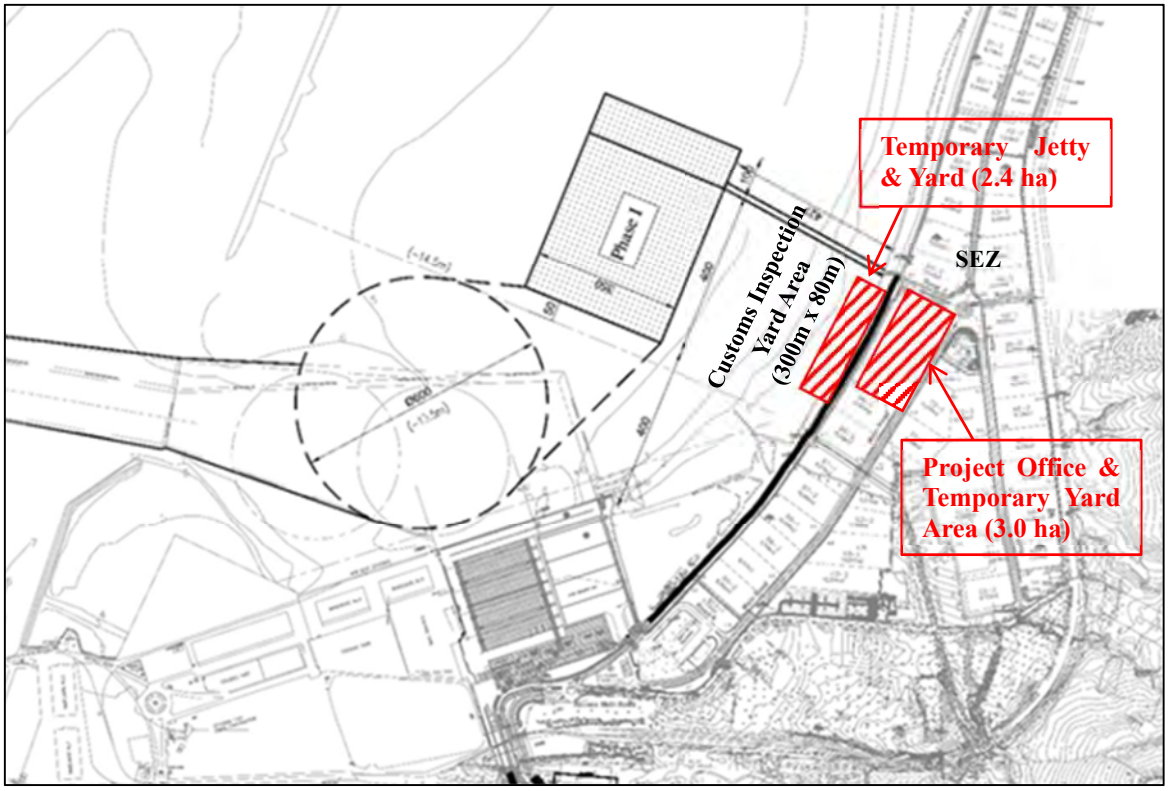
1) Arrangement of a Temporary Yard for the Construction (Storage Yard for Materials, Equipment, etc.)

Temporary yard (total area: 5.4 ha) is necessary for storage of materials, equipment, project office etc. as follows

- Steel pipe pile and strut steel pipe stock yard: 1.5 ha,
- Fenders, bollards, ladders, filter sheets and access bridge materials: 1.0 ha,
- Production yard of wave dissipating concrete blocks: 0.5 ha,
- Stone, gravel and sand material stock yard: 1.0 ha,
- Land construction equipment and workshop: 0.5 ha,
- Temporary Jetty: 0.6 ha, and
- Office and others: 1.3 ha

Location of the temporary yard is described in the Figure 10.1-1.

The project office and temporary yard for land construction equipment, fender, bollard, ladder, filter sheet etc. will be in the SEZ area because it is a safety and secure area. And the customs inspection area before X-ray installation is in a very good position regarding the temporary jetty and stock yard and the smooth access from the existing road.



Source: JICA Survey Team

Figure 10.1-1 Location of Temporary Yard and Project Office Area

2) Production and the Transport Periods of the Steel Pipe Piles, and the Establishment of Implementation System for Heavy-Duty Anticorrosion in the Splash Zone by Shop Fabrication

According to a large Japan-based Steel Manufacturer, the following steel pipe piles can be fabricated in Vietnam's steel mill and transported from Vietnam to Sihanoukville Port within 4.5 months. However, the following strut steel pipes can be only fabricated in Japan.

Table 10. 1-1 Steel Pipe Piles and Strut Steel Pipes for foundation of Berth

Description	Weight (Ton)	Quantity (Pieces)
Steel Pipe Pile (1000 mm, t=16 mm, L=30～37.5 m)	1,005	75
Steel Pipe Pile (900 mm, t=16 mm, L=30～37.5 m)	4,516	375
Strut Steel Pipe (5.2 ton/set x 50 sets)	260	
Total	5,521	450

Source: JICA Survey Team

Strut Steel Pipes that have been subjected to a heavy-duty corrosion-resistant treatment have a thick-film lining (2 mm or thicker) of a urethane elastomeric material to sustain the corrosion resistance for a long period of time. They have stable quality because the lining application is carried out in the factory under strict quality control.

In the case of the Steel Pipe Pile, after driving the piles, divers will install the "FRP Cover on Petrolatum Lining" in the splash zone area of the steel pipe piles.

3) Quarry Location for the Armor Stone of Revetment Material, Gravel for the Concrete and Crusher-Run Stone for the Pavement

The armor stone for the revetment material, gravel for the concrete, and crusher-run stone for the pavement is only available at a far distance from the project site. The existing quarry site is in the area of Phnom Penh approximately 150 km away from the construction site on national road, Route No. 4. This is a possible source for this New Container Terminal project.

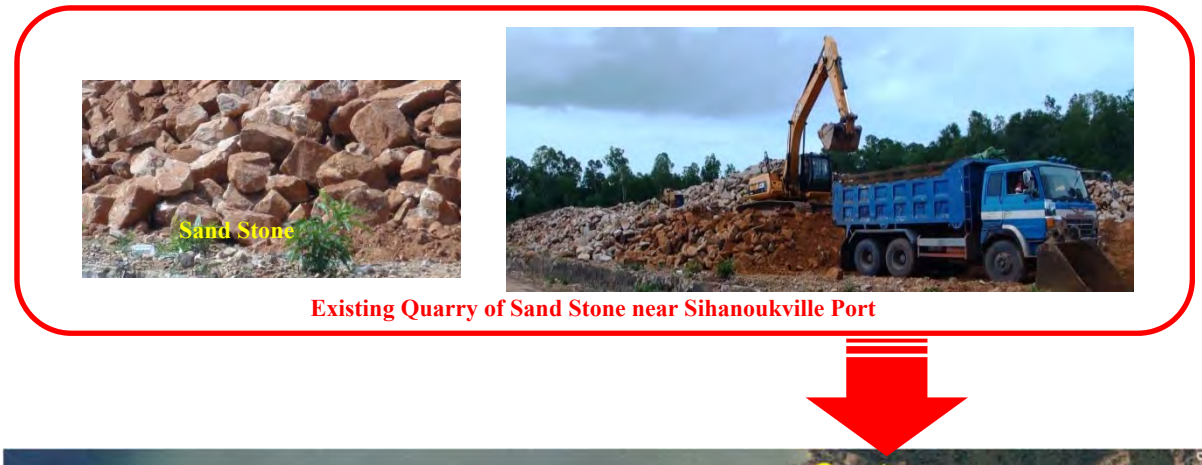
Quarry with Stone Crusher in Kampong Spue for armor stone of revetment material, gravel of concrete and crusher-run stone of pavement

Source: JICA Survey Team

Figure 10.1-2 Location of Quarry Site for Armor Stone and Gravel for Concrete

More than 25 stone and gravel quarries with stone crushers are operating in Kampong Spue Area. According to the stone/gravel suppliers, the stone transport trucks from the quarries to Sihanoukville use the empty trailer trucks after returning the full container trailer trucks from Sihanoukville Port to Phnom Penh.

On the other hand, an existing Sand Stone quarry is located near Sihanoukville Port, only 2.6 km away which is shown in the following.



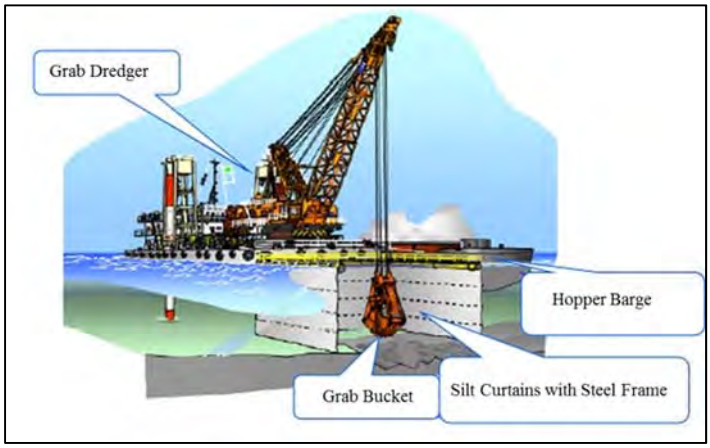
Source: JICA Survey Team

Figure 10.1-3 Location of Sand Stone Quarry Site

4) Arrangement of the Disposal Area for the Dredged Materials and the Countermeasures for the Environmental Considerations

Main dredging works are required to excavate the seabed to the level of -13.5 to -14.5 m depth at the port basin, approach channel and berth box and total dredging volume is 3.977 million m^3 including 173,000 m^3 of Weathered Rock and 27,000 m^3 of Rock (Grade III Rock).

Grab bucket and trailing suction hopper are applicable methods of dredging in this project and, in the view of the environmental consideration and dredging cost estimation, the use of grab bucket in combination with hopper barges is applied to this dredging operation, the dredging vessel is to be out-fitted with silt protection sheets and the excess water in the hopper barges is strictly controlled to prevent spilling out into the sea water.



Source: Ministry of Land, Infrastructure, Transport and Tourism of Japan (MLIT)

Figure 10.1-4 Grab Dredging with Silt Curtains

In the case of dredging of Weathered Rock and Rock (Grade III Rock), grab dredger can dredge rocks using an attached drop chisel as shown in the following Figure 10.1-5. A considerable volume of dredging work is needed to complete project. Dredged marine subsurface deposits deems unsuitable for use as filling materials for reclamation in areas with heavy live loads due to the large contents of fine materials. However, for cost saving purposes, dredged materials (Sand, Weathered Rock and Rock) can be used in the Terminal reclamation area. It is estimated that this would amount to about 800,000 m^3.

Grab Dredger with Silt Frame loading dredging soil onto a hopper barge

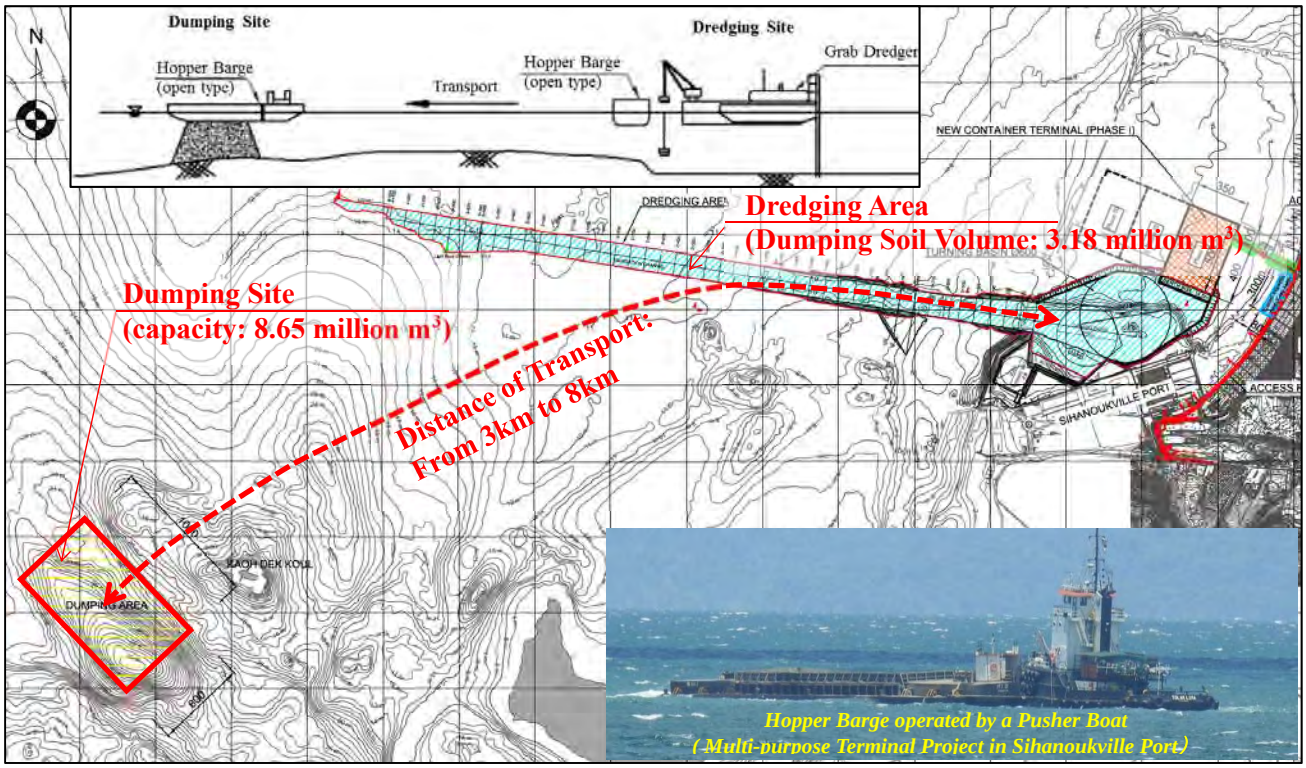
Rock breaking with a rock breaker drop chisel

Source: Handbook for Execution of Port and Harbour Works, SCOPE

Figure 10.1-5 Grab Dredging with Hopper Barge and Rock Breaking Operation

Hopper barges equipped with bottom openings will facilitate the disposal of dredged soils into water in mass form so as to minimize the dispersion of finer materials at the dumping site. One possible offshore site near Deck Koul Island for dumping dredged soils is recommended as shown in Figure 10.1-6.

The dumping site was approved by MOE in the EIA of the Sihanoukville Port Urgent Rehabilitation Project in 1997 because it was deeper than 25m, it was near the dredging area and in a non-fishing activity area. In the regulation for dumping sites, the seabed must be greater than 20m in depth.



Source: JICA Survey Team

Figure 10.1-6 Dumping site for the Dredged Materials

Environmental monitoring is scheduled during the dumping operation of the hopper barge as well as near the suitable locations near Dek Koul Island and Kaoh Poah Island.

5) Quarry Site for the Reclamation Materials and Setting of the Construction Periods and Equipment Arrangement based on the Supplying Capacity;

Preliminary volume of reclamation work for the container terminal is shown in Table 10.1-2.

Table 10. 1-2 Preliminary Volume of Reclamation

Reclamation of Dredged Materials	800,000	m^3
Reclamation of Sand Materials (including settlement volume)	700,000	m^3
Total	1,500,000	m^3

Source: JICA Survey Team

The fill soils for reclamation will be obtained from a river sand borrow pit located at Sre Ambel, about 68 km distance from the project site. Revetments will be constructed to enclose the area to be reclaimed in advance of starting reclamation works as follows.

Source: JICA Survey Team

Figure 10.1-7 Borrow-pit Location and Reclamation Method

Based on the previous section 8.3.1, the average consolidation settlement of reclamation is estimated at approximately 0.5 to 0.6 m. However, in the detail design stage of this project, the settlement analysis shall be conducted using the actual monitoring data of settlement in the Multi-Purpose Terminal Project. Moreover, during the reclamation works, settlement plates shall be installed in the reclamation area and periodic monitoring conducted.

6) Securing Navigation Safety between the Fishing Boats and the Construction Working Vessels during Jetty, Dredging and Reclamation Works.

Work vessels need to take precautions to assure safe navigation of fishing boats and avoid collisions with other work vessels, for example, by clearly marking locations of mooring anchors of the work vessels to let fishing boats know the presence of the anchors.

Work vessels must keep work beacon lights and anchorage lights turned on without fail during night time work.

a) Methods for securing and indicating the work area shall be determined upon consultation with PAS, the harbour master and other relevant organizations, and made widely known to relevant organizations prior to the work by using weekly meetings, posters and other means.

b) During work execution, the conditions for permission and instructions by the authorities for the area shall be complied with. If any failure occurs such as malfunction of a light buoy or sign, a report shall be made immediately to the relevant organizations and prompt action taken to remedy it.

c) Work vessels shall display signs consisting of lights and markers specified by laws and regulations for each work operation such as towing.

d) Watch boats shall be employed as needed for securing the work area, such as during towing and other works.

10.1.3 Construction Supervision Plan

Main works in the project are the marine civil work (dredging, reclamation, berth construction) and the access road/bridge work. Therefore, a civil engineer (with experience in large-scale marine civil projects) will be stationed as resident engineer who will coordinate and make the technical assistance regarding the construction planning for the Cambodian side. Moreover, in the project staff planning, the geotechnical/soil improvement expert will estimate the soil settlement in the reclamation and conduct the forecast of settlement in various periods, and plan the design for the pavement in the container terminal yard. And in the other key staff plan, the road/bridge engineer will make accurate judgment for bridge foundation work and bridge temporary work in the access road/bridge work.

The details of the construction supervision plan are described in the following Section 10.2.1.

10.1.4 Procurement of Construction Material and Equipment

10.1.5 Construction Schedule

10.2. Construction Plan

11. ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

11.1. Summary of the Proposed Project

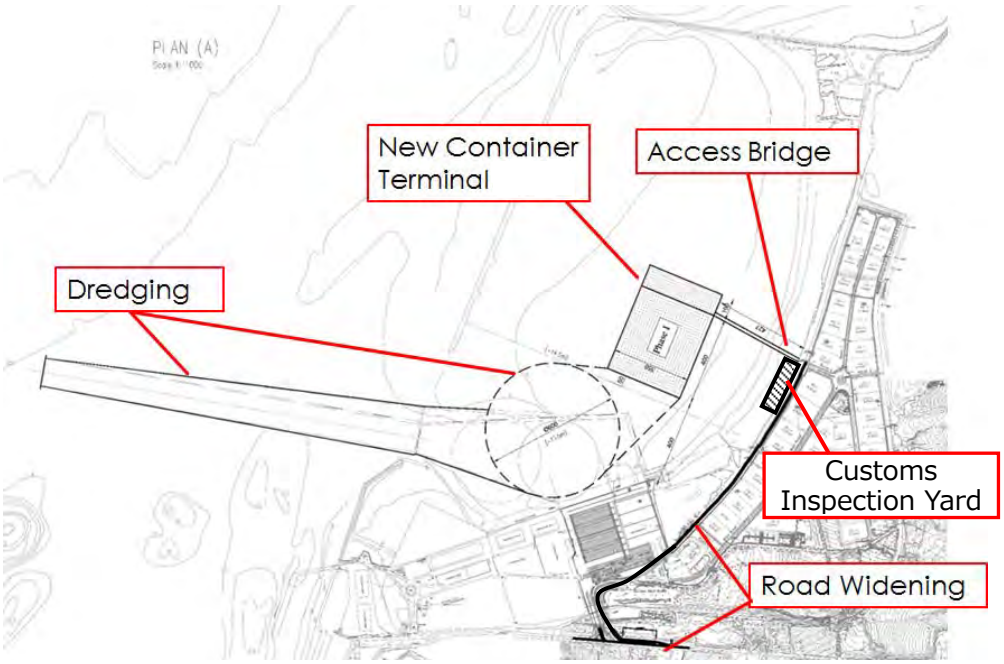
11.1.1 Items of the Proposed Project

The items of the proposed project and its location are shown in Table 11.1-1 and Figure 11.1-1.

Table 11.1-1 Items of the Proposed Project

No.	Items	Details
1	Development of new container terminal	Size of berth: 350 m x 500 m
2	Development of access road	Road widening
3	Dredging of access channel and turning basin	Dredging volume: about 4 million m^3
4	Construction of administration building and maintenance building	- Administration building - Maintenance building - Water supply and electrical works
5	Construction of Customs Inspection Yard	Near access bridge

Source: JICA Survey Team



Source：JICA Survey Team

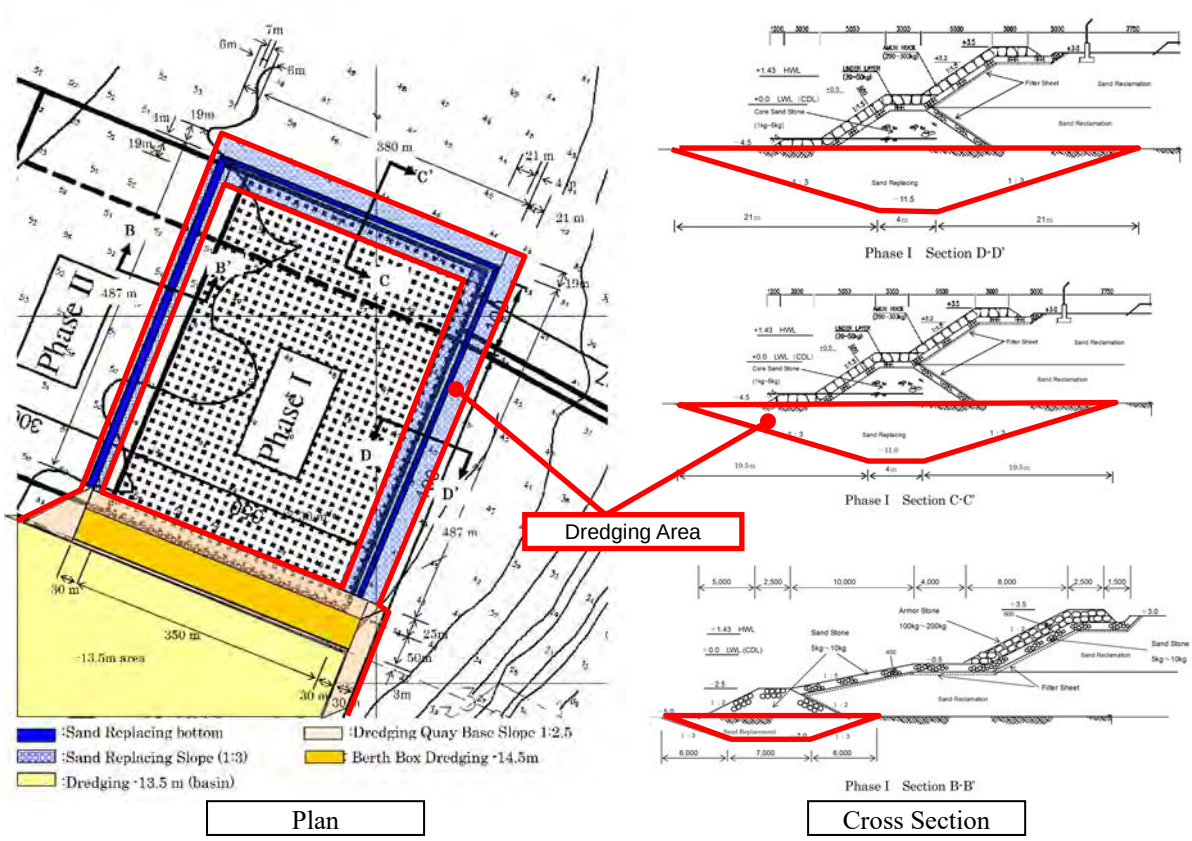
Figure 11.1-1 General Layout Plan

11.1.2 Main Construction Works of the Proposed Project

The main construction works of the proposed project, which might give impact on the surrounding environment, are as follows:

(1) Base Dredging Works for the New Container Terminal

The sea bottom, where the new container terminal will be constructed, consists of soft layer surface. The soft layer in the construction area of quay and seawall will be dredged and replaced with sand to secure the stability of structures as shown in Figure 11.1-2. The total dredging volume is 0.3 million m^3.



Source: JICA Survey Team

Figure 11.1-2 Plan and Cross Section of Sand Replacement and Seawall Structure

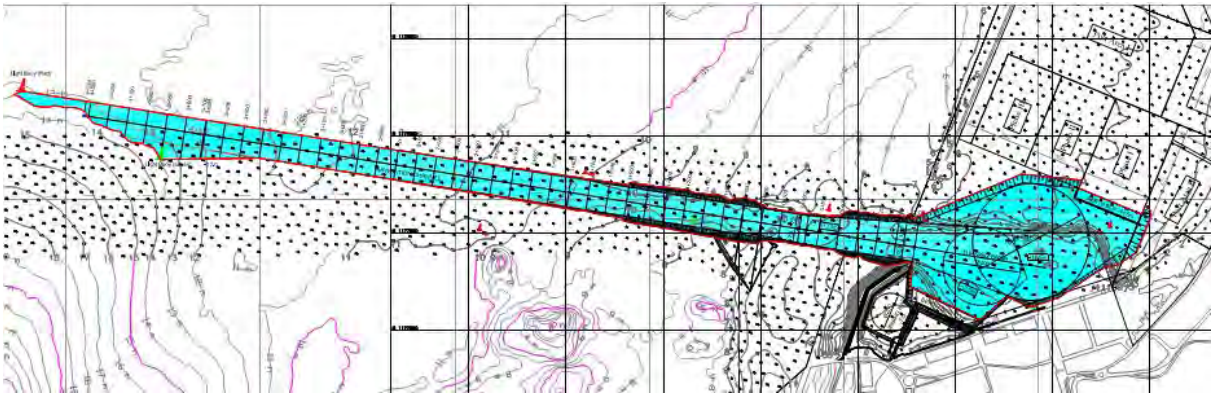
(2) Spillway of Reclamation Works for the New Container Terminal

The new container terminal will be developed through reclamation of a 350 m by 500 m area. The land volume for reclamation is 1,500,000 m^3. The 47% of land reclamation materials will be brought from the mountain side or river in the suburbs of Preah Sihanouk City, similar to the ongoing Multipurpose Terminal Development Project (hereinafter referred to as MPT Project). The remaining 53% of land reclamation materials will be reused dredged soil with more than 80% sand content.

The water discharged from spillway of the reclamation area will include sediment, and treatment to reduce sediment discharge is necessary. The details will be proposed by the contractor in the construction phase.

(3) Dredging Works for the Access Channel and Turning Basin

The access channel and turning basin will be dredged to accept larger vessels. The dimension is 4.5 km in length and 150 m in width as illustrated in Figure 11.1-3. The design depth is construction datum level (CDL) -13.5 m. The berth box will also be dredged to depth of CDL -14.5 m. The total dredging volume will be 4.0 million m^3.



Note: The dredging area is colored blue.
Source: JICA Survey Team

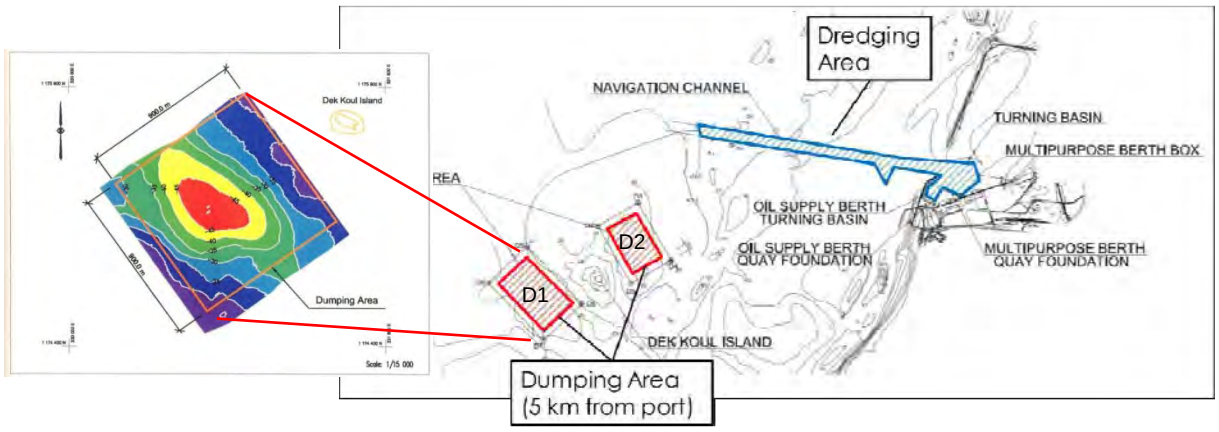
Figure 11.1-3 Layout Plan of Dredging

(4) Dumping Works for Dredged Materials

The dredged sediments will be disposed at the two designated dumping sites, which are also being used on the ongoing MPT Project. The dumping sites are located 5 km west of the port as shown in Figure 11.1-4.

The deep spots were designated as dumping sites. The deeper site D1 is the main dumping site with depth of CDL -52 m. The space from the sediment to CDL -20 m is designed as the capacity. The total capacity is 10.3 million m^3, and the designed dumping volumes of MPT and the new container terminal projects are 1.3 million m^3 and 3.2 million m^3, respectively. Therefore, the remaining capacity will be 5.8 million m^3 at the completion of the proposed project. The D2 site will be full after MPT Project, and will not be utilized in the new container terminal project.

The details of dumping works will be studied in the detailed design stage.



Source: JICA Survey Team

Figure 11.1-4 Location Map of Dumping Sites

11.1.3 Clarification of Environmental Category under JICA Environmental Guidelines

The project is not likely to have significant adverse impact on the environment in terms of its sectors, characteristics, and areas. Therefore, the Japan International Cooperation Agency (JICA) classified the proposed project as "Category B" under the JICA Guidelines for Environmental and Social Considerations (hereinafter 'JICA Guidelines') (April 2010). The Category B means that:

The Category B projects' potential adverse impacts on the environment and society are less adverse than those of Category A projects. Generally, they are site-specific; few if any are irreversible; and in most cases, normal mitigation measures can be designed more readily.

11.2. Legal Framework Related to Environmental and Social Consideration

11.2.1 Environmental Aspect

(1) Main Laws, Regulations, Standards, and Guidelines

The Law on Environmental Protection and Natural Resource Management (1996) is the primary source of guidelines for environmental legislation in Cambodia. It deals with pollution, environmental impact assessment, environmental planning, and natural resource management.

Relevant environmental laws and regulation in Cambodia are listed in Table 11.2-1.

Table 11.2-1 Legal Framework Related to the Environmental Aspect in Cambodia

Title	Provisions
Basic Law	
Law on Environmental Protection and Natural Resources Management (1996)	Development of national and regional environmental plans; environmental impact assessments; natural resources management; environmental protection; monitoring and inspection; public participation and information disclosure; environmental endowment funds; and penalties.
Institution	
Sub-decree on Organization and Functions of Ministry of Environment (1997)	National environmental plan and regional environmental plans are required to be drawn up, reviewed, and revised once every five years. The functions and structure of the MOE and the function of each of the seven departments. Each provincial level authority and district is to establish a department of environment and a district agency of environment, respectively.
Declaration on the Organization of the Provincial and Municipal Environment Department (1999)	Provincial and municipal responsibilities in environmental management. Illegal activities carried out in national protected areas, inspection and monitoring of pollution sources, environmental education programs, and data management.
Environmental Impact Assessment (EIA)	
Sub-decree on the Environmental Impact Assessment Process (1999)	The project owner shall conduct an initial environmental impact assessment (IEIA) for a project to determine whether an EIA is required. If a project requires a full-scale EIA report as judged by the MOE, a project owner shall conduct and submit the EIA report. MOE has the responsibility to evaluate and review the IEIA/EIA reports.
General Guideline for Conducting Environmental Impact Assessment Report (IEIA/EIA) (2009)	The project's owners should prepare an EIA report with at least the following contents: (1) Project Summary, (2) Introduction, (3) Purpose of the Project, (4) Project Description, (5) Description of Environmental Resources, (6) Public Participation, (7) Environmental Impact Analysis, (8) Environmental Impact Mitigation Measures, (9) Economic Analysis and the Environmental Value, (10) Environmental Management Plan, (11) Institutional Capacity, (12) Conclusions and Recommendations, and(13) References.
Registration of Consultancy Company for Preparation of Environmental and Social Impact Assessment (2014)	EIA report for all development projects in Cambodia should be prepared only by consultants authorized by MOE and should obtain approval from MOE before starting any construction work.
Pollution Control	
Sub-decree on Water Pollution Control(1999)	Standard for effluent discharge from any source of pollution and public water is stipulated. MOE has responsibility for monitoring of pollution sources and the situation of the water pollution in public water bodies.
Sub-decree on Solid Waste Management(1999)	MOE shall establish guidelines on household waste management and hazardous waste management. The authorities of the provinces and cities shall establish the waste management plan and have the responsibility for the collection, transport, storage, recycling, minimizing, and dumping of waste.
Sub-decree on Air and Noise Pollution Control(2000)	Maximum allowable concentration of hazardous substances in ambient air; maximum allowable standard of pollution substance for immobile sources in the ambient air; ambient air quality standard; and maximum permitted noise level in public areas.
Drinking Water Standard (2004)	The Drinking Water Standard (2004) was prepared by the Ministry of Industry, Mine, and Energy through close collaboration with institutions concerned, supported by the World Health Organization (WHO). The parameters should be analyzed based on the designated standard for clean water supply to ensure good quality water for human usage throughout the country.

Title	Provisions
Protected Area	
Decree on Creation and Designation of Protected Areas (1993)	National protected areas, which are managed and supervised for the development and protection of natural areas by the Secretariat of Environment, are classified into four categories:(1) national parks, (2) wildlife sanctuaries, (3) protected landscapes, and (4) multiple use areas.
Declaration No.1033 on Protected Areas(1994)	Prohibited activities include hunting, deforestation, exploitation of minerals, and water pollution activities within the protected areas.

Source: JICA Survey Team

(2) Cambodian Environmental Laws and Guidelines

The Ministry of Environment (MOE), in collaboration with concerned ministries, should conduct research, assess the environment impacts on natural resources, and provide the concerned ministries with recommendation to ensure that the natural resources are managed in an environmentally rational and sustainable manner. The Royal Government of Cambodia promulgated Law No. 1296-36 NS/RKM dated 24 December 1996 that defines the Law on Environmental Protection and Natural Resource Management.

The purposes of this law are as follows:

- To protect and promote environmental quality and public health through prevention, reduction, and control of pollution;
- To assess the environmental impacts of all proposed projects prior to the issuance of the decision by the royal government;
- To ensure the rational and sustainable conservation, development management, and use of natural resources of the Kingdom of Cambodia;
- To encourage and enable the public to participate in environmental protection and natural resource management; and
- To suppress any acts that cause harm to the environment.

All port construction projects and projects involving dredging works of more than 50,000 m^3 are required to provide an environmental impact assessment (EIA) report according to the guidelines issued by MOE. Similar basic study of the environment for the project was already completed in the "The Project for the Study on Strengthening Competitiveness and Development of the Sihanoukville Port (SSCD)" conducted in 2012 by JICA. In accordance with Cambodian law, the implementing body of the project, Sihanoukville Autonomous Port (*Port Autonome de Sihanoukville*: PAS), is required to prepare an EIA report in the feasibility study stage and submit it to MOE, which is the authority that evaluates and approves the EIA report.

Table 11.2-2 Major Points of the EIA System in Cambodia

Contents	EIA System in Cambodia
Integration of environmental and social considerations into planning and decision-making process	- The EIA guideline in Cambodia stipulates stakeholder involvement in the early stage of project planning to the greatest extent possible.
EIA preparation work	- An EIA can be prepared only by consultants authorized by MOE. - New regulation started in July 2014.
EIA-related documents in understandable language	An EIA report is prepared in Khmer. Documents for stakeholder meeting are also prepared in plain Khmer for better understanding of the participants, who are not familiar with environmental issues.
Categorization of the proposed project	- The EIA guideline in Cambodia classifies a project, including port projects, into four major categories based on project type and scale. (All port projects and projects that include 50,000 m^3 of dredging require an EIA report.)
Examination of various impacts and measures	- The EIA guideline in Cambodia provides only the general scope for examination of impacts and measures such as physical, biological, and socioeconomic aspects. - Terms of reference (TOR) for EIA has to be approved by MOE before preparation of draft EIA.

Contents	EIA System in Cambodia
Information disclosure and stakeholder consultation	- The EIA guideline in Cambodia ensures information disclosure with public consultation (stakeholder meeting).
Consideration for socially vulnerable groups, involuntary resettlement, etc.	- Legal framework for resettlement does not exist in Cambodia. Laws and sub-decrees exist for land acquisition and compensation and several laws and sub-decrees are under deliberation. However, any dispute and argument create an unstable situation as the legal system for land acquisition and compensation is still not well established.
Monitoring after project implementation	- The EIA guideline in Cambodia stipulates that an environmental management plan, including a monitoring plan, should be included in the EIA.

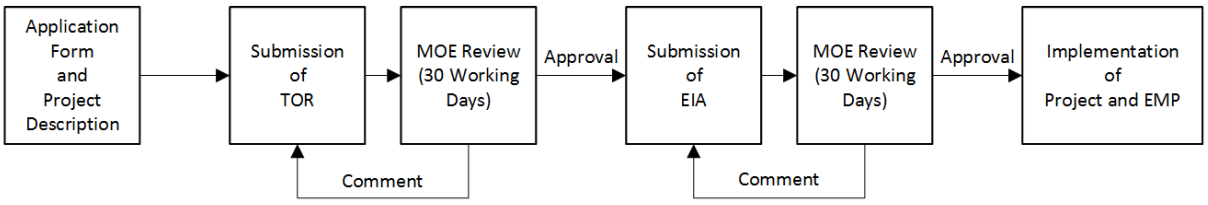
Source：JICA Survey Team

(3) Procedure of EIA Application and Approval

In accordance with the environmental law in Cambodia, PAS is required to prepare an EIA report. Sub-Decree No.72 on Environmental Impact Assessment Process (1999) mentioned that regulates the contents and procedures of the EIA report in detail; however, the sub-decree is under revision works.

According to Registration of Consultancy Company for Preparation of Environmental and Social Impact Assessment (2014), the EIA report should be prepared only by consultants authorized by MOE and should obtain approval from MOE before starting any construction works.

MOE conducts its evaluation of scoping plan within six weeks. After the evaluation, the notice of result is issued to the implementing body. According to the results of the evaluation, a draft EIA should be submitted to MOE. In case the draft EIA report is not approved, the applicant will revise the report accordingly based on MOE's comments and then resubmits until the EIA is finally approved. Figure 11.2-1 shows the approval process of an EIA report.



[Abbreviation]
TOR: Terms of Reference
EIA: Full Environmental Impact Assessment
MOE: Ministry of Environment
EMP: Environmental Management Plan

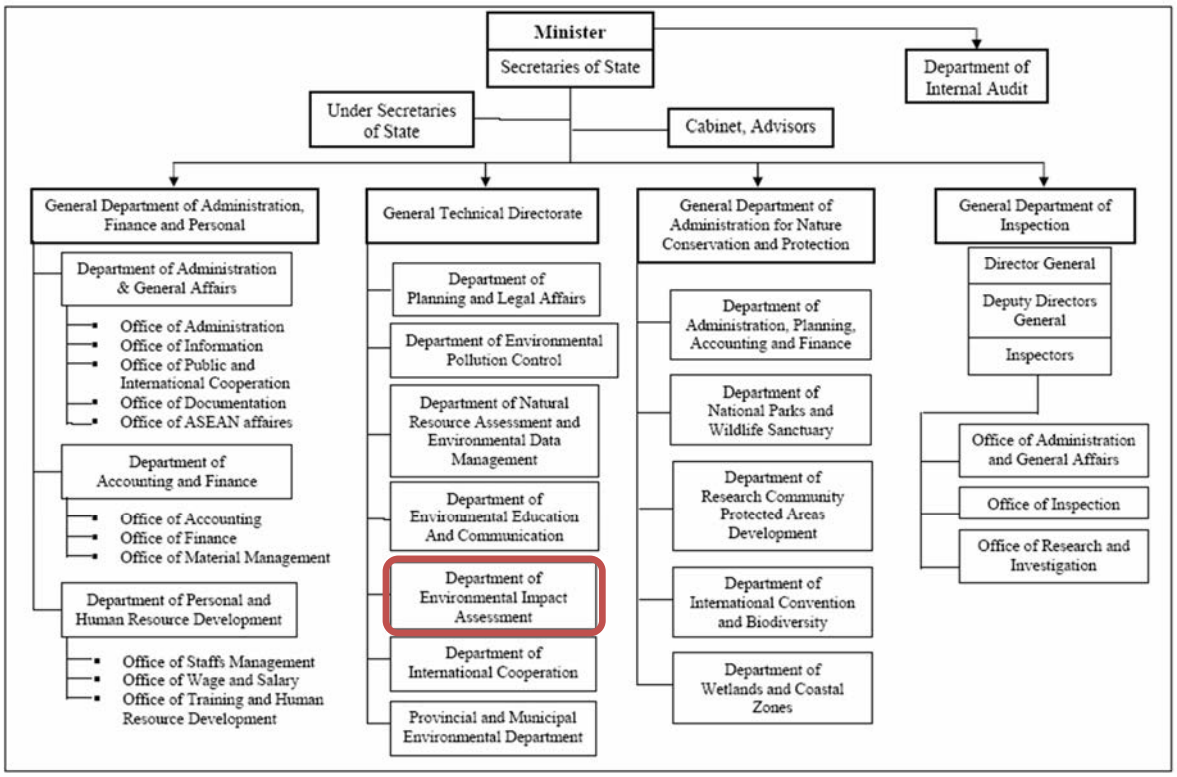
Source: Ministry of Environment

Figure 11.2-1 Flowchart of EIA Application and Approval Procedure

(4) Organization in Charge of EIA/IEIA

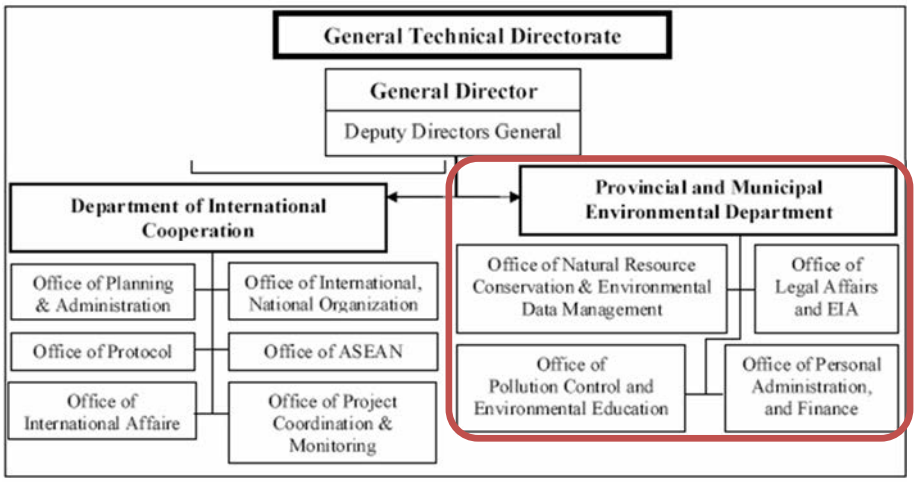
The Department of Environmental Impact Assessment (DEIA) is a structure of the MOE since its establishment in 1994.However, the declaration of its organization and functioning has been adopted only on December 2005. This department is set under the General Technical Department. Its main role and responsibility is focused on reviewing the EIA/IEIA report and monitoring the environmental management plan of both public and private development projects. It works according to the application of the Law on Environmental Protection and Natural Resource Management (1996) and the Sub-decree on Environmental Impact Assessment Process (1999). Under DEIA, five offices share the responsibilities for projects of national level: Office of Administration and Accounting, Office of Planning and Statistics, Office of Project Review, Office of Project Monitoring, and Office of Disputed Legislative and International Cooperation. Because of growing importance of works, DEIA's personnel has been increased from 16 staff in 1998 to 49 staff in 2011.

The Provincial and Municipal Environment Department (PMED) is in charge of projects on regional level, mainly for private projects.



Source: Department of Environmental Impact Assessment, Ministry of Environment

Figure 11.2-2 Organization of DEIA



Source: Department of Environmental Impact Assessment, Ministry of Environment

Figure 11.2-3 Organization of the Provincial and Municipal Environmental Department

(5) Environmental Standards

1) Water Quality Standard

The Sub-Decree on Water Pollution Control enacted in 1999 prescribes effluent discharge permits, maximum allowable level of effluent waste water to be discharged to public water, water quality standard in public water bodies such as rivers, lakes and reservoirs, and coastal water, and bio-diversity conservation and water quality standards in public water bodies for public health protection. Table 11.2-3 shows the water quality standard for rivers, lakes, reservoirs, and coastal water for biodiversity conservation.

Table 11.2-3 Water Quality Standard in Public Water Bodies for Biodiversity Conservation

No.	Parameters	Unit	Standard Value
Rivers			
1	pH	-	6.5-8.5
2	Biological oxygen demand (BOD)	mg/L	1 - 10
3	Suspended solids	mg/L	25 - 100
4	Dissolved oxygen	mg/L	2.0 - 7.5
5	Coliform	MPN/100mL	< 5,000
Lakes and Reservoirs			
1	pH	-	6.5-8.5
2	Chemical oxygen demand (COD)	mg/L	1 - 8
3	Supended solids	mg/L	1 - 15
4	Dissolved oxygen	mg/l	2.0-7.5
5	Coliform	MPN/100mL	< 1,000
6	Total nitrogen	mg/L	0.1 - 0.6
7	Total phosphorus	mg/L	0.005 - 0.05
Coastal Water			
1	pH	-	7.0-8.3
2	COD	mg/L	2 - 8
3	Dissolved oxygen	mg/L	2.0-7.5
4	Coliform	MPN/100mL	< 1,000
5	Oil content	mg/L	0
6	Total nitrogen	mg/L	-1.0
7	Total phosphorus	mg/L	0.02 - 0.09

Source: Sub-decree on Water Pollution Control

2) Ambient Air Quality Standard

Air quality standard is specified in the Sub-Decree on Air and Noise Control enacted in 2000 as shown in Table 11.2-4.

Table 11.2-4 Ambient Air Quality Standard

	Parameter	1-HourAverage (mg/m^3)	8-HourAverage (mg/m^3)	24-HourAverage (mg/m^3)	1-Year Average (mg/m^3)
1	Carbon monoxide (CO)	40	20		
2	Nitrogen dioxide (NO_2)	0.3		0.1	
3	Sulfur dioxide (SO_2)	0.5		0.3	0.1
4	Ozone (O_3)	0.2			
5	Lead (Pb)			0.005	
6	Total suspended particulate(TSP)			0.33	0.1

Note:- This standard applies to ambient of air quality and to monitoring of air pollution status.
- Method for analysis of ambient air quality
Source: Sub-decree on Air and Noise Pollution Control

The standard on maximum quality of hazardous substance permitted in the air is specified in the Sub-Decree on Air and Noise Control enacted in 2000 as shown in Table 11.2-5.

Table 11.2-5 Maximum Allowance Concentration of Hazardous Substance in Ambient Air

No.	Name of ChemicalSubstance	Formula	Maximum Level (mg/m^3)
1	Aniline	$C_6H_5NH_2$	0.03
2	Ammonia	NH_3	0.2
3	Acetic acid	CH_3COOH	0.2
4	Sulfuric acid	H_2SO_4	0.3
5	Nitric acid	HNO_3	0.4
6	Benzene	C_6H_6	1
7	Benzidine	$NH_2C_6H_4C_6H_4NH_2$	
8	Carbondisulfide	CS_2	0.02
9	Chloroform	CH_3Cl_3	0.01
10	Carbon tetrachloride	CCl_4	3
11	Particle containing ssnestos	-	-
12	DDT	$C_8H_{11}C_{l4}$	0.5

No.	Name of ChemicalSubstance	Formula	Maximum Level (mg/m^3)
13	Formaldehyde	HCOH	0.012
14	Hydrogen arsenic	AsH_3	0.002
15	Hydrogen cyanide	HCN	0.01
16	Hydrogen fluoride	HF	0.002
17	Hydrogen sulfide	H_2S	0.001
18	Phenol	C_6H_5OH	0.01
19	Styrene	$C_6H_5CHCH_2$	0.003
20	Tetra chloroethylene	C_2Cl_4	0.1
21	Tetraethyle lead	$Pb'C_2H_5)_4$	0.005
22	Trichloroethylene	$ClCHCCl_2$	0.2
23	Toluene	$C_6H_5CH_3$	0.4
24	Vinyl chloride	$ClCHCH_2$	0.05
25	Arsenic (compound organic)	As	0.00001
26	Cadmium (compound and oxide)	Cd	0.003
27	Chromium (compound and metal)	Cr	0.0015
28	Nickel (compound and metal)	Ni	0.0002
29	Mercury (compound and metal)	Hg	0.0001
30	Petrol		5

Source: Sub-decree on Air and Noise Pollution Control

3) Noise

Maximum permitted noise levels in public areas are described in the Sub-Decree on Air and Noise Control enacted in 2000 as shown in Table 11.2-6.

Table 11.2-6 Maximum Standard of Noise Level Allowable in the Public and Residential Areas

(Unit: dB)

No	Area	Period of Time		
		06:00 a.m.–06:00 p.m.	06:00 p.m – 10:00 p.m.	10:00 p.m.- 06:00 a.m.
1	Quiet areas, hospitals, libraries, schools, and kindergartens	45	40	35
2	Residential areas, hotels, administration officers, and houses	60	50	45
3	Commercial and service area and mix	70	65	50
4	Small industrial factories, intermingling in residential areas	75	70	50

Source: Sub-decree on Air and Noise Pollution Control

4) Solid Waste Management

The purpose of the Sub-decree on Solid Waste Management is to regulate the solid waste management in a proper and safe technical manner in order to ensure protection of human health and conservation of biodiversity. This sub-decree also applies to all activities related to disposal, storage, collection, transport, recycling, and dumping of garbage and hazardous waste. The collection, transport, storage, recycling, minimizing, and dumping of waste in the provinces and cities are responsibilities of the authorities of the provinces and cities.

11.2.2 JICA Guidelines for Environmental and Social Considerations and the Policies

(1) Outline of JICA Guidelines for Environmental and Social Consideration

The JICA Guidelines aims to encourage a recipient government to conduct appropriate environmental and social examinations at various stages of a feasibility study or project preparation as well as appropriate participation of stakeholders to ensure transparent procedures and decision making. Adequate support and confirmation to be provided by JICA are also stipulated in the JICA Guidelines. It is important to examine and understand the consistency and verification between the regulations in Cambodia and JICA policies.

In addition to the national environmental legal framework and JICA Guidelines, the project should also consider the World Bank Safeguards Policies as countermeasures on the effects in the environment that will be caused by the project. Many large-scale projects are carried out presently according to these policies in Cambodia. These safeguard policies will mainly govern the environmental aspects and social due diligence of the project. The important items of the World Bank Environmental and Social Safeguard Policies are listed below.

- OP4.01 Environmental Assessment
- OP4.02 Involuntary Resettlement (if available)
- OP4.04 Natural Habitats

(2) Comparison of and Verification between the Cambodian EIA System and JICA Guidelines

Table 11.2-7 shows the consistency of the EIA system in Cambodia with the JICA Guidelines. The key points of the process of environmental and social examination in line with the JICA Guidelines are shown in Table 11.2-7.

Table 11.2-7 Gaps Between the JICA Guidelines (WB OP4.12) and the EIA Procedure in Cambodia

Item	JICA Guidelines	Laws and Regulations of Cambodia	Countermeasures for the Project
Public disclosure of EIA report and related documents using official language or in a language widely used in the country	EIA reports must be written in the official language or in a language widely used in the country in which the project is to be implemented.	The detailed public disclosure method and period of IEIA/EIA report is not regulated under the Cambodian laws and regulation. The EIA report under the Cambodian law is prepared in Khmer as official language.	The EIA report will be disclosed in PAS port office during a certain period. The EIA is prepared in Khmer and English.
Scope of impact to be assessed	The impacts to be assessed with regard to environmental and social considerations include impacts on the natural environment such as air, water, soil and others. These also include social impacts, including involuntary resettlement, vulnerable social groups such as the poor, equality of benefits and losses and equality in the development process, and working conditions including occupational safety. The direct and immediate impacts of projects, the derivative, secondary, and cumulative impacts, as well as impacts associated with indivisible projects, will also be assessed with regard to environmental and social considerations.	Negative impact on natural environment, pollution, society, economy, health and safety, cultural heritage, risks, and direct/indirect impact caused by projects should be forecasted and evaluated through EIA. In addition, forecast of cumulative impact was required by MOE.	No difference. Forecast of cumulative impact was required by MOE to draft TOR.
Comparison of alternatives	A number of alternatives should be analyzed to avoid negative impact, to minimize impact, and to select the best alternative for environmental and social considerations.	During the EIA process, comparison of alternatives should be conducted. Then, detailed selected alternatives and reasons for selection should be recorded in the EIA report.	Alternative analysis would be stipulated in the EIA.
Environmental management plan and monitoring plan	Follow-up plan such as EMP/EMoP and structures, cost, and procurement methods should be proposed.	Preparation and implementation of EMP/EMoP are specified in related laws. Implementation cost and structures are not required under Cambodian laws.	Implementation agency and cost would be stipulated in the EIA.

Item	JICA Guidelines	Laws and Regulations of Cambodia	Countermeasures for the Project
Public disclosure and stakeholder participation	For EIA report preparation, stakeholder meetings for local people should be held to provide enough information on the Project. The results of meetings should be recorded. The stakeholder meetings with local people should be held from an early stage of the project, as necessary. It is recommended that the meetings are held twice, at the scoping stage and draft EIA stage.	Article 16 of the Expropriation Law states "in conducting survey of entitlements, public consultations shall be organized to provide specific and concise information and collect inputs from all stakeholders regarding the proposed basic infrastructure project …"	Stakeholder meeting for EIA will be held twice, at scoping stage and draft EIS stage.

Source: JICA Survey Team

11.2.3 Laws, Standards, and Guidelines Related to Land Acquisition and Resettlement

The proposed project would not cause resettlement and land acquisition because the entire project site is inside of existing port area managed by PAS. Then, the resettlement action plan will not be prepared for the proposed project. However, many illegal residents have been living along coastal area, next to the existing port. In the future, PAS plan to remove them from existing area to a resettlement area.

(1) Legislative System on Land Acquisition and Resettlement in Cambodia

Cambodia has experienced severe social, economic, and political turmoil during the last quarter of the century. Before the Khmer Rouge came to power in 1975, private land ownership was widespread as governed by the Cambodia Civil Code of 1920. However, under the Khmer Rouge regime from 1975 to1979, private property was abolished and all records were destroyed. After the Khmer Rouge regime, the new government introduced usufruct rights to facilitate the orderly occupation of vacant lands and structures by people returning to the urban areas. However, all lands in Cambodia remained to be properties of the State until private ownership was fully restored in 1989. The current legislation governing land ownership is the Land Law of October 1992 and of August 2001, which recognizes claims to land made after the downfall of the Khmer Rouge in 1979.With this background, the fundamental systems for "resettlement", which include i) land management system, ii) policy and system for land acquisition, illegal occupation, and resettlement, and iii) methodology to fill the gap between development partners' (DPs') policy on resettlement and the Cambodian laws and regulations related to resettlement are still improving, and therefore, cooperation between them is necessary in terms of dealing with resettlement issues caused by development projects.

Table 11.2-8 Related Authority and Institutions, and Laws and Regulations Related to Land Acquisition and Resettlement

Authority or Institution In-Charge	Laws and Regulations	Function	Remarks
Nation	- Constitution (1993)	Fundamental basis for the right to ownership and the right to confiscate (land) possession only in the public interest with fair and just compensation in advance.	The Land Law (2001) and the Law on Expropriation (2011) both support the constitution. However, there is still a need to establish further supporting procedures or regulatory frameworks such as sub-decrees.
Prime Minister's Office (PMO)	- Sechkdey Prakas No.6: Measure to Crack Down on Anarchic Land Grabbing and Encroachment (1999)	- The first regulation to set the right of way (ROW) - Compulsory acquisition with public enforcement	- The government, however, failed to adequately inform the public about the ROW. - Prior to the issuance of the Prakas, the width of the ROW was not legally defined. - Does not provide how to acquire land from those who are living within the set ROW before its issuance.

Authority or Institution In-Charge	Laws and Regulations	Function	Remarks
			- Article about land ownership with five years of peaceful occupancy is reiterated in Land Law 2001. This land law is silent on whether or not this applies to ROW land, but it does not specifically state that it does not apply. Nevertheless, the government is enforcing this article selectively.
Ministry of Economy and Finance (MEF)	- Decision No. 13 and Prakas No. 98 (1997)	- It created the Inter-Ministerial Resettlement. Committee (IRC) which is chaired by the MEF.	- The IRC plays a major role in the planning and implementation of resettlement. - Not entitled to any compensation or social support, regardless of their being an affected people (AP) or a member of vulnerable groups. - Does not govern any expropriation regulated in any agreement or memorandum on supporting investment between the Royal Government of Cambodia (RGC) and DP countries. In case of no such agreement and memorandum or they do not deal with expropriation, any expropriation shall be governed under this law.
	- MEF Prakas No.961 (2000)	- It disallows any payment to be drawn from the national budget for structures and other assets located within the ROW.	
	- Sub-decree on Socio-Economic Impact Caused by Development Project (Draft, 2008)	- This sub-decree follows the safeguard policies of the Asian Development Bank (ADB).	
	- Law on Expropriation (2011)	- The policy, mechanism, and procedure of land expropriation from the legitimate land owner	
Ministry of Land Management, Urban Planning, and Construction (MLMUPC)	- Land Law (2001 and 1992)	- Individual's rights to ownership and compensation	- The mechanisms and standards for land acquisition or for determining levels of compensation are not clearly defined. - While the sub-decree requires the preparation of a development plan, it does not provide the framework and procedures for the preparation and fulfillment/accomplishment of the plan. - With this reason, the guidelines of DPs in development projects are followed.
	- Sub-decree on Social Land Concessions (2003)	- The criteria, procedures, and mechanism for the granting and transferring of private state lands to the poor for residential and/or family farming purposes with development plan	

Source: JICA Survey Team

(2) Gaps Between Relevant Cambodian Laws and JICA Policy

The proposed project will not cause any resettlement and land acquisition. The gaps between the JICA Guidelines and Cambodian Laws are shown in Table 11.2-9 as reference.

Table 11.2-9 Gaps between JICA Environmental and Social Guidelines and Land Acquisition Procedure of Cambodia

No	JICA Guidelines	Laws and Regulations of Cambodia	Gaps
1	Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives. (JICA GL)	- Constitution (1993)Article 44 - Land Law(2001)Article 4 and 5	Cambodian laws regulate land acquisition and purpose and situation. On the other hand, no laws and regulations for avoidance of relocation and loss of means of livelihood.

No	JICA Guidelines	Laws and Regulations of Cambodia	Gaps
2	When population displacement is unavoidable, effective measures to minimize impact and to compensate for losses should be taken. (JICA GL)	- Constitution (1993) Article 44 - Land Law (2001) Article 5	Cambodian laws do not mention that effective measures to minimize impact on resettlement.
3	People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities, and production levels to pre-project levels. (JICA GL)	- Constitution (1993) Article 44 - Land Law (2001) Article 5 - Expropriation Law (2009) Article 4 and 22	Both of JICA guidelines and Cambodian laws regulate compensation policy. However, Cambodian laws and regulations do not clarify type of compensation target PAPs. Expropriation refers to confiscation of ownership, **with fair and just compensation in advance**.
4	Compensation must be based on the full replacement cost as much as possible. (JICA GL)	- Expropriation Law (2009)Article 23	Cambodian laws do not ensure fill replacement cost. Cambodian laws mention the owner and/or the rightful owner has the right to compensation for **actual damages** commencing from the last date of declaration of expropriation for which they are entitled to fair and just compensation.
5	Compensation and other kinds of assistance must be provided prior to displacement. (JICA GL)	- Constitution (1993)Article 44 - Land Law (2001)Article 5 - Expropriation Law (2009)Article 19	Both the JICA Guidelines and the Cambodian laws ensure to provide compensation cost before resettlement. However, Cambodian laws do not regulate other kinds of assistance.
6	For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. (JICA GL)	- No matching regulations or Laws in Cambodia	Cambodian laws do not stipulate condition for preparation of resettlement action plan.
7	In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. (JICA GL)	- Expropriation Law (2009)Article 16	No difference
8	When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people. (JICA GL)	- Expropriation Law (2009)Article 16	Both the JICA Guidelines and the Cambodian laws regulate public consultation meeting for PAPs. However, no laws regulate language and methods for public consultation meetings in Cambodia.
9	Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans. (JICA GL)	- Expropriation Law (2009)Article 16	Cambodian laws regulate participation of public consultation meeting for PAPs; however, others are not regulated in the laws.
10	Appropriate and accessible grievance mechanisms must be established for the affected people and their communities. (JICA GL)	- Law on Expropriation (2011).	Grievance redress system is stipulated in the Law on Expropriation (2011).
11	Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey) preferably at the project identification stage, to prevent subsequent influx of encroachers who wish to take advantage of such benefits. (WB OP4.12 Para.6)	- Expropriation Law (2009)Article 16	No difference (Cambodian laws do not stipulate detailed methodology for the identification.)
12	Those eligible for benefits include the PAPs who have formal legal rights to land (including customary and	- Expropriation Law (2009)Article 16 and 18	Under Cambodian laws, 'owner of immovable property and/or rightful owner refers to a physical person,

No	JICA Guidelines	Laws and Regulations of Cambodia	Gaps
	traditional land rights recognized under law), the PAPs who don't have formal legal rights to land at the time of census but have a claim to such land or assets, and the PAPs who have no recognizable legal right to the land they are occupying. (WB OP4.12 Para. 15)		private legal person, or public legal entity including proprietor, possessor, and all persons who have rights to land and are affected by the expropriation project' as compensation target. The PAPs who have occupied the land or public properties illegally are not entitled to any compensation or social support.
13	Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based. (WB OP4.12 Para.11)	- No matching laws and regulations in Cambodia	Cambodian laws have no clear policy or procedure to restore the livelihood of PAP.
14	Provide support for the transition period (between displacement and livelihood restoration). (WB OP4.12 Para.6)	- No matching laws and regulations in Cambodia	Cambodian laws do not regulate providing support for resettlement.
15	Particular attention must be paid to the needs of vulnerable groups among those displaced, especially those below the poverty line, the landless, the elderly, women and children, and ethnic minorities. (WB OP4.12 Para.8)	- No matching laws and regulations in Cambodia	Cambodian laws do not address socially vulnerable groups.
16	For projects that entail land acquisition or involuntary resettlement of fewer than 200 people, abbreviated resettlement plan is to be prepared. (WB OP4.12 Para.25)	- No matching laws and regulations in Cambodia	Cambodian laws do not regulate the abbreviated resettlement plan.

Source: JICA Survey Team

11.2.4 Policy and Status of Gender Issue for the Project Sector

As for gender issues in Cambodia, the social and economic status of women are still lower than men. There are significant negative situations for women in the country such as violence, low literacy rate, and high maternal mortality rate.

The Constitution affirms full protection of the fundamental rights of the Khmer people in Chapter III, including an emphasis on protection of women's rights. The protection covers the right to equality before the law and prohibition of all forms of discrimination against women. Moreover, Cambodia is a signatory to several international agreements including the Committee on the Elimination of Discrimination against Women (CEDAW) that was ratified in 1992. CEDAW requires the state to address gender inequality in the civil, political, economic, and social spheres as well as in cultural and family life. The leading national government machinery for gender is the Ministry of Women's Affairs (MoWA) established in 1996. MoWA is mandated to influence and guide line ministries and lower-level administration units to mainstream gender. The Cambodian government approached several tasks through MoWA; however, the actions are not enough to improve the situation of women in Cambodia yet.

The National Strategy Development Plan 2006-2010 (extended to 2013 suggested to pay attention to gender equality in all sectors and to promote full women's participation on development projects. On the other hand, PAS do not have a special program for interorganizational gender issues. They agreed to prepare a special program for women when a large-scale resettlement occurs in the long-term plan. It is recommended to practice an approach for understanding gender issues among staffs of PAS, for example, to have awareness raising program for women staff and education program on gender issues for all staffs.

11.3. Baseline Data of Natural and Social Environment

11.3.1 Natural Environment

(1) Weather

Cambodia's weather is warm to hot all year round, and the climate is dominated by the annual monsoon cycle with its alternating wet and dry seasons. The monsoon cycle is driven by cyclic air pressure changes over Central Asia. As the pressure drops during the summer months (June to October), moist air is drawn landward from the ocean bringing the southwest monsoon rains to Cambodia. Come the winter months (November to May), the air pressure over Central Asia rises, driving cool dry air back across Southeast Asia and bringing on a largely rainless dry season to Cambodia. Table 11.3-1 to Table 11.3-3 show the weather conditions in Sihanoukville City in 2015.

Table 11.3-1 Monthly Maximum and Minimum Temperature

Unit: °C

Items	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Average
Max.	31.0	32.0	34.0	35.0	34.0	34.5	33.5	34.0	33.0	33.0	34.0	33.0	33.4
Min.	21.0	20.0	24.0	24.0	23.0	22.5	22.0	22.5	22.0	23.0	21.0	21.0	22.2

Source: Ministry of Water Resource and Meteorology, Department of Meteorology

Table 11.3-2 Monthly Rainfall and Humidity Record

Unit: Rainfall-mm, Humidity-%

Items	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Notes
Rainfall	2.8	1.6	27.4	50.8	190.4	459.2	321.1	458.2	636.4	146.2	184.5	25.7	Total:2,504.3
Humidity	80.1	82.3	81.6	80.2	79.5	81.8	81.5	83.6	85.0	85.7	82.0	77.0	Average:81.7

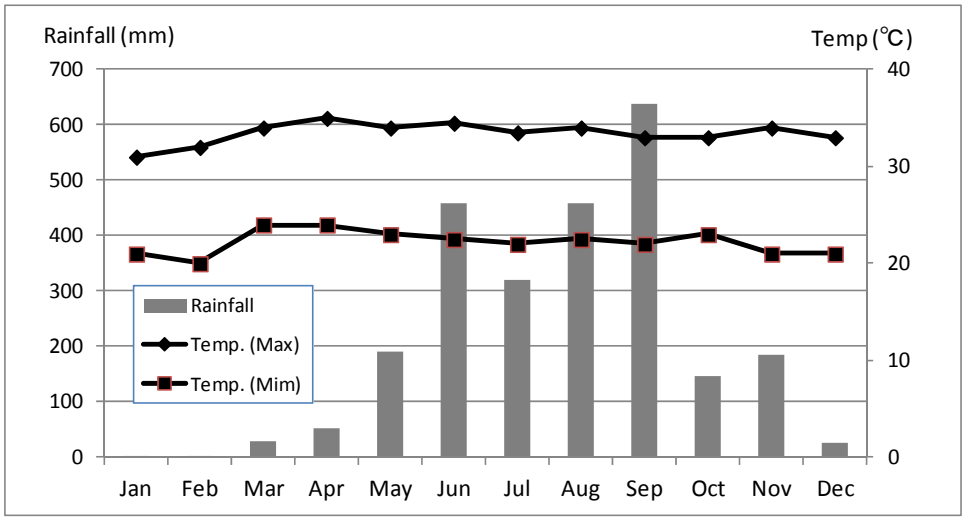
Source: Ministry of Water Resource and Meteorology, Department of Meteorology

Table 11.3-3 Monthly Maximum Wind Speed and Wind Direction

Unit: Wind speed-m/s

Items	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Notes
Direction	NE	S	NNE	E	SSW	E	SW	NW	SW	SSW	SW	N	Altitude: 13 m
Speed	6.0	6.0	6.0	6.0	7.0	8.0	7.0	7.0	12.0	6.0	8.0	6.0	-

Source: Ministry of Water Resource and Meteorology, Department of Meteorology



Source: JICA Survey Team

Figure 11.3-1 Rainfall and Temperature in Cambodia

(2) Topography

There are many beautiful coasts in downtown Sihanoukville City, which are presently utilized by the citizens as recreational areas. There are several capes covered by rocks, although almost all areas are situated in sandy coasts and are being utilized by citizens and visitors for swimming since the view of this area is scenic. This area is designated as a resort area according to the development plan and city planning prepared by the central government and the municipality. There is an existing access channel beside the Koh Poah Island. The coastal line of this island is covered with rocks except for a part in the north beach.

Sihanoukville City is located southwest of Phnom Penh on the coast of the Gulf of Thailand and covers an area of 868 km^2. About two-thirds of the land are classified as mountainous or hilly land with the highest peak at 327 m (Phnom Mousna Mountain) and one-third is flatland including wetlands and 24 islands. The topography of changes from east to west: outskirts of sandstone massif of the Elephant Mountains in the east to mud flat/sandy bottom in the west with the plain area on its center. The coastline of Sihanoukville is 119.5 km long, about a quarter (35 km) of which is sand beach and the remaining 84.5 km is rock, mud, and mangrove forest.

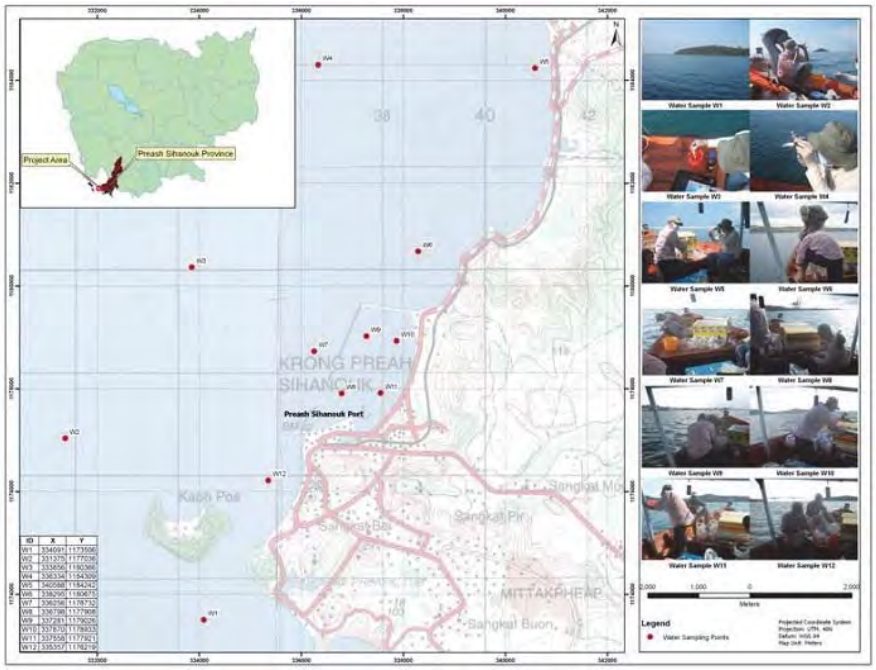
(3) Water Quality

The water quality on the proposed project area was surveyed several times in the past studies. The latest surveys are as follows:

- The Project for the Study on Strengthening Competitiveness and Development of the Sihanoukville Port (SSCD), November 2011, JICA
- Baseline survey data for the Multipurpose Terminal (MPT) Project, wet and dry season in 2015, Toyo-Maeda Joint Venture

1) SSCD Project

The surveyed data in October 2011 showed seawater polluted with oil and coliform (see Table 11.3-4). Turbidity was 0.00 NTU, and total suspended solids (TSS) was 272.00-340.00 mg/L in the surface layer.



Source: The Project for the Study on Strengthening Competitiveness and Development of the Sihanoukville Port, 2012,JICA.

Figure 11.3-2 Location Map of Seawater Quality Sampling Sites (SSCD)

Table 11.3-4 Results of Seawater Quality Survey (October 2011, SSCD)

		Temp.	pH	DO	Salinity	Turbidity	TSS*2	COD	T-N	T-P	Oil content	Coliform bacteria
Unit		°C	-	mg/l	‰	NTU	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100ml
Standard*1		-	7.0-8.3	>2.0-7.5	-	-	-	<2-8	<0.2-1.0	<0.02-0.09	0.00	<1000
W1	S	30.0	8.4	7.51	2.90	0.00	276.00	1.09	0.47	0.02	27.60	0
	M	30.0	8.5	7.45	2.85	0.00	258.00	1.51	0.43	0.02	11.80	$2.4x10^3$
	B	30.1	8.5	8.58	3.00	10.00	324.00	1.43	0.49	0.03	0.50	< 30
W2	S	30.2	8.4	7.72	2.30	0.00	272.00	1.68	0.32	0.01	31.20	0
	M	30.0	8.4	8.71	2.60	0.00	268.00	0.84	0.83	0.04	7.80	0
	B	30.2	8.4	9.88	2.65	2.00	292.00	1.18	1.50	0.03	2.10	0
W3	S	30.5	8.5	7.17	2.65	0.00	284.00	1.76	0.63	0.01	19.80	0
	M	29.9	8.5	7.23	3.00	0.00	298.00	2.18	0.79	0.01	0.40	0
	B	29.9	8.4	10.10	2.50	8.00	298.00	3.11	1.08	0.03	0.00	0
W4	S	30.3	8.5	7.04	2.80	0.00	318.00	1.60	0.45	0.03	19.00	0
	M	30.0	8.5	6.83	3.00	0.00	98.00	2.02	0.58	0.05	5.40	0
	B	29.9	8.4	7.30	3.20	1.00	296.00	1.09	0.56	0.03	0.18	0
W5	S	30.1	8.5	6.49	3.00	0.00	290.00	1.68	0.45	0.03	2.80	0
	M	30.1	8.4	6.72	2.90	0.00	258.00	3.19	0.48	0.03	0.20	0
	B	30.1	8.4	4.89	2.90	5.00	270.00	3.53	0.48	0.01	0.00	0
W6	S	30.2	8.5	7.00	2.80	0.00	274.00	1.93	0.41	0.02	37.40	< 30
	M	30.1	8.4	6.81	2.40	0.00	276.00	2.69	0.46	0.02	5.60	0
	B	30.1	8.5	6.79	2.75	3.00	252.00	3.61	0.46	0.02	0.60	0
W7	S	30.2	8.6	6.84	2.90	0.00	286.00	3.02	0.63	0.03	9.20	< 30
	M	30.1	8.6	6.52	3.10	0.00	302.00	2.02	0.38	0.04	0.00	< 30
	B	30.1	8.6	6.39	3.00	2.00	270.00	2.52	0.39	0.03	0.00	0
W8	S	30.4	8.6	7.17	3.10	0.00	310.00	2.52	0.46	0.02	4.00	0
	M	30.3	8.6	7.22	2.90	0.00	298.00	1.68	0.45	0.04	0.00	< 30
	B	30.2	8.6	7.14	3.20	1.00	282.00	2.69	0.51	0.04	0.00	0
W9	S	30.5	8.8	8.37	3.00	0.00	318.00	1.85	0.44	0.04	18.60	$9.2x10^2$
	M	30.6	8.8	7.62	3.10	0.00	324.00	1.85	0.64	0.04	1.60	< 30
	B	30.3	8.6	2.30	3.20	4.00	356.00	0.92	0.53	0.03	0.22	0
W10	S	30.6	8.7	7.66	3.00	0.00	340.00	1.09	0.48	0.02	4.80	< 30
	M	30.6	8.7	7.56	3.00	0.00	292.00	0.84	0.62	0.04	0.00	36
	B	30.7	8.7	3.56	3.10	7.00	284.00	0.34	0.62	0.04	0.00	0
W11	S	30.3	8.6	7.11	3.10	0.00	302.00	0.17	0.32	0.04	1.80	$9.3x10^3$
	M	30.3	8.7	7.17	3.00	0.00	302.00	1.18	0.61	0.05	0.06	$2.3x10^2$
	B	30.2	8.7	6.68	3.20	6.00	274.00	0.59	0.40	0.03	0.00	0
W12	S	30.2	8.6	6.70	3.00	0.00	306.00	0.92	0.36	0.04	4.20	$2.3x10^2$
	M	30.2	8.6	6.78	3.10	0.00	276.00	0.17	0.54	0.03	0.40	$9.2x10^2$
	B	30.2	8.6	5.71	3.15	3.00	292.00	0.34	0.63	0.02	0.00	0

S: surface layer, M: middle layer, B: bottom layer
*1: Water quality standard in public water areas for bio-diversity conservation (for Coastal Water) in annex 4 of the Sub-decree on Water Pollution Control, April 06 1999.
*2: The values of TSS may not be correct as the values are excessively high. Possible error in the laboratory analysis process.
Note: Gray cell indicate that the values exceed Cambodian water quality standard.

Source: The Project for the Study on Strengthening Competitiveness and Development of the Sihanoukville Port, 2012,JICA.

2) MPT Project

The water quality samples in January and July 2015 were taken from the surface and bottom layers, and at three points including W1 near the fishing cages, W2 in the turning basin, and W3 in the access channel (see Figure 11.3-3).

The survey results are shown in Table 11.3-5.The surveyed data showed seawater polluted with oil and coliform. Turbidity was 0.00 NTU, and TSS was 248.00-418.00 mg/L during the dry season. Turbidity was 0.9-2.5 NTU/FTU, and TSS was 170.00-322.00 mg/L during the dry season.

Source: Multipurpose Terminal Project

Figure 11.3-3 Location Map of Seawater Quality Sampling Sites (MPT)

Turbidity was also observed during the dry and wet seasons of 2015 to obtain the baseline of monitoring during the construction phase. The observation was conducted in the surface, middle, and bottom layers, and at four points including W1 near the fishing cages, W2 in the turning basin, W3

in the access channel, and D1 in the dumping area. Turbidity was 0.0 NTU during the dry season, and 1.4-2.7 NTU and 2.8-3.8 FNU during the wet season (see Table 11.3-6).

Table 11.3-5 Results of Seawater Quality Survey (MPT Project)

(Dry Season, January 2015)

Parameter	No	Unit	Standard	Result (W-1)		Result (W-2)		Result (W-3)	
				Sample S.1	Sample S.2	Sample S.1	Sample S.2	Sample S.1	Sample S.2
pH	1	-	7.0-8.3	7.34	7.77	6.98	7.62	7.82	7.74
Water Temperature	2	°C	NV	29.40	28.60	29.80	28.80	29.10	28.70
Turbidity	3	NTU	5.0*	0.00	0.00	0.00	0.00	0.00	0.00
Salinity	4	ppt	NV	18.37	17.55	19.98	18.75	17.58	18.87
Dissolved Oxygen (DO)	5	mg/l	2.0-7.5	6.58	6.82	6.53	6.62	6.26	6.69
Total Suspended Solid (TSS)	6	mg/l	NV	272.00	280.00	272.00	264.00	248.00	418.00
Biochemical Oxygen Demand (BOD)5	7	mg/l	NV	0.98	1.19	1.03	1.22	1.06	1.25
Chemical Oxygen Demand (COD)OH	8	mg/l	2.0-8.0	2.28	2.47	2.15	2.32	2.07	2.12
Oil & Grease	9	mg/l	0	3.20	1.40	2.72	0.38	1.61	0.57
Total Nitrogen (TN)	10	mg/l	0.2-1.0	0.41	0.48	0.15	0.33	0.39	0.43
Total Phosphorus (TP)	11	mg/l	0.02-0.09	0.04	0.04	0.02	0.03	0.02	0.05
Total Coliform	12	MPN/100ml		7.5x 10^5	2.3x1 0^5	1.5x1 0^5	7.4x10^4	2.8x10^5	2.0x10^5

**Annex 4 Sub-decree on Water Pollution and Control, Ministry of Environment, Cambodia*
**As per Technical specifications*

(Wet Season, July 2015)

ល.រ No	ប៉ារ៉ាម៉ែត្រ Parameter	ខ្នាត Unit	លទ្ធផល Result				ស្តង់ដារ Standard
			Sample W.1	Sample W.2	Sample W.3	Sample D.2	
1	*pH	-	8.16	8.24	8.19	8.21	7.0-8.3
2	*Temperature	^{0}C	28.6	28.4	28.7	28.7	NV
3	*Turbidity	NTU/FTU	1.6	1.2	2.5	0.9	NV
4	*Salinity	ppt	4.31	5.04	4.9	5.05	NV
5	*Dissolved Oxygen (DO)	mg/L	6.3	7.35	7.21	7.51	2.0-7.5
6	Total Suspended Solid (TSS)	mg/l	298.00	170.00	284.00	322.00	NV
7	Biochemical Oxygen Demand (BOD)5	mg/l	0.85	0.72	0.88	0.85	NV
8	Chemical Oxygen Demand (COD)OH	mg/l	2.24	1.98	2.12	1.08	2.0-8.0
9	Oil & Grease	mg/l	1.60	0.95	1.69	1.05	0
10	Total Nitrogen (TN)	mg/l	0.19	0.19	0.67	0.10	0.2-1.0
11	Total Phosphorus (TP)	mg/l	0.03	0.02	0.02	0.02	0.02-0.09
12	Total Coliform	MPN/100ml	430	930	72	360	1000

Source: Multipurpose Terminal Project

Table 11.3-6 Results of Turbidity Survey (MPT Project)

(Dry Season, 2015)

No	Parameter	Unit	Result	Standard	Reference Method
1	Turbidity, [Dumping Area (DI)], Surface	NTU	0	NV	Method MAJI Meter
2	Turbidity, [Dumping Area (DI)], Middle	NTU	0	NV	Method MAJI Meter
3	Turbidity, [Dumping Area (DI)], Bottom	NTU	0	NV	Method MAJI Meter
4	Turbidity, [Dumping Area (DI)], 500m, Surface	NTU	0	NV	Method MAJI Meter
5	Turbidity, [Dumping Area (DI)], 500m ,Middle	NTU	0	NV	Method MAJI Meter
6	Turbidity, [Dumping Area (DI)], 500m ,Bottom	NTU	0	NV	Method MAJI Meter
7	Turbidity, [Dumping Area (DI)], 1000m, Surface	NTU	0	NV	Method MAJI Meter
8	Turbidity, [Dumping Area (DI)], 1000m ,Middle	NTU	0	NV	Method MAJI Meter
9	Turbidity, [Dumping Area (DI)], 1000m ,Bottom	NTU	0	NV	Method MAJI Meter
10	Turbidity, **W.2, 100m,** Surface	NTU	0	NV	Method MAJI Meter
11	Turbidity, **W.2, 100m,** Middle	NTU	0	NV	Method MAJI Meter
12	Turbidity, **W.2, 100m,** Bottom	NTU	0	NV	Method MAJI Meter
13	Turbidity, **W.2, 500m,** Surface	NTU	0	NV	Method MAJI Meter
14	Turbidity, **W.2, 500m,** Middle	NTU	0	NV	Method MAJI Meter
15	Turbidity, **W.2, 500m,** Bottom	NTU	0	NV	Method MAJI Meter
16	Turbidity, **W.2, 1000m,** Surface	NTU	0	NV	Method MAJI Meter
17	Turbidity, **W.2, 1000m,** Middle	NTU	0	NV	Method MAJI Meter
18	Turbidity, **W.2, 1000m,** Bottom	NTU	0	NV	Method MAJI Meter
19	Turbidity, **W.3, 100m,** Surface	NTU	0	NV	Method MAJI Meter
20	Turbidity, **W.3, 100m,** Middle	NTU	0	NV	Method MAJI Meter
21	Turbidity, **W.3, 100m,** Bottom	NTU	0	NV	Method MAJI Meter
22	Turbidity, **W.3, 500m,** Surface	NTU	0	NV	Method MAJI Meter
23	Turbidity, **W.3, 500m,** Middle	NTU	0	NV	Method MAJI Meter
24	Turbidity, **W.3, 500m,** Bottom	NTU	0	NV	Method MAJI Meter
25	Turbidity, **W.3, 1000m,** Surface	NTU	0	NV	Method MAJI Meter
26	Turbidity, **W.3, 1000m,** Middle	NTU	0	NV	Method MAJI Meter
27	Turbidity, **W.3, 1000m,** Bottom	NTU	0	NV	Method MAJI Meter

(Wet Season, 2015)

No	Parameter	Location	Point	Unit	Baseline
1	Turbidity,	D2	100M	NTU	2.7
2	Turbidity	D2	500M	NTU	
3	Turbidity	D2	1000M	NTU	
4	Turbidity	W1	100M	NTU	1.4
5	Turbidity	W1	500M	NTU	
6	Turbidity	W1	1000M	NTU	
7	Turbidity	W2	100M	NTU	2.3
8	Turbidity	W2	500M	NTU	
9	Turbidity	W2	1000M	NTU	
10	Turbidity	W3	100M	NTU	2.5
11	Turbidity	W3	500M	NTU	
12	Turbidity	W3	1000M	NTU	

No	Parameter	Location	Point	Unit	Baseline
1	Turbidity	D2	100M	FNU	3.4
2	Turbidity	D2	500M	FNU	
3	Turbidity	D2	1000M	FNU	
4	Turbidity	W1	100M	FNU	2.8
5	Turbidity	W1	500M	FNU	
6	Turbidity	W1	1000M	FNU	
7	Turbidity	W2	100M	FNU	3.8
8	Turbidity	W2	500M	FNU	
9	Turbidity	W2	1000M	FNU	
10	Turbidity	W3	100M	FNU	3.7
11	Turbidity	W3	500M	FNU	
12	Turbidity	W3	1000M	FNU	

Source: Multipurpose Terminal Project

(4) Sediment Quality

Sea sediment was also surveyed in the two previous projects, same as water quality.

1) SSCD Project

The surveyed data in October 2011 showed mild pollution of heavy metal (see Table 11.3-7).

	Lat	Long.
S1	103°28'30.5"	10°39'53.2"
S2	103°29'14.7"	10°39'31.7"
S3	103°30'30.1"	10°38'52.0"
S4	103°30'36.7"	10°39'17.9"
S5	103°30'39.7"	10°39'51.4"
S6	103°31'00.4"	10°39'46.6"
S7	103°30'56.2"	10°39'20.0"
S8	103°30'51.8"	10°39'01.7"
S9	103°29'27.2"	10°38'46.9"

Source: The Project for the Study on Strengthening Competitiveness and Development of the Sihanoukville Port, 2012,JICA.

Figure 11.3-4 Location Map of Sediment Quality Sampling Sites (SSCD)

Table 11.3-7 Results of Sediment Quality Survey (October 2011, SSCD)

No	Parameter	Unit	S1	S2	S3	S4	S5	S6	S7	S8	S9	Canada*1		Australia*2	
												ISQG	PEL	SL	SQG-high
1	Specific Gravity	-	2.700	2.761	2.501	2.650	2.715	2.670	2.650	2.559	2.625	-	-	-	-
2	Water Content	%	38.23	35.42	56.13	31.46	56.27	52.68	36.02	29.34	32.76	-	-	-	-
3	Particle Size Distribution >0,85mm	%	17.15	2.30	24.31	2.86	40.03	36.86	46.06	9.01	54.87	-	-	-	-
	0,85mm ÷ 0,355mm	%	29.88	28.51	39.63	10.64	42.73	35.50	30.47	61.32	31.39	-	-	-	-
	0,355mm ÷ 0,25mm	%	0.16	0.33	0.65	0.11	0.19	0.24	1.99	0.46	0.09	-	-	-	-
	0,25mm ÷ 0,18mm	%	20.83	18.41	7.80	12.22	5.74	6.70	4.60	12.80	2.81	-	-	-	-
	0,18mm÷ 0,15mm	%	20.55	27.98	7.04	23.78	3.67	6.89	4.37	7.82	3.02	-	-	-	-
	0,15mm ÷ 0,125mm	%	5.84	7.95	3.41	15.12	1.78	2.35	1.99	2.29	1.45	-	-	-	-
	0,125mm ÷ 0,106mm	%	1.66	2.70	0.94	5.03	0.47	1.54	1.01	1.11	0.60	-	-	-	-
	0,106mm ÷ 0,095mm	%	0.31	0.71	0.38	1.53	0.25	0.32	0.17	0.44	0.09	-	-	-	-
	0,095mm ÷ 0,085mm	%	1.09	3.60	0.88	0.53	0.10	0.10	0.16	0.67	0.09	-	-	-	-
	0,085mm ÷ 0,075mm	%	0.58	1.66	2.18	7.22	1.46	1.94	1.57	0.75	1.37	-	-	-	-
	< 0,075mm	%	1.95	5.85	12.77	20.96	3.57	7.56	7.62	3.34	4.22	-	-	-	-
4	Total Organic Carbon (TOC)	mg/kg	4,700	7,600	22,100	2,700	20,400	23,600	13,100	6,000	35,100	-	-	-	-
5	Oil (Total Petroleum Hydrocarbon)	mg/kg	< 10	< 10	< 10	20	20	< 10	30	10	< 10	-	-	550	-
6	Detergent (Methylene Blue Active Substances)	mg/kg	0.598	0.678	1.202	1.460	0.540	1.543	1.613	0.638	1.440	-	-	-	-
7	Phenol	mg/kg	0.195	0.137	0.202	0.101	0.492	0.238	0.310	0.123	0.119	-	-	-	-
8	Nitrate	mg/kg	2.01	100.4	28.15	32.50	121.2	2.001	45.05	386.4	15.90	-	-	-	-
9	Chlorine	mg/kg	<0.54	<0.54	<0.54	<0.54	<0.54	<0.54	<0.54	<0.54	<0.54	-	-	-	-
10	Sulfate	mg/kg	1,033	1,750	2,776	846.6	2,050	2,484	5,513	1,933	4,872	-	-	-	-
11	Phosphate	mg/kg	<0.65	<0.65	<0.65	2.75	<0.65	<0.65	<0.65	<0.65	<0.65	-	-	-	-
12	Total Nitrogen (TN)	mg/kg	1,270	530	1,880	430	1,850	2,360	1,260	680	1,090	-	-	-	-
13	Total Phosphorus (TP)	mg/kg	561.1	342.7	360.2	240.1	366.8	366.8	279.4	80.8	318.7	-	-	-	-
14	Total Sulphur (TS)	mg/kg	1.13	2.63	23.14	9.34	12.13	4.21	2.57	3.12	1.09	-	-	-	-
15	Cyanide (CN)	mg/kg	0.037	0.022	0.03	0.027	0.025	0.028	0.027	0.024	0.032	-	-	-	-
16	Barium (Ba)	mg/kg	478.1	140.7	267.5	310.3	499.1	381.8	315.6	215.6	109.3	-	-	-	-
17	Arsenic (As)	mg/kg	2.087	2.274	3.065	1.818	2.383	2.573	3.378	2.221	1.376	7.24	41.6	20	-
18	Tin (Sn)	mg/kg	1.085	0.790	1.341	0.333	1.324	0.945	1.003	0.258	2.149	-	-	-	-
19	Iron (Fe)	mg/kg	4,421	4,961	11,008	3,271	11,736	9,082	7,877	2,134	9,343	-	-	-	-
20	Manganese (Mn)	mg/kg	547.9	648.5	1,437.4	269.5	1,245.9	764.3	927.2	100.7	1,288.8	-	-	-	-
21	Cadmium (Cd)	mg/kg	0.111	0.238	0.524	0.140	0.785	0.717	0.509	0.056	0.462	0.7	4.2	1.5	10
22	Chromium (Cr)*6	mg/kg	0.31	0.61	0.93	0.82	0.90	1.10	0.80	0.55	1.27	-	-	-	-

No	Parameter	Unit	S1	S2	S3	S4	S5	S6	S7	S8	S9	Canada*1		Australia*2	
												ISQG	PEL	SL	SQG-high
23	Lead (Pb)	mg/kg	11.20	6.70	14.90	2.75	15.35	19.20	13.05	3.05	6.65	30.2	112	50	220
24	Mercury (Hg)	mg/kg	0.171	0.227	0.086	0.053	0.100	0.027	0.193	0.034	0.083	0.13	0.70	0.15	1
25	Copper (Cu)	mg/kg	4.75	4.003	24.35	5.452	40.90	76.80	51.10	7.051	8.452	18.7	108	65	270
26	Nickel (Ni)	mg/kg	19.20	17.05	25.65	15.70	26.65	23.70	21.55	15.65	25.90	-	-	21	52
27	Zinc (Zn)	mg/kg	19.40	14.95	48.30	14.45	66.15	72.30	59.45	15.70	32.25	124	271	200	410
28	Total PCBs	μg/kg	<5.4	<5.4	<5.4	<5.4	<5.4	<5.4	<5.4	<5.4	<5.4	21.5	189	25*3	-
29	Total DDT	μg/kg	<3.1	<3.1	<3.1	<3.1	<3.1	<3.1	<3.1	<3.1	<3.1	1.19	4.77	1.6*3	46*3
30	Dioxins (PCDDs&PCDFs)	ng/kg	0.0027	0.0492	0	0.1690	0.4050	1.0294	1.7152	0.3031	0.1865	0.85	21.5	-	-
31	Tributyltin (TBT)	μg/kg	0.78	0.04	0.32	<0.02	0.29	0.13	<0.02	<0.02	0.16			9*3	-

*1: Canadian Sediment Quality Guidelines for the Protection of Aquatic Life
ISQG (Interim sediment quality guideline): Concentration below which adverse biological effects are expected to occur rarely
PEL (Probable effect level): Level above which adverse effects are expected to occur frequently
*2: National Assessment Guidelines for Dredging 2009
SL (Screening level): Level of a substance in the sediment below which toxic effects on organisms are not expected
SQG-high (Sediment quality high values): Very significant contamination
*3: Normalized to 1 per cent total organic carbon
Note: Gray cell indicate that the values exceed either ISQG or SL.

Source: The Project for the Study on Strengthening Competitiveness and Development of the Sihanoukville Port, 2012,JICA.

2) MPT Project Survey

The sediment quality samples during the dry season of 2015 were taken from three points including W1 near the fishing cages, W2 in the turning basin, and W3 in the access channel (see Figure 11.3-3). The surveyed sediment quality data showed mild pollution of heavy metal (see Table 11.3-8).

Table 11.3-8 Results of Sediment Quality Survey (Dry Season 2015, MPT Project)

No	Parameter	Unit	Result (W-1)		Result (W-2)		Result (W-3)	
			Sample. 1	Sample. 2	Sample. 1	Sample. 2	Sample. 1	Sample. 2
1	pH	-	8.25	8.3	7.44	8	8.51	8.53
2	Arsenic (As)	mg/kg-dry	7.52	7.71	10.19	10.32	4.93	5.12
3	Cadmium (Cd)	mg/kg-dry	0.06	0.14	0.2	0.15	0.11	0.05
4	Chromium Hexavalent (Cr+6)	mg/kg-dry	1.83	1.69	1.35	1.28	0.78	0.81
5	Chromium (Cr total)	mg/kg-dry	14.63	15.02	112.87	36.86	19.38	21.69
6	Copper (Cu)	mg/kg-dry	3.95	ND	160.24	93.04	8.09	14
7	Cyanide (CN)	mg/kg-dry	9.1	8.72	7.76	7.48	7.1	6.81
8	Lead (Pb)	mg/kg-dry	8.14	6.82	34.12	23.06	11.89	15.84
9	Mercury (Hg total)	mg/kg-dry	0.37	0.27	0.24	0.18	0.15	0.19
10	Zinc (Zn)	mg/kg-dry	12.93	13.21	78.8	10.96	12.91	12.73
11	Total Nitrogen (TN)	mg/kg-dry	2100	2100	2500	2500	1600	2000
12	Total Phosphorus (TP)	mg/kg-dry	940	882	1086	1042	1098	1145
13	Polychlorinated Biphenyl (PCB)	ppm	66.2	31.9	26	25.5	28	41.6

Source: Multipurpose Terminal Project

3) Monitoring Results of the MPT Project Survey

The monitoring of sediment concentration is being conducted in the MPT Project. The construction works of the proposed new container terminal project related to sediment dispersion are similar to the works of the MPT Project, as described in Chapter 2. Therefore, the monitoring data of the MPT Project can be utilized for the impact prediction of the proposed project.

The monitoring points are set in the downstream of construction works sites. There are three stations in profile and three in vertical for each construction works site (see Table 11.3-9 and Figure 11.3-5).

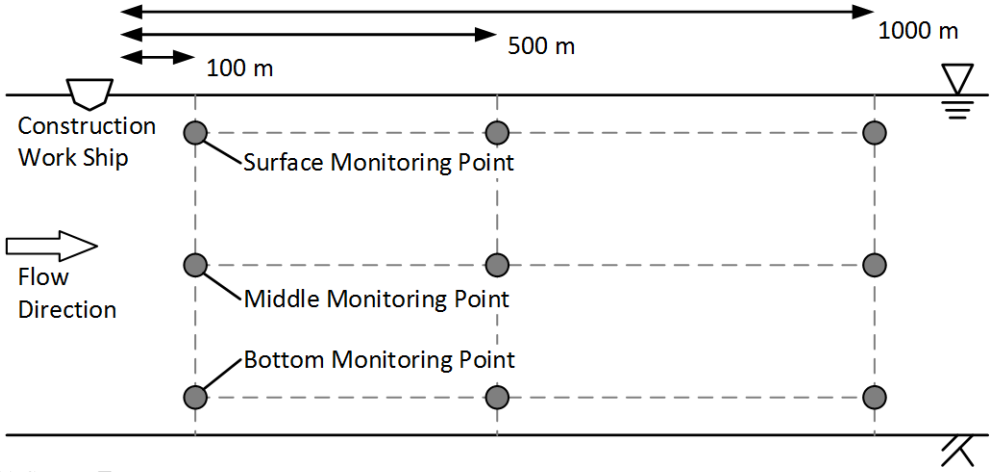
There is no standard for TSS or turbidity in Cambodia. Therefore, the standard for the MPT Project was set as "background plus 5 NTU" considering impact on fish. If the monitoring results show excess with the standard, the contractor will inform the engineer.

The monitoring results showed turbidity of less than 5 NTU as shown in Figure 11.3-6, and no major trouble or impact is observed in the MPT Project. Similar situation is expected in the proposed new container terminal project.

Table 11.3-9 Technical Specifications of Turbidity Monitoring in MPT Project

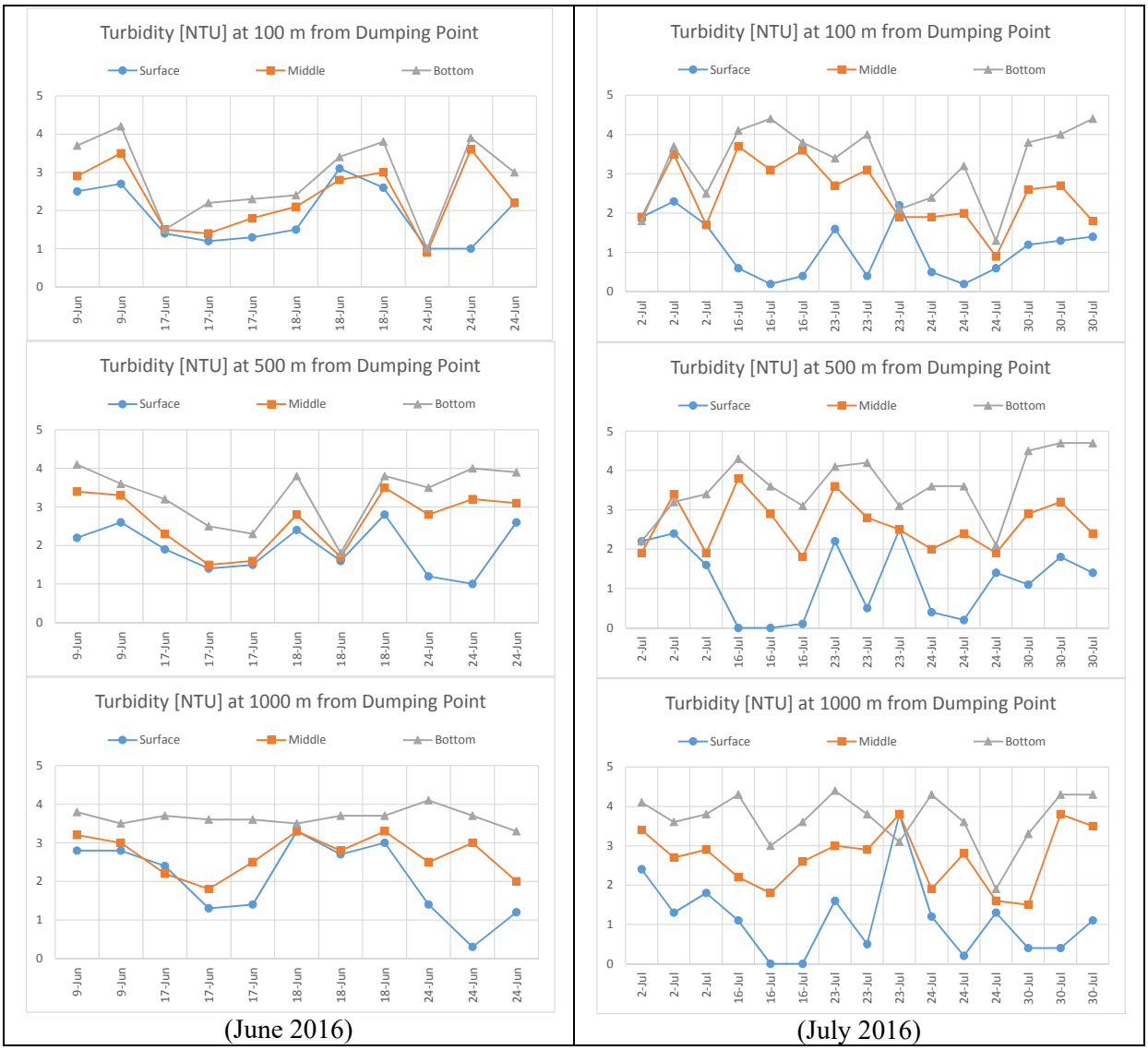
Location (Construction)	Monitoring Item	Monitoring Point	Sampling Depth	Frequency
Access channel and turning basin (for dredging)	Turbidity	- Three stations (100 m, 500 m, and 1,000 m downstream from dredging point) - Nearby existing fish cage inside of breakwater	Three depths (surface, mid depth, and bottom)	Every working day during construction, one hour continuously for every six-hour period.
Dumping area (for dumping)	Turbidity	- Three stations (100 m, 500 m, and 1,000 m downstream from dredging point) - Coastal area of Dek Koul Island	Three depths (surface, mid depth, and bottom)	Every working day during construction, one hour continuously for every six-hour period.
Land reclamation area (inside of breakwater)	Turbidity	- One station at discharging point and two stations: 200 m and 500 m from discharging point at New Port basin - Nearby existing fish cage inside of breakwater.	Three depths (surface, mid depth, and bottom)	Every working day during construction, one hour continuously for every six-hour period.

Source: Multipurpose Terminal Project



Source: JICA Survey Team

Figure 11.3-5 Schematic Image of the Monitoring Point



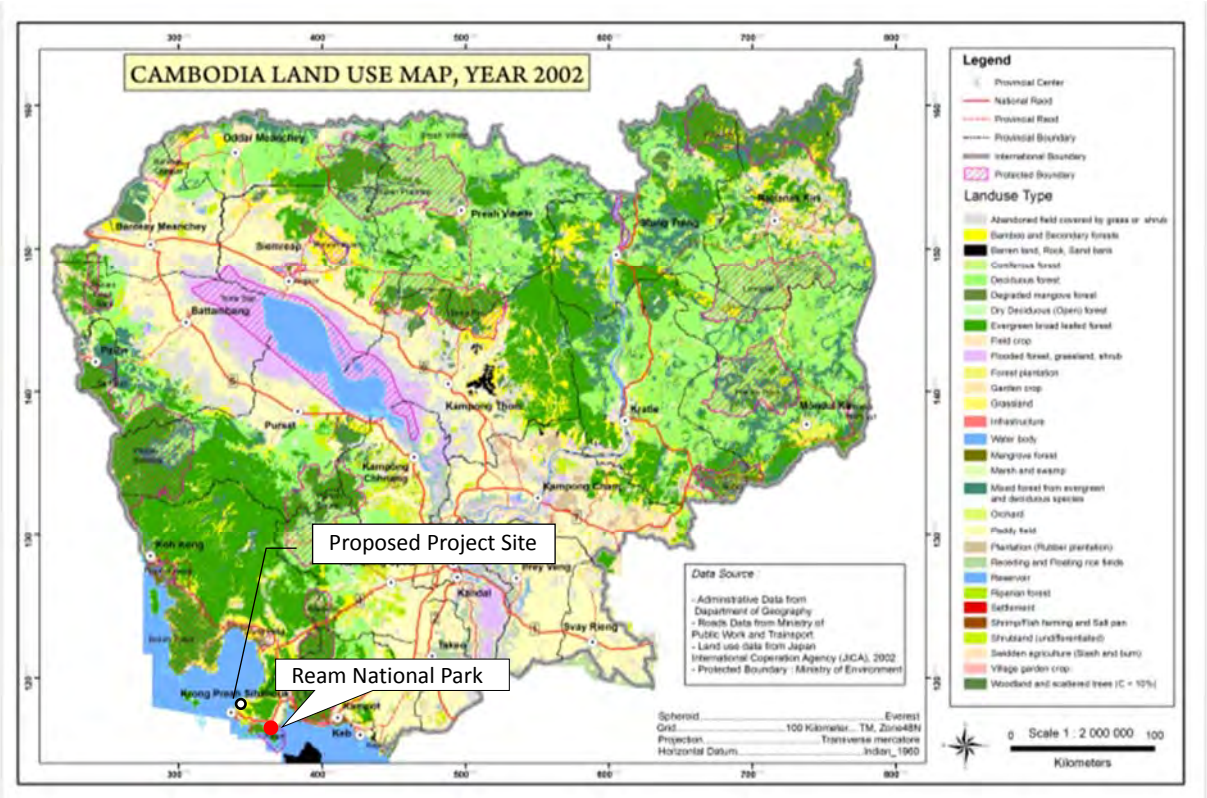
Source: JICA Survey Team

Figure 11.3-6 Example of Turbidity Monitoring Data

(5) National Park and Protected Area

Cambodia has 33 protected areas (23 areas under MOE and10 areas under the Ministry of Agriculture, Forest, and Fisheries (MAFF)). The protected natural areas are under the jurisdiction of MOE amounting to 18%of Cambodia's total area. In addition, by 2002, the Forest Administration (FA) of the MAFF had defined an additional 1,346,225 ha or 7.5% of the country's total area as conservation areas. Therefore, the total protected areas had increased to 25.5% of the country's total area. In2003, there was an amendment to the protected natural areas under MOE, reducing Cambodia's protected areas under MOE total area to3,194,471 ha.

Ream National Park is the nearest national park to the proposed project among them, is located at about 20 km southeast of the Sihanoukville Port, and the distance is enough far to exclude from the proposed project. A variety of wildlife animals and birds exist in the Ream National Park.



*Land Use: 2002, National Road: 2007
Source: Department of Natural Resource Assessment and Environmental Data Management, Ministry of Environment

Figure 11.3-7 Natural Protected Area in Cambodia

(6) Terrestrial Fauna and Flora

1) Proposed Area for Phase I Project

The proposed project component in the landside is only the development of access road. The existing National Road No.4 and the coastal community road are to be widen to set dedicated lanes for container trucks. No new road development is involved. The lands for the proposed access road are the land on the special economic zone (SEZ) and the vacant areas along the existing road owned by the Ministry of Public Works and Transport (MPWT), which are obviously not the habitats of significant wild animals or birds. The proposed area of access road is shown in Figure 11.3-8.

Source: JICA Survey Team

Figure 11.3-8 Project Area for the Proposed Access Road in Phase I

2) Proposed Area for Bypass Access Road in Phase II

The survey of terrestrial flora and fauna was conducted in SSCD for the environmental consideration of the bypass access road planning. The route of the bypass road is described in Section 9.5. Hereunder, the survey outputs of SSCD is referred for the environmental consideration of long-term road planning, not for the proposed project in Phase I.

The Sihanoukville Port is close to Kbal Chhay Protected Forest as shown in Figure 11.3-9, and the survey area was set between the port and the protected forest. The marks of T1 – T5 in Figure 11.3-9 show the location of transection for flora survey.

The flora survey was conducted with the line-transect method. Total of 85 tree species were identified through the survey. The dominant tree species were acacia and eucalyptus. Two identified tree species, *Dipterocarpuscostatus* and *Xylopiapierrei* are classified as threatened under the International Union for Conservation of Nature and Natural Resources (IUCN) Red List, which are endangered (EN) and vulnerable (VU), respectively.

Both species are common in Cambodia and do not require any special conservation yet. However, it is better to select a road route to avoid the habit of those threatened species.

Source： The Project for the Study on Strengthening Competitiveness and Development of the Sihanoukville Port, 2012, JICA.

Figure 11.3-9 Survey Area of Terrestrial Flora and Fauna in SSCD

The fauna survey was conducted with the interview to local residents around the survey area. A total of 83 species were identified to exist around the survey area consisting of mammals (16 species), birds (39 species), reptiles (18 species), and amphibians (10 species). Within the identified species, two mammals and three reptile species are classified as threatened under the IUCN Red List. Table 11.3-10 shows the identified threatened species and their classification under IUCN Red List.

The habitat of those threatened species should be surveyed in EIA stage of bypass road.

Table 11.3-10 Threatened Fauna Species and their Classification under IUCN Red List

Category	Common Name	Scientific Name	IUCN Category
Mammals	Sunda pangolin	*Manis javanica*	Endangered (EN)
	Lyle's flying fox	*Pteropuslylei*	Vulnerable (VU)
	Indochinese box turtle*	*Cuoragalbinifrons*	Critically Endangered (CR)
	Snail-eating turtle	*Malayemyssubtrijuga*	Vulnerable (VU)
Reptiles	King cobra	*Ophiophagushannah*	Vulnerable (VU)

*: According to IUCN Red List information on Indochinese box turtle, they can be found in Cambodia
Source: The Project for the Study on Strengthening Competitiveness and Development of the Sihanoukville Port, 2012,JICA.

(7) Marine Fauna and Flora

1) Seagrass Beds

While seagrass beds are limited or non-existent in waters adjacent to the port, small patches of seagrass beds are found in Koh Rong and Koh RongSamloem islands (UNEP, 2007), which are located approximately 20 km west of Sihanoukville Port. While extensive seagrass beds are distributed along the coast of Kampot Province, these areas will not be affected by the port project as they are more than 30-40 km east of the port.

2) Mangrove

Along the coast of Sihanoukville, mangroves are mostly distributed along small inlets. These mangroves are unlikely to be affected by the port development primarily due to their distant locations. No mangroves are found near the port.

3) Coral Reefs and Fish

Coral reefs in Cambodia are mostly distributed along parts of the mainland and around islands. Figure 11.3-10 shows the distribution of coral reefs in Cambodia. In Sihanoukville, coral reefs are found in the nearshore and offshore islands, which may be affected by port development such as dredging activities. A baseline coral reef survey was conducted by "The Project for the Study on Strengthening Competitiveness and Development of the Sihanoukville Port (SSCD)" in November 2011, targeting Koh Rong, Koh RongSamloem, and Koh Thas islands. These islands are located 10-20 km west of the port. The near shore coral reefs were not surveyed due to limited water visibility. The survey was conducted with the reef check method. A total of 11 sites were surveyed as indicated in Figure 11.3-12. The average hard coral coverages at Koh Rong, Koh RongSamloem, and Koh Thas were 36%, 34%, and 20%, respectively. The rate of bleaching was low at around 3% at all sites. Some hard corals were infected by pink-spotted disease, which is caused by a parasitic flatworm.

Fish abundance was highest in Koh Rong at around 130 individuals/100 m^2. Fish abundance at Koh Rong Samloem ranged between around 5-30 individuals/100 m^2. Fish abundance was lowest at Koh Thas, and was less than 5 individuals/100 m^2. The most commonly observed fish were snappers, sweetlips, and butterfly fish. One bumphead parrotfish (*Bolbometoponmuricatum*) individual was observed in Koh Rong Samloem, which is classified as vulnerable (VU) under the IUCN Red List. Invertebrate abundance was generally low throughout the three islands. The main observed species were urchins. One crown-of-thorn starfish was observed in Koh Rong Samloem.

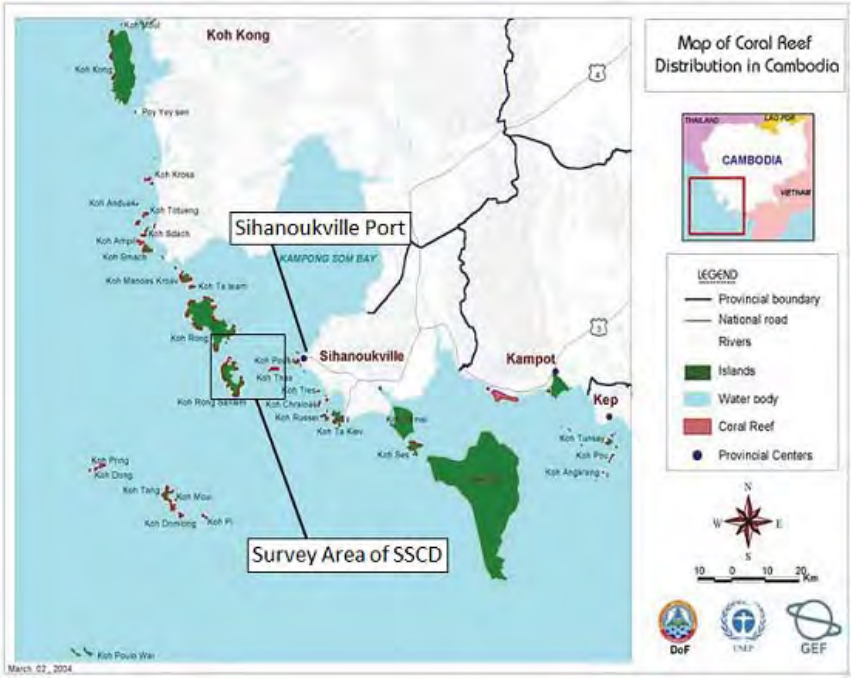
Although hard coral coverage at the surveyed islands are relatively low (20-30%), the health of these corals appears to be in relatively good state as indicated by the low rate of bleaching. As these coral reefs play an important role in the regional ecosystem, impacts from construction activities should be prevented by implementing appropriate mitigation measures and monitoring.

4) Marine Mammal

According to the survey conducted by Beasley et al. (2007)[1], ten marine mammal species were confirmed in Cambodian waters. Nine were cetaceans and one dugong. In the Sihanoukville area,

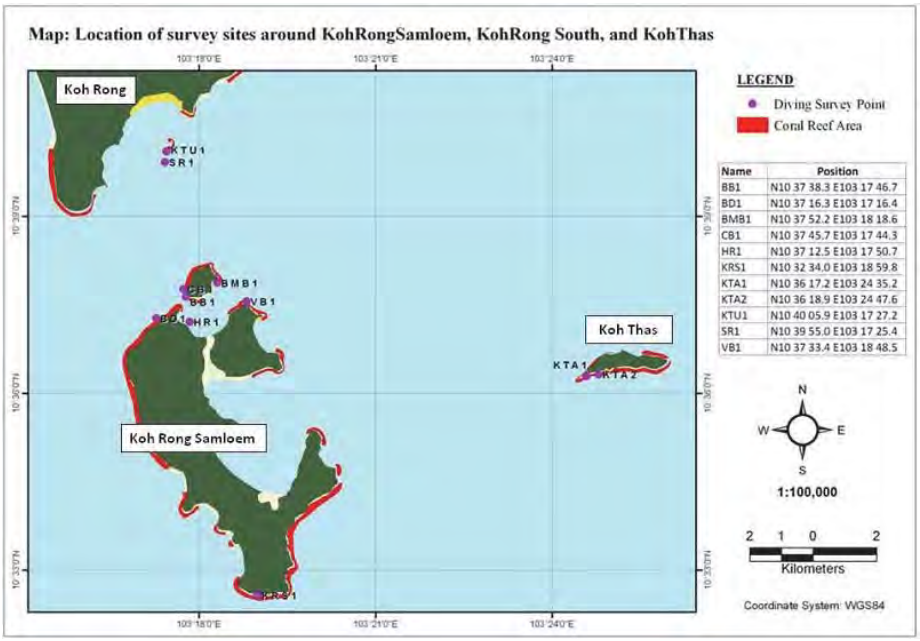
[1] Beasley et al (2007), Conservation Status of Marine Mammals in Cambodian Waters, including Seven New Cetacean Records of Occurrence, Aquatic Mammals 2007, 33(3), 368-379

Irrawaddy dolphins were known to inhabit the adjacent waters of Ream National Park. Oceanic species were commonly observed around Koh Rong and Koh Rong Samloem. Dugongs were formerly abundant in waters around Kep and Kampot provinces but its present status is unknown. Dugongs were also reported around Koh Rong and Koh Rong Samloem, but probably persist occasionally and in a very low numbers.



Source: UNEP 2007, National Report on Coral Reefs in the Coastal Waters of the South China Sea
Note: Location of Sihanoukville Port and survey area of SSCD was indicated by the JICA Survey Team.

Figure 11.3-10 Distribution of Coral Reefs in Cambodia

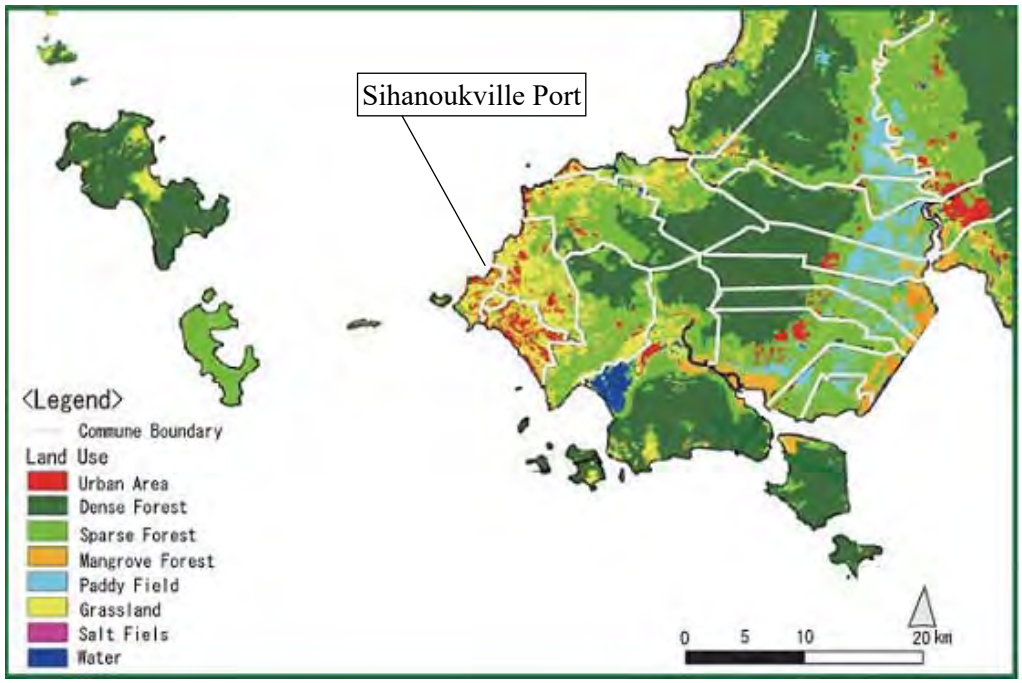


Source: The Project for the Study on Strengthening Competitiveness and Development of the Sihanoukville Port, 2012, JICA.

Figure 11.3-11 Location of Coral Reef Survey Sites

(8) Land Use

The land use of coastal lines in Preah Sihanouk Province is shown in Figure 11.3-12.Most of the land area is covered by forests, which is 81% of the total land. The proportion of urban area and paddy fields are 6% and 3%, respectively.



Source: The Project for the Study on Strengthening Competitiveness and Development of the Sihanoukville Port, 2012,JICA.
Note: Location of Sihanoukville Port was indicated by JICA Survey Team.

Figure 11.3-12 Land Use of Coastal Lines in Preah Sihanouk Province

11.3.2 Social Environment

(1) Population

Sihanoukville City has a population of approximately 240,000 people with a population density of about 271 per km^2. Regarding the project area, including the SEZ area, which is located in Phum Tumnub Rolok (Phum 4) of Sangkat 1 and Phum Thmey (Phum 3) of Sangkat 3. There are about 12,000 people living in the coastal area of the port.

There are several nationalities and ethnicities living in the fishing village beside the port along Hunsen Beach Road that work as fishermen, technicians, mechanics, farmers, small businessmen, and industrialists. Their nationalities are Vietnamese, Chinese, Thai, and others.

Table 11.3-11 Demography in Sihanoukville Municipality

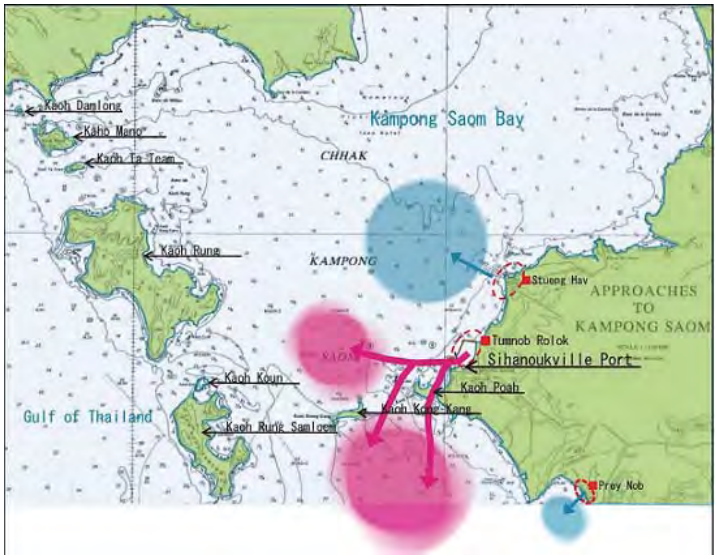
Description	Year		
	2013	2014	2015
Number of households	17,003	18,034	17,250
Total population	77,657	82,048	78,380
Population age 0-17 years	28,307	30,561	24,617
Population age 18-60 years	44,901	46,659	48,665
Population age 61 years up	4,449	4,828	5,098
Female househead (%)	10.8	13.9	13.2
Average household size (people/family)	4.6	4.5	4.5

Source: Sihanoukville Provincial Department of planning 2016

(2) Fishing in the Coastal Area in Preah Sihanoukville Province

There are no existing fishing rights or fisherman's union defined in the statute of Cambodia. The sub-decree regarding water rights was promulgated once in the 1950s; however, it automatically lost its legal force under the chaos of civil war during the Pol Pot Regime and has since never been reformulated.

In the coastal areas, there is a certain tacit consent among fishermen and regional government over fishery grounds. Fishery grounds among the three main fishery villages in Preah Sihanouk Province show clear separation without conflict. The fishermen using large-scale boat conduct fishing operation in the Bay of Kampon Sam and Gulf of Thailand as shown in Figure 11.3-.



Source: The Project for the Study on Strengthening Competitiveness and Development of the Sihanoukville Port, 2012,JICA.

Figure 11.3-13 Map of the Fishing Grounds of the Coastal Area

(3) Beach and Resort Area

The tourism in Preah Sihanouk City is rapidly growing in recent years. There are several beach resort areas in the city.

Source: The Project for the Study on Strengthening Competitiveness and Development of the Sihanoukville Port, 2012,JICA.

Figure 11.3-13 Map of Tourism Resources Around Sihanoukville Port

(4) Residential Area Along the Coastal Road

1) Outline of the Residential Area

Two residential areas, Sangkat 1,Mondul 3 and Sangkat 3, Mondul 3 are widely spread and illegally located along Hun Sen Street[2] in the PAS jurisdiction (see Figure 11.3-15 and Figure 11.3-16). Most of residents in the area are fishermen and their families. The residents do not have land titles and right to live in the area. Approximately, 12,000 people (2,200 families) lived illegally in the area.

The development of Sihanoukville Port started in the 1950s. A civil war erupted at the time of completion of breakwater, and the port development was stopped due to the chaos. It is said that some of the residents moved in the idle land and calm water area inside the breakwater, from another coastal area of Cambodia and Vietnam during this era. After the civil war, residents increased along with urban growth. In addition, the restart of port development made the calm water area wider, and the residential area on the water was also enlarged.

Fishermen in the areas constructed small jetties and houses on the water and conducted fishing and business. Illegal settlers constructed jetties and houses in the beginning and moved to the urban area of Sihanouk City, leaving those jetties and houses behind.

Source: JICA Survey Team

Figure 11.3-14 Map of the Residential Area Along the Coastal Road

Source: JICA Survey Team

Figure 11.3-15 Photos of the Residential Area Along the Coastal Road

[2]The coastal road connecting the National Road No. 4 and Stung Hav is called the Hun Sen Street. The formal name is Terakvi Thei Samdach Akka Moha Sena Padei HUN SEN Street.

2) Social Infrastructures in the Residential Area

a) Electricity

There is a power supply system in the two illegal communes, and almost all local residents who live in the village use electricity supplied by *Electricite du Cambodge* (EDC) at present. However, the power supply is cut-off sometimes.

b) Water

The water supply main pipeline with a diameter of 200 mm was installed along the Hun Sen Beach Road. This pipeline was constructed by the water supply authority (Water Supply of Preah Shihanouk Province), and many local residents utilize fresh water in the fishing villages at present.

c) Public Facilities

There is one school called "Sakura School" in the fishing village in Sungat 3 area supported by a Japanese non-governmental organization (NGO) (see Figure 11.3-16). The school is located beside Hun Sen Beach Road and SEZ area and started its operation in 1998. This is the only school in the fishing village at present. This school was established as a primary school and elementary school in the fishing village. The conditions of the school population are shown in Table 11.3-12.

Source: JICA Survey Team

Figure 11.3-16 School in the Fishing Village

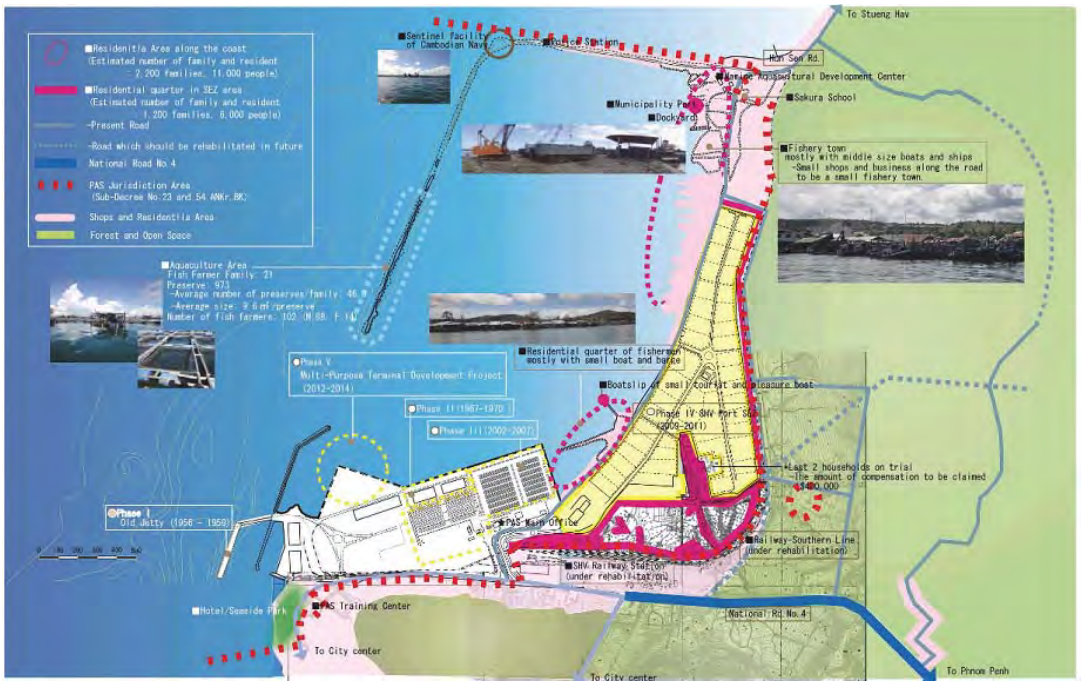
Table 11.3-12 Conditions of the Sakura School

School Population	Boy	Girl	Total
Primary School	1,427	877	2,304
Elementary School	414	204	618
Total	1,841	1,081	2,922

Source: JICA Survey Team

(5) Residential Area Around SEZ

There is also an illegal settlers' area in the south of SEZ (see Figure 11.3-18), and most of the illegal settlers flowed into the area to get the compensation for resettlement due to development projects. There were troubles on the resettlement during the development of the SEZ, and the resettlement is a very sensitive issue in and around the jurisdiction of PAS.



Source: The Project for the Study on Strengthening Competitiveness and Development of the Sihanoukville Port, 2012,JICA.

Figure 11.3-17 Land Use of Sihanoukville Port

(6) Fishery

Many types of small-scale or artisanal, middle-scale, and large-scale fishing gears are being used in Cambodia (see Figure 11.3-18 and Figure 11.3-19). According to a proclamation made by MAFF, small-scale or artisanal and middle-scale fishing gears are distinguished by the capacity of boat engine, fishing gear size, and the size of its catch net. Marine capture fisheries in Cambodia are divided into two categories, namely, middle-scale fisheries, and small-scale or artisanal fisheries. Fishing boats in Sihanoukville Port are categorized as small-scale. Table 11.3-13 shows the data of fishing boats and the data shows that a total of 544 fishing boats are being used in the above two communes.

Table 11.3-13 Data of Fishing Boat

Items	Family Fishing in Fish Pond		Small-scale Fishery		Total (excluding Row Boat)
	Row Boat	<10 hp	<33 hp	>33 hp	Total
Preah Sihanoukville Province	560	397	1,251	289	1,937
Total Sihanoukville City	27	39	484	201	724
Communes 1 and 3	3	0	323	221	544

Source: Marine Fisheries Administration Inspectorate. Kampong Som Fisheries Administration Cantonment, Minister of Agriculture, Forestry, and Fisheries.

Source: JICA Survey Team

Figure 11.3-18 Small-scale Fishing Boat

Source: JICA Survey Team

Figure 11.3-19 Large-scale Fishing Boat

1) Aquaculture in the Port

Aquaculture fish farmers conduct operation beside the breakwater (see Figure 11.3-20 and Figure 11.3-21). A total of 102 people from 21 families conduct fish farming in this area with 973 fish cages. Fishing folks who have fish farms mainly breed three kinds of fishes such as sea bass, grouper, and snapper in their cages.

Source: JICA Survey Team

Figure 11.3-20 View of Aquaculture (1)

Source: JICA Survey Team

Figure 11.3-21 View of Aquaculture (2)

11.4. Comparison of Alternative Plans

Several alternative plans such as site plan, structure of container terminal, and bridge type were studied. Analysis of alternatives were carried out in two stages, layout plan and structure design of container terminal, in technical and environmental aspects.

11.4.1 Layout Plan

(1) Alternatives

Outlines of alternatives of layout plan are shown in Table 11.4-1. Detailed conditions of alternative layout plan are described in Clause 7.1.2. Three alternatives for the long-term plan were studied considering different distance between the east edge of existing container berth and the south edge of new container berth, i.e. offset distance of existing and new berths.

Table 11.4-1 Outline of the Alternative Layout Plans

Plan A	Plan B	Plan C
		
Offset distance is 400m (50m+300m+50m).	Offset distance is 210m consistent to PAS's future plan.	Offset distance is 700m considering the development of future two berths.

Source: JICA Survey Team

(2) Evaluation of Alternatives

Table 11.4-2 shows the evaluation of three alternative plans. Based on the technical aspect studied in Chapter 7, Plan-A was selected as the best alternative. In environmental aspect, there are no significant differences among the three alternatives; however, Plan-A was also selected as the best alternative based on dredging and disposal volume differences among the three plans.

Therefore, Plan-A is recommended as best alternative of layout plan from both technical and environmental aspects.

Table 11.4-2 Comparison of Alternative Layout Plans

Contents		Alternatives		
		Plan A	Plan B	Plan C
Description		The offset distance is 400m (50m+300m+50m).	The offset distance is 210m, consistent with PAS's future plan.	The offset distance is 700m considering development of future two berths.
Technical Evaluation		Excelent	Good	Poor
Environmental Aspect	Pollution	The dredging and disposal volumes are minimized because the existing ship turning basin is utilized in this plan. Impacts on water pollution and aquaculture are minimized.	The dredging and disposal volumes are minimized because the existing ship turning basin is utilized in this plan. Impacts on water pollution and aquaculture are minimized.	Huge dredging and disposal works are expected. There is high potentiality of water pollution and aquaculture impact.
		Good	Good	Poor
	Natural Env.	Serious impact on natural environment is not expected because the project site is planned to be located far from national parks/reserved areas.		

Contents		Alternatives		
		Plan A	Plan B	Plan C
Environmental Aspect	Social Env.	Serious impact on social environment is not expected.	Proposed location of phase 1 is adjacent to the existing fishing village. It is more difficult to reach a consensus with them than with the other plan.	Serious impact on social environment is not expected.
		Good	Poor	Good
	Total	Excelent	Good	Good
Overall		Recommended	-	-

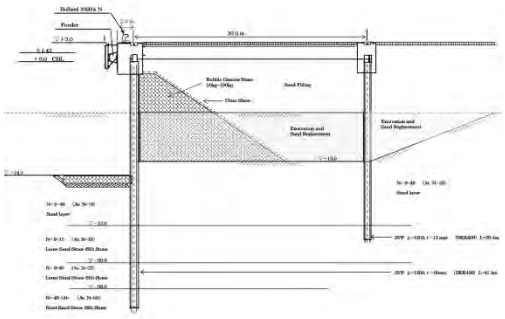
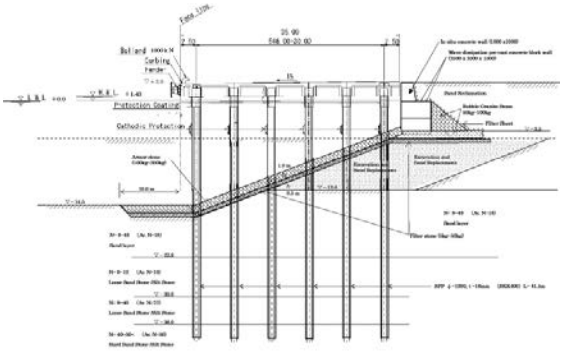
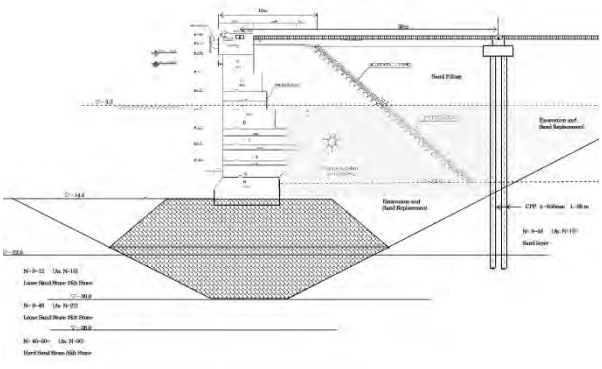
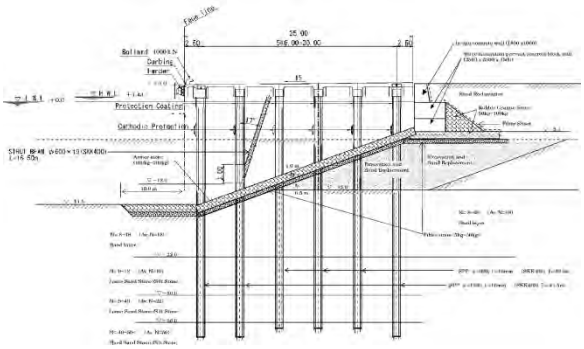
Env.: Environment
Source: JICA Survey Team

11.4.2 Structural Design Plan

(1) Alternatives of Structural Design Plans

The outlines of four alternatives of structural design plan are shown in Table 11.4-3. Detailed conditions of alternative layout plan are described in Chapter 8.

Table 11.4-3 Comparison of Alternative Layout Plans

Plan-1: Steel Pipe Sheet Pile Structure	Plan-2: Concrete Deck on Steel Pipe Pile
	
Plan-3: Concrete Block Method	Plan-4: Concrete Deck on Steel Pipe Pile and Strut Beam
	

Source: JICA Survey Team

(2) Evaluation of Alternatives

Table 11.4-4 shows the evaluation of alternative plans among the three alternatives. With regard to technical aspect (shown in Chapter 8), Plan-4 is selected as the best alternative among the proposed three alternatives.

Table 11.4-4 Comparison of Alternative Layout Plans

Contents		Alternatives			
		Plan-1	Plan-2	Plan-3	Plan-4
Concept		Steel pipe sheet pile structure	Concrete deck on steel pipe pile	Concrete block method	Concrete deck on steel pipe pile and strut beam
Technical Evaluation		3	2	4	1 (best alternative)
Environmental Aspect	Pollution	Vibration impact will occur due to vibro-hammer works. However, the impact might be not so large because the site is located far from the residential area. In addition, construction works cause little muddy water.	Construction noise due to pipe driving works will be highest. However, the impact might be not so large because the site is located far from the residential area. In addition, construction works cause little muddy water.	Noise and vibration impact by the construction works are at the lowest level. In addition, construction works cause little muddy water.	Construction noise due to pipe driving works will be highest. However, the impact might be not so large because the site is located far from the residential area. In addition, construction works causes little muddy water.
	Natural Env.	Serious impact on natural environment is not expected because the project site is planned to be located far from national parks/reserved areas.			
	Social Env.	Traffic congestion will occur due to construction works.	Traffic congestion will occur due to construction works.	Traffic congestion will occur due to construction works. The impact is highest among the alternatives because the construction period of the plan is the longest one.	Traffic congestion will occur due to construction works.
		Good	Good	Poor	Good
	Total	Good	Good	Poor	Good
Overall		-	-	-	Recommended

Source: JICA Survey Team

11.4.3 Alternatives of Structural Type of Access to New Container Terminal

The two alternatives of structural type of access to the new container terminal from the coast were studied, and Plan-1 of bridge type was selected. On the condition of completion of Phase III, the water area inside the breakwater is divided by the planned berth. In the north-south direction, the current can flow and fishing boats can also pass through Plan-1 only.

Table 11.4-5 Comparison of Alternatives of Structural-type of Access to New Container Terminal

Contents		Alternatives	
		Plan-1	Plan-2
Concept		Bridge	Embankment
Technical Evaluation		2 (high cost)	1
Environmental Aspect	Pollution	Construction works cause little muddy water; however, the impact is not so large.	Construction works cause little muddy water; however, the impact is not so large.
	Natural Env.	Serious impact on natural environment is not expected because the project site is planned to be located far from the national parks/reserved areas.	
	Social Env.	Impact on fishermen's livelihoods will be minimized by the alternative because they can use the waterway under the bridge as exit of the port during operation phase.	The alternative will cause significant negative impact on fishermen's livelihood because the proposed embankment will block the waterway during operation phase.
	Total	Good	Poor
		Recommended	-

Source: JICA Survey Team

11.4.4 Zero Option and Business as Usual

In case that the proposed project is not implemented, the construction of the new container terminal on the sea and access roads on the land are not anymore necessary, which in effect will not cause any negative impact to the environment. In case of no additional jetty, it will be extremely difficult to achieve a stable port operation on import and export materials. The target large-scale jetty will be utilized for handling containers to achieve smooth operation of the port; however, if the operation of containers stops or becomes unstable, it would bring significant impact to the economy and on people's life in Cambodia. It is crucial to achieve stable operation of port for economic development in Cambodia, so sustainable construction development plan considering the environment, social, and economic conditions should be formulated.

11.5. Scoping Results

Scoping was the first phase and provided for in the identification of issues that needs to be investigated and addressed during the following phases. A scoping process was then conducted to determine potentially significant issues that would form the basis of the EIA study to be included in the TOR and to exclude issues unlikely to be of any significance. The primary stakeholders were also identified during the scoping phase. The results of scoping are shown in Table 11.5-1.

Table 11.5-1 Results of Scoping

Category	No.	Impact Factors	BC and DC Phase	O Phase	Reason
Social Environment	1	Involuntary resettlement/land acquisition (if needed)	D	D	(Before construction) No involuntary resettlement of residents is needed in the proposed construction work of the port facilities and new access road in Phase I. There is a buffer zone between the existing coastal road and SEZ, which will be utilized for the land of the new access road. The land of new access road at the junction of National Road No. 4 is owned by MPWT. (During operation) No activities are planned that will cause the item.
					<u>(Long-term Plan managed by PAS)</u> PAS has a long-term plan for relocation of illegal occupants along the coastal area. The detailed plan is mentioned in Chapter 11.12 as reference. However, the relocation project is not included in the proposed project.
	2	Local economies such as employment, livelihood, etc.	B-/+B	B-/+B	(During construction) New job creation is prospected due to the construction of the project. The cages of aquaculture will not be removed. On the other hand, local fishery might be disturbed by the construction works (ex. increase in number of construction ships, increase in turbidity caused by dredging and reclamation works). (During operation) Since this project is a large-scale development, it will provide job opportunity to the locals in Sihanoukville City. The project will result in an overall socioeconomic improvement of Cambodia including people living around the project area. On the other hand, local fishery boat might face the increasing risk of accidents at the sea because the proposed project narrowing their waterway to the sea.
	3	Land use and utilization of local resources	B-	B-	(During construction/During operation) Local fishermen conduct aquaculture beside the existing breakwater. The impact on fish farming may occur due to mud flow caused by dredging and reclamation works. The fishery boat traffic for aquaculture/fishing outside the port might be obstructed by construction ships or container vessels. In addition, the traveling route of boats in the port will be changed because of the proposed berth.
	4	Social institutions such as social infrastructure and local decision-making institutions	D	D	(During construction/During operation) Since no residents live in the prospected project area during the construction phase, only limited environmental impact would occur. The comments of the local residents will be collected through stakeholder's meeting which will be held three times.
	5	Existing social infrastructures and services	B-	B-	(During construction/During operation) Traffic of construction vehicles and container trucks may cause traffic jam along the National Road No.4 and the coastal road.
	6	The poor, indigenous, or ethnic people	C	C	(During construction/During operation) Residents living in the surrounding area are categorized as poor people and will require consideration during the implementation of the project. No indigenous live in the surrounding area. The total number of residents who live in community (Sangkat3-Commune3) in the port is approximately 1,200.

Category	No.	Impact Factors	BC and DC Phase	O Phase	Reason
Social Environment	7	Misdistribution of benefits and damages	B-	B-	(During construction/During operation) There is a possibility of misdistribution of benefits and damages during construction phase. For example, fishermen's work might be disturbed by the proposed project but some person can get working opportunities (ex. construction worker, workers in new port, and others) via the proposed project.
	8	Cultural heritage	D	D	(During construction/During operation) The project area is located in the coastal area and no historical ruins or cultural heritages are found. No activities are planned that will cause the item.
	9	Gender	D	D	(During construction/During operation) No activities are planned that will cause the item.
	10	Children's rights	D	D	(During construction/During operation) No activities are planned that will cause the item.
	11	Local conflicts of interest	B-	B-	(During construction/During operation) There is a possibility of local conflict between beneficiary and affected people due to misdistribution of benefits and damages.
	12	Water usage or water rights and communal rights	B-	B-	(During construction/During operation) Eight families are illegally conducting aquaculture in the existing breakwater inside the existing port. In addition, fishermen are conducting small-scale fishery in the coastal area and it is expected that some impact will occur according to the layout of port facilities during both construction and operation phases. The access route for small- and medium-size fishing boats to mooring site is changed and new route is reserved under the proposed bridge.
	13	Public health	B-	D	(During construction) Risks of the item would increase with fixed probability due to influx of laborers into the proposed project area. In addition, risk of sexually transmitted disease (STD)/sexually transmitted infection (STI) and HIV/AIDS would increase between construction workers and local people. The common deadly disease affecting the majority of the people in Sihanoukville City is malaria. (During operation) No activities are planned that will cause the item.
	14	Hazards (risk) infectious diseases such as HIV/AIDS	B-	D	(During construction) There might be some possibility for diseases to be introduced at the site because of the expected migration of many workers from other regions. (During operation) No activities are planned that will cause the item.
Natural Environment	15	Topography and geographical features	D	D	(During construction/During operation) No activities are planned that will cause the item.
	16	Soil erosion	D	D	(During construction/During operation) No negative impact leading to soil erosion is anticipated in this project; all external walls of the new container yard will be protected by concrete structures.
	17	Groundwater	D	D	(During construction/During operation) No activities are planned that will cause the item.
	18	Hydrological situation	D	D	(During construction/During operation) There is a small river near the project area. However, no negative impact to the hydrological situation is anticipated in this project.
	19	Coastal zone	B-	D	(During construction) The proposed port facilities are planned inside the existing port area. In order to construct an access channel for vessels, dredging and disposal of dredged soils are anticipated and some impact to the water quality is expected. (During operation) No activities are planned that will cause the item because the proposed project location is inside the existing port which is a developed area.

Category	No.	Impact Factors	BC and DC Phase	O Phase	Reason
Natural Environment	20	Flora, fauna, and biodiversity	B-	B-	(During construction/During operation) The project site is not located within the preserved zone or conservation area for biodiversity regulated by international treaties or national laws. No ecologically valuable flora and fauna inhabit around the proposed project site. However, some species living in the proposed project site might be affected by the project, especially the aquatic ecosystem.
	21	Landscape	D	D	(During construction/During operation) The proposed project area is not designated as national park or preservation area. The maximum height of the new facilities is estimated at 8 - 15 m, and location is beside the existing port. As a result, the landscape would be harmonious.
Pollution	22	Air pollution	B-	B-	(During construction) Some impact of exhaust gas and dust generated from construction equipment and material transportation vehicles are anticipated. Local residents inhabit the coastal area beside the proposed construction site and necessary countermeasures and mitigations are needed. (During operation) Exhaust gas and dust due to increase of container truck traffic will cause air pollution.
	23	Water pollution	B-	D	(During construction) Dredging and disposal of dredged soils is required for the port and access channel so it is possible that the soils and sediment will be disturbed. As a result, some impact would occur. Necessary adequate countermeasures are needed to reduce pollution. (During operation) No negative impact on water pollution is anticipated by the proposed project.
	24	Soil contamination	C	C	(During construction/During construction) Construction of port facilities will require soil for earthwork for entrance of new container terminal base. The source for the earthwork materials should be selected in an appropriate and safety site. The site of the source for earthwork materials will be studied in the detailed design stage and be decided in the construction phase, so the impact is presently unknown.
	25	Waste	B-	B-	(During construction) It is expected that garbage from the workers' camps and solid waste generated from the construction work will cause some impact. However, the amount of hazardous waste generated in this project would be limited. (During operation) Oil might leak from the bilge in vessels which has potentially significant impacts is expected. In case there are no oil treatment facilities in the port, leaked oil from bilge of vessels should be treated by waste treatment company.
	26	Noise and vibrations	B-	B-	(During construction/During operation) It is expected that the noise during construction is from piling work and equipment; however, all construction work will be done inside the project site. Some construction work will be carried out near the residential area. Transportation of machineries and materials will be via sea transport; however, some transportation will be done by land which will cause impacts such as traffic, noise, and vibrations.
	27	Ground subsidence	D	D	(Before construction/During construction) No activities are planned that will cause the item because the proposed project does not include large scale groundwater use and other work related to ground subsidence.
	28	Offensive odors	D	D	(During construction/During operation) No odor source is anticipated in the construction work and no notable source of offensive odors.

Category	No.	Impact Factors	BC and DC Phase	O Phase	Reason
Pollution	29	Bottom sediment	C	D	(During construction) During disposal of dredged soils in the disposal site in the sea area, there is a possibility of soil sedimentation. However, only limited impact would be projected. The disposal site will be monitored by the GPS system installed in the vessel. The proposed disposal site has been utilized by PAS for the disposal site of the project. (During operation) No negative impact on bottom sediment is anticipated by the proposed project.
Others	30	Accidents	B-	B-	(During construction) Traffic due to construction machinery transport by sea and land is expected to cause some impact to the local communities. (During operation) Increase in number of cargo transportation trucks increases the possibility of accidents and appropriate mitigation is required.
	31	Global warming	D	D	(During construction/During operation) Increment on power supply is required for port operation. Such increment on power supply would contribute to global warming, but the impact of this project is projected to be limited.

Source: JICA Survey Team
Evaluation
A: Serious impact is expected.
B: Some impact is expected.
C: Extent of impact is unknown.
D: No impact or impacts are negligible, no further study required.
+: Positive impact
-: Negative impact

Note: BC: Before Construction (Design Phase), DC: During Construction, O: Operation

11.6. TOR for Environmental and Social Consideration Survey

11.6.1 Preliminary TOR

Based on the scoping results, necessary survey items were proposed by the JICA Survey Team. Detailed description of survey's terms of reference (TOR) is shown in Table 11.6-1. The TOR was submitted to MOE in April 2016 to get official approval under the Cambodian EIA system.

Table 11.6-1 Details of the TOR for Environmental and Social Considerations Survey

Factors	Survey Items	Survey Methods
Legal framework	➢ Laws, regulations, and standards related to environmental and social considerations	➢ Literature research
Involuntary resettlement/land acquisition (if necessary)	➢ Confirmation of residents in the proposed project area. ➢ Related laws and regulations in Cambodia ➢ Information on PAS's resettlement plan	➢ Confirmation of existence of residents, buildings, land usage, livelihood, and baseline in and around the project area by conducting a subcontracted work and field survey. ➢ Consultation with related agencies, information collection through literature review, and identification using the JICA Guidelines. ➢ Collect information on future resettlement plan in the future from PAS.
Local economies such as employment, livelihood, etc.	➢ Baseline data collection	➢ Site survey of socioeconomic condition
Land use and utilization of local resources	➢ Confirmation of the living situation of local residents who live in the proposed project area (Sangkat3-Commune3)	➢ Survey on local residents including fishing activities through sub-contracted work and evaluation of impact based on existing materials.
Existing social infrastructures and service	➢ Survey on social infrastructure and services around the proposed project area	➢ Sub-contracted work and field survey and evaluation of impact based on the existing materials
The poor, indigenous, or ethnic people	➢ Existence of poor people who live in and around the proposed project area (Sangkat3-Commune3).	➢ Consultation with local residents through a sub-contracted work and field survey, and evaluation of impact based on literature review.
Water usage or water rights and communal rights	➢ Confirmation of the aquaculture living situation of fishermen who live in and around the proposed project area.	➢ Survey on fishing activities through sub-contracted work and evaluation of impact based on existing materials.
Hazards (risks) of infectious diseases such as HIV/AIDS	➢ HIV/AIDS prevalence and related situation in Sihanoukville City among subcontractors and construction workers	➢ Performance survey on related large projects and evaluation of impact based on literature review.
Coastal zone	➢ Survey on dredging method and water pollutions caused by dredging and disposal of dredged soils.	➢ Evaluation of impact based on literature review and evaluation of impact based on existing data and monitoring record of previous project.
Air pollution	➢ Collection of standards ➢ Baseline data collection ➢ Understanding of the countermeasures against coal particles during the dry season.	➢ Literature research ➢ Site survey of air quality ➢ Prediction and evaluation of environmental impacts through examination of performance survey on related large-scale projects using air pollution standards in Cambodia.
Water pollution	➢ Collection of standards ➢ Understanding the current water quality on the port area and access channel ➢ Impact during dredging and disposal work in the port area and coastal area ➢ Conditions of discharged water from SEZ.	➢ Literature research ➢ Study of the results of water quality survey and construction methods will be conducted and carried out in the study on environmental prediction. ➢ Study of impact based on literature review and evaluation of impact based on existing data and monitoring record of previous project. ➢ Study of the conditions of discharged water from SEZ and local residents since the surface water in the port is polluted.
Waste	➢ Understanding the current conditions of solid waste management	➢ Evaluation of impact based on literature review and evaluation of impact based on existing data and

Factors	Survey Items	Survey Methods
Waste	➢ Hazardous waste ➢ Non-hazardous waste	record of previous project.
Noise and vibrations	➢ Collection of standards ➢ Information of current condition of traffic volume, and noise and vibrations ➢ Impact during construction and operation	➢ Literature research ➢ Site survey of traffic volume, and noise and vibrations ➢ Prediction of impacts by conducting a field survey through a sub-contracted work, and performance survey of related large-scale projects and its prospected methods of construction and transportation.
Ground subsidence	➢ Understanding of the current geographical features ➢ Impacts after implementation	➢ Prediction of impacts from the results of field survey and related projects ➢ Study impact based on literature review and evaluation of impact based on existing data
Bottom sediment	➢ Collection of standards ➢ Survey of sea area where dredging is proposed, and survey of sea bottom sediment. ➢ Prediction of impacts during and after construction.	➢ Literature research ➢ Site survey of bottom sediment ➢ Evaluation of heavy metals and prediction of contamination caused by dredging and study impact according to the existing sediment quality survey data.
Accidents	➢ Traffic volume of access road and neighboring roads in the prospected project area ➢ Record of traffic accidents	➢ Field survey and performance survey on related large projects and evaluation of impact based on literature review. ➢ Survey records of traffic accident recorded in Sihanoukville City

Source: JICA Survey Team

11.6.2 Comments by MOE

The MOE sent their comments on the preliminary TOR on July 2016. MOE's comments are detailed in Table 11.6-2. The JICA Survey Team and PAS discussed the correspondence for the requests.

Table 11.6-2 Official Comments from MOE

Sector	Item	Contents
Physical Resources	Hydrology	The study needs to be conducted with a radius of 5 km from the project area.
	Sedimentation	Simulation analysis is needed to be conducted at the dumping sites and also the alternatives for bringing the dredged materials to the land surface areas need to be studied.
	Seawater quality	Five samples, which locations are presented in the TOR, are requested to have new data. Parameters, such as Hg, Fe, and As, should be added
	Groundwater Quality	Three samples of groundwater, which locations are presented in the TOR, are requested to have new data.
	Mud analysis	Two mud samples along the proposed dredging channel need to be studied. Aside from the general parameters, additional parameters such as Hg, Fe, Pb, Sn, Z, and phosphate need to be added.
	Air, noise and vibration	Add one sample of air, noise, and vibration measurement along the road to be widened nearby the newly proposed road and bridge construction to the new port.
Biological Resources	Fishery	Additional study for fish cage owners (20 households).
Socio-economic Resources	Socioeconomic study	Socio-economic study should be conducted with a radius of 1.5 km from the proposed new port (bias 5% using Yamane Taro Formula).
Public Consultation	Attendance	The following attendees should be invited to public consultation:1) people, 2) fishermen/fishing communities, 3) local authorities, 4) relevant provincial departments and NGOs, and 5) workshop to disseminate the study results to all relevant stakeholder.
Other points	Cumulative impacts	Cumulative impacts should be analyzed in the EIA report.
	Methodology of economic analysis and environmental value	The EIA report should implement economic analysis for the proposed project.

Source: JICA Survey Team

11.7. Preliminary Results of the Field Survey

The site survey is subcontracted to Phnom Penh International Consultants (PPIC Co., Ltd.). As of 01 October 2016, some parts of the site survey are still ongoing in field because the JICA Survey Team and PPIC should respond to additional requests by MOE. The preliminary survey result is shown below.

11.7.1 Natural Environment Survey

(1) Seawater Quality

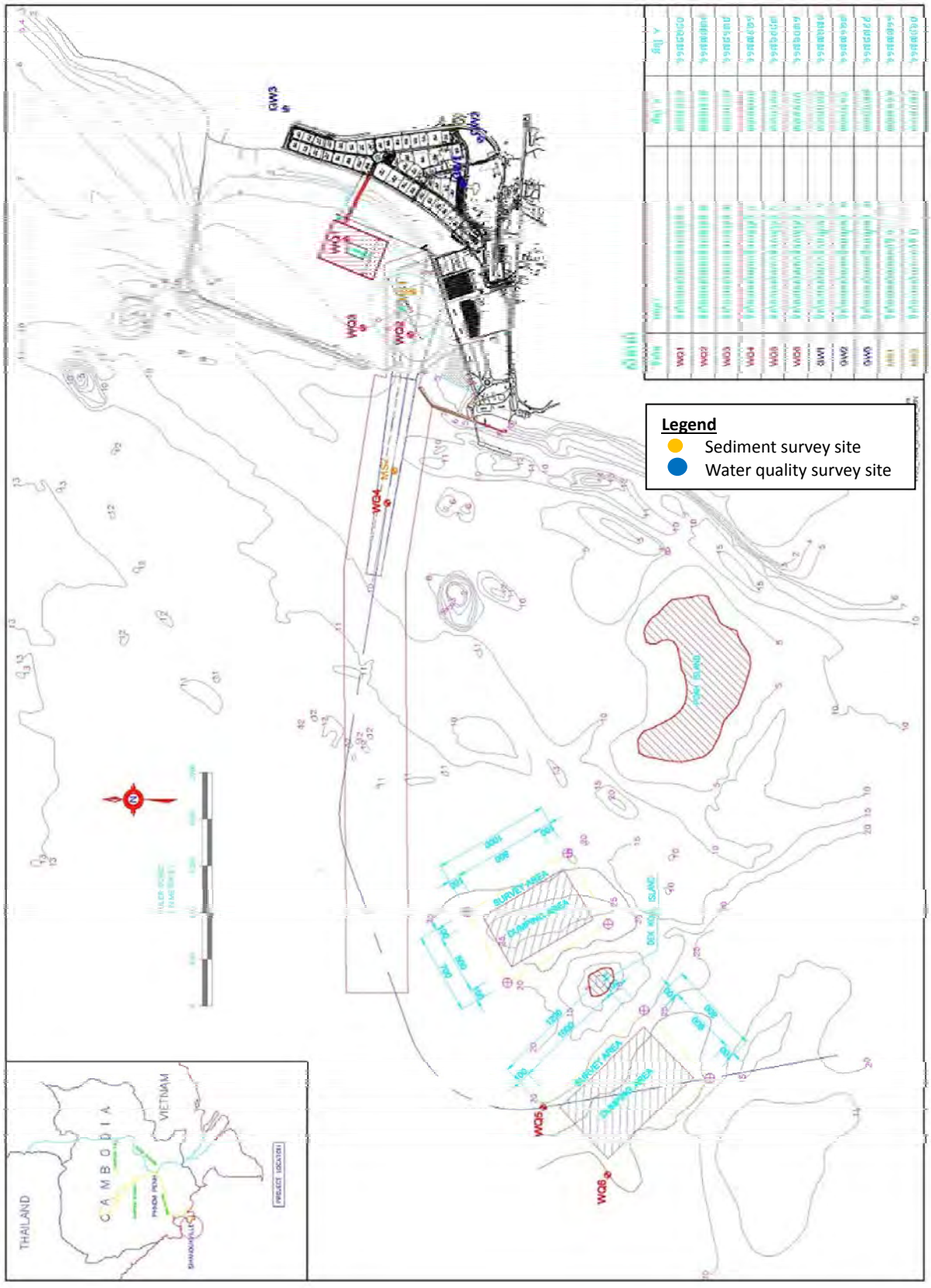
The seawater quality was surveyed on August 2016 in six points and three layers, for a total of 18 samples. The locations of survey sites are shown in Figure 11.7-1.

Table 11.7-1 shows the 13 items tested in the MOE laboratory. The survey results are tabulated in Table 11.7-2. Oil and grease exceeded the water quality standard of Cambodia. The pollution source seems to be the wastewater from residential area. The TN, TP, and total coliform also exceeded the water quality standard. The pollution source is estimated as the wastewater from residential area. As the parameters for sediment dispersion, turbidity was 0.00-4.00 NTU and TSS was 103.00-180.00 mg/L in the surface layer.

Table 11.7-1 Survey Items for Seawater Quality

No	Parameter	Unit	Standard	LDL	Method
1	Dissolved Oxygen (DO)	mg/L	2.0-7.5	0	MAJI meter
2	Turbidity	NTU	NV	0	MAJI meter
3	Salinity	%	NV	0	Refractometer
4	Total Suspended Solid (TSS)	mg/L	NV	NV	2540 D
5	Biochemical Oxygen Demand (BOD)5	mg/L	NV	NV	5210 B
6	Chemical Oxygen Demand (COD)OH	mg/L	2.0-8.0	NV	JIS K 0102
7	Oil and Grease	mg/L	0	0	5520 D
8	Total Nitrogen (TN)	mg/L	0.2-1.0	0.01	JIS K 0102 45
9	Total Phosphorus (TP)	mg/L	0.02-0.09	0.01	JIS K 0102 46
10	Arsenic (As)	mg/L	<0.01	0.001	Digital Arsenator
11	Iron (Fe-total)	mg/L	NV	0	Photometer S7000
12	Mercury (Hg-total)	mg/L	<0.0005	0.005	Metalyzer HM1000
13	Total Coliform	MPN/100ml	<1000	0	NF T90-413

LDL: Lowest Detection Limit
NV: No Value
Source: MOE laboratory



Source: JICA Survey Team

Figure 11.7-1 Survey Location for Water Quality and Sedimentation

Table 11.7-2 Survey Results for Seawater Quality

Parameter	Unit	Result											
		Surface Layer						Middle Layer					
		WQ-01-1	WQ-02-1	WQ-03-1	WQ-04-1	WQ-05-1	WQ-06-1	WQ-01-2	WQ-02-2	WQ-03-2	WQ-04-2	WQ-05-2	WQ-06-2
DO	mg/L	5.80	6.60	5.40	5.80	6.00	5.60	5.20	6.40	5.40	5.60	5.60	5.20
Turbidity	NTU	0.00	0.00	0.70	0.00	4.00	2.00	0.00	0.20	0.80	4.00	8.00	6.00
Salinity	%	0.10	0.10	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
TSS	mg/L	180.00	104.00	136.00	114.00	103.00	106.00	195.00	116.00	152.00	134.00	182.00	115.00
BOD	mg/L	1.17	0.93	0.86	0.83	0.98	1.56	1.06	1.07	1.46	1.26	1.39	1.75
COD	mg/L	2.29	2.07	2.15	2.06	1.84	3.29	2.71	2.32	2.54	2.83	2.97	3.66
Oil and Grease	mg/L	**2.54**	**1.47**	**3.67**	**3.05**	**2.88**	**2.93**	**1.93**	**0.91**	**1.96**	**2.44**	**2.17**	**1.10**
TN	mg/L	0.86	0.41	0.30	0.59	0.64	**1.06**	0.55	0.83	0.43	0.66	0.84	0.55
TP	mg/L	0.05	0.03	0.07	0.04	0.05	0.09	0.02	0.03	0.02	0.05	**0.14**	0.08
As	mg/L	ND	0.003	ND	ND	ND	ND	0.003	ND	0.001	0.001	0.003	ND
Fe	mg/L	0.13	0.01	0.001	0.01	0.08	0.06	0.03	0.07	0.15	0.17	0.12	0.02
Hg	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Coliform	MPN /100ml	$3.6x10^2$	$2.9x10^2$	$6.4x10^2$	**$1.1x10^3$**	$6.4x10^2$	**$1.5x10^3$**	$4.3x10^2$	**$1.2x10^3$**	$6.4x10^2$	**$1.5x10^3$**	$6.4x10^2$	**$1.5x10^3$**

Parameter	Unit	Result					
		Bottom Layer					
		WQ-01-3	WQ-02-3	WQ-03-3	WQ-04-3	WQ-05-3	WQ-06-3
DO	mg/L	4.80	5.80	5.00	5.40	5.00	3.20
Turbidity	NTU	1.38	4.00	2.70	10.00	22.00	24.00
Salinity	%	0.20	0.20	0.20	0.20	0.20	0.20
TSS	mg/L	230.00	129.00	181.00	175.00	289.00	172.00
BOD	mg/L	1.98	1.29	1.64	1.29	1.56	1.92
COD	mg/L	3.18	2.86	2.97	3.28	4.80	4.09
Oil and Grease	mg/L	**0.84**	**0.52**	**0.23**	**0.44**	**1.01**	**0.89**
TN	mg/L	0.65	0.35	0.39	0.72	0.96	0.69
TP	mg/L	0.05	**0.14**	0.06	**0.14**	**0.22**	**0.11**
As	mg/L	0.003	0.003	0.003	0.005	0.008	0.003
Fe	mg/L	0.03	0.03	0.08	0.14	0.21	0.18
Hg	mg/L	ND	ND	ND	ND	ND	ND
Total Coliform	MPN /100ml	$4.3x10^2$	$9.2x10^2$	$6.1x10^2$	**$1.5x10^3$**	$3.8x10^2$	$7.5x10^2$

ND: Not Detected
Source: tested by MOE laboratory

(2) Sediment Quality

The seabed quality was surveyed on August 2016 in two points. The locations of survey sites are shown in Figure 11.7-1 above.

Table 11.7-3 shows the 12 items tested in the MOE laboratory and the survey results. There are no Cambodian guidelines for seabed quality, so Canadian guidelines were applied. The surveyed seabed quality data showed mild pollution of heavy metal; however, the values were lower than the standard.

Table 11.7-3 Survey Results for Seabed Quality

No	Parameter	Unit	Result *1		Standard *2		Method
			MS-01	MS-02	ISQG	PEL	
1	pH (H20)		7.31	8.71	NV	NV	SA-002 (ISRIC 1993)
2	Arsenic (As)	mg/kg-dry	2.80	1.66	7.24	41.6	3500-As D (HNO3, HCl Digestion)
3	Cadmium (Cd)	mg/kg-dry	0.11	0.08	0.7	4.2	3500-Cd C (HNO3, HCl Digestion)
4	Chromium Hexavalent (Cr6)	mg/kg-dry	3.26	2.24	NV	NV	3060A
5	Copper (Cu)	mg/kg-dry	0.98	2.06	18.7	108	3500-CuC (HNO3, HCl Digestion)
6	Cyanide (CN-)	mg/kg-dry	2.24	1.86	NV	NV	4500 E
7	Iron (Fe-total)	mg/kg-dry	146.06	159.30	NV	NV	3050 B (HNO3, HCl Digestion)
8	Lead (Pb)	mg/kg-dry	1.85	2.17	30.2	112	3500-Pb C (HNO3, HCl Digestion)
9	Mercury (Hg)	mg/kg-dry	0.02	0.04	0.13	0.70	3500-Hg B (HNO3, HCl Digestion)
10	Zinc (Zn)	mg/kg-dry	16.50	20.80	124	271	3500-Zn C (HNO3, HCl Digestion)
11	Total Nitrogen (TN)	ppm	2450.00	2100.00	NV	NV	Kjeldal Sulfuric
12	Total Phosphorus (TP)	ppm	283.96	179.77	NV	NV	Nitric Digestion

Source *1: Samples were tested by MOE laboratory
Source *2: Canadian Sediment Quality Guidelines for the Protection of Aquaitc Life was applied.
ISQG (Interim Sediment Quality Guideline): Concentration below which adverse biological effects are expected to occur rarely
PEL (Probable Effect Level): Level above which adverse effects are expected to occur frequently
NV: No Value

(3) Aquatic Flora and Fauna

1) Fish and Crustacean

There are 61 marine fish species and 6 species of crustacean in the survey area according to the interview survey to 90 fishermen.

Table 11.7-4 List of Marine Fishes and Crustaceans in the Survey Area

No.	Khmer Name	English Name	Scientific Name	No.	Khmer Name	English Name	Scientific Name
Marine Fish							
1	ត្រីតុកកែក្រឹម	Bluelined grouper	*Cephalopholis formosa*	32	ត្រីបេកាដំរី	Indo-Pacitic sailfish	*Istiophorus platypterus*
2	ត្រីតុកកែ	Red spotted rockcod	*Cephalopholis leopardus*	33	ត្រីអាំងកឹយ		*Lutjanus johnii*
3	ត្រីតុកកែអ៊ិចក្រហម	Coral hind	*Cephalopholis miniata*	34	ត្រីត្រសក់	Fourlined terapon	*Pelates quadrinlineatus*
4	ត្រីសំបោរហៀរ	Toothpony	*Gazza minuta*	35	ត្រីចោរ	Herring scand	*Alepes vari*
5	ត្រីក្រហមស្រកាវក្រាស់	Redspot monocle bream	*Nemipterus furcosus*	36	ត្រីកាំគួច	Golden trevally	*Gnathanodon speciosus*
6	ត្រីក្រហមស្រកាវទន់	Teardrop threadfin bream	*Nemipterus isacathus*	37	ត្រីឆ្លាម	Brownbanded bambooshark	*Chiloscyllium punctatum*
7	ត្រីគោ	Longspined tripodfish	*Pseudotriacanthus strigilfer*	38	ត្រីផ្ទក់	Cobia	*Rachycentron canadus*
8	ត្រីក្រហមភ្នែកលាន	Moontail bullseye	*Priacanthus hamrur*	39	ត្រីស្លឹកឫស្សី	Scaly hairfin anchovy	*Setipinna taty*
9	ត្រីក្រហម	Red bigeye	*Priacanthus macracanthus*	40	ត្រីចិនចាស់	African pompano	*Alectis ciliaris*
10	ត្រីដូអង្គរ		*Gerres abbreviatus*	41	ត្រីគួន	Kelee shad	*Hilsa kelee*
11	ត្រីស្រោមដាវ	Dorab wolf-herring	*Chirocentrus dorab*	42	ត្រីគិ		
12	ត្រីអណ្តាតឆ្កែ	Doublelined tonguesole	*Paralagusia bilineata*	43	ត្រីកាហ៊ីរ		
13	ត្រីកន្ទុយរឹង	Toredo scad	*Megalaspis cordyla*	44	ត្រីកាឡក្រប៊ូ	African pompano	*Alectis ciliaris*
14	ត្រីក្តូចិន	Greater lizazdfish	*Saurida tumbil*	45	ត្រីបាឡាំង	Island mackerel	*Rastrelliger faughni*
15	ត្រីកន្ទាំងភ្លើង	Orangespotted spinefood	*Siganus guttatus*	46	ត្រីអ៊ុដុយ		
16	ត្រីកន្ទាំងប្រផេះ	Streamlined spinefood	*Siganus argenteus*	47	ត្រីអំបូរ		
17	ត្រីកន្ទាំងថ្ម	Doublebarred spinefood	*Siganus virgatus*	48	ត្រីចាបស	Silver pompfret	*Pampus argeteus*
18	ត្រីបែកឆ្នាំង	Tripletail	*Lobotes surinmensis*	49	ត្រីចាបខ្មៅ	Black pompfret	*Parastromateus niger*
19	ត្រីអណ្តែងពុយ		*Clarias nieuhofi*	50	ត្រីក្បាលគោ/ តាំងគោ		
20	ត្រីកាម៉ុង	Short mackerel	*Rastrelliger brachysoma*	51	ត្រីកាំគួច		
21	ត្រីផ្ទោង		*Tylosurus acus melanotus*	52	បបែល		
22	ត្រីចង្កូមបី	Trgertooth crocker	*Otolithes ruber*	53	សាំប៉ាន		
23	ត្រីកន្ទុយក្របី		*Xenocephalus sp.*	54	ត្រីសេក	Freckle goatfish	*Upeneus tragula*
24	ត្រីកូនគុំ	Yellowtail scad	*Atule mate*	55	ត្រីឈាម	Striped bonito	*Sarda orientalis*
25	ត្រីបោះត្រា	Russell's snapper	*Lutjanus russelli*	56	ត្រីកេស		
26	ត្រីការជី	Painted sweetlips	*Diagramma pictum*	57	ត្រីកាម៉យ	Chacunda gizzard shad	*Anodontostoma chancunda*
27	ត្រីកាឡាំង	Talang gueenfish	*Scomberoides commersonianus*	58	ត្រីជប៉ុន	Japanese threadfin	*Nemipterus japonicus*
28	ត្រីក្អុក	Spotted catfish	*Arinus sp*	59	ត្រីក្ដរស្វា		
29	ត្រីព្រលួស	Silver sillago	*Sillago sihama*	60	ត្រីដាវ	Dorab wolf-herring	*Chirocentrus dorab*
30	ត្រីអ៊ែ្រង		*Sphyraena sp*	61	ត្រីអាចម៏ស្អុយ	Rusty jobfish	*Aphareus rutilans*
31	ត្រីបេកា	Broad-barred spanish mackerel	*Scomberomorus semifaciatus*				
Crustacean							
1	ក្តាមសេះ	Blue crab	*Portunus pelagicus*	4	បង្គាឪខាក់		*Penaeus sp*
2	បង្គារស			5	មឹកបំពង់		*Uroteuthis duvaucelii*
3	បង្គារក្រហម			6	បង្កង		

Source: Interview survey on July 2016

(4) Terrestrial Flora and Fauna

Terrestrial flora and fauna survey was focused on mammals, birds, reptiles and amphibians in and surrounding port area. There were two methods applied to the study: (1) field survey and photo records of wildlife found in the project location and (2) interviews with people who often go to the project location. The survey was implemented in July 2016.

1) Fauna

Total of 132species, 24 mammal species, 72 bird species, 26 species of reptiles, and 10 species of Class Amphibia, were found in and around the project area. Most of the result is based on the interview survey to local people. The result of the survey is shown in Table 11.7-5.

Table 11.7-5 Summary of Fauna Survey Results

	Description	Mammal	Bird	Reptile	Amphibia	Total
1	Little concern (LC)	12	62	9	10	**93**
2	Near threaten)NT)		3			**3**
3	Vulnerable (VU)		2	4		**6**
4	Endangered (EN)	2	2			**4**
5	Critically endangered (CR)	1		1		**2**
6	Not yet evaluation	9	3	12		**24**
Total		**24**	**72**	**26**	**10**	**132**

Source: JICA Survey Team

2) Flora

There are 25tree species in the survey area according to the interview survey to local people.

Table 11.7-6 Summary of Flora Survey Results

	Local Name	Scientific Name	IUCN	WQC*
1	Trasek	*Peltophorumvogelianum*		First
2	Korki	*Hopeaodorata*	VU	First
3	Maysak	*Tectonagrandis*		First
4	Tatrao	*Fagracafragrans*	LC	Luxury
5	Thnoung	*Pterocarpusindicus*	VU	Luxury
6	Angkanh	*Cassia siamensis*		Luxury
7	CheulTealNeang Deng	*Dipterocarpuscostatus*	EN	Second
8	Pring Bay	*Syzygiumcumini*		Third
9	Thlork	*Parinariannamensis*		Third
10	PringSratob	*Syzygiumpolyanthum*		Third
11	Pring Thom	*Syzygiumtinctorium*		Third
12	Kray	*Polyalthiacerasoides*		Third
13	Krabao	*Hydnocarpusannamensis*	VU	Third
14	KravanhChrouk	*Cyperusrotundus*	LC	Other
15	Kok	*Juncuseffusus*	LC	Other
16	MoukChhneang	*Christiavespertilionis*	LC	Other
17	KrobBek	*Swieteniamacrophylla*	VU	Other
18	PreahKhlob	*Mimosa pudica*	LC	Other
19	PopealKhae	*Alstoniascholaris*	LC	Other
20	Tonsae	*Caryotaurens*	LC	Other
21	Thnaot	*Borassusflabellifer*	EN	Other
22	RusseiSrok	*Dendrocalamusmembranaceus*	LC	Other
23	Mien	*Dimocarpuslongan*	NT	Other
24	KanhChhet	*Neptuniaoleracea*	LC	Other
25	Rolous Bay	*Erythrina variegata*	LC	Other

WQC: Wood Quality Classification

Source: Interview with local people, July 2016

11.7.2 Social Environment Survey

(1) Survey Area

The social environment was surveyed in July 2016. The location map of the survey site is shown in Figure 11.7-2.

Source: JICA Survey Team

Figure 11.7-2 Location Map for Social Environment Survey Area

(2) Condition of Local Society

The survey area belongs to the administrative district of Sangkat 1, Mondul 3 and Sangkat 3, Mondul 3 in the Preah Sihanouk Province. The total population of Sangkat 3 and Sangkat 1 is 39,000 (see Table 11.7-7). The total number of households in the survey area is 1,846, and survey samples were taken from 329 households. The estimated population in the survey area is 8,300 on the assumption of 4.5 persons per household.

The percentage of Cambodian in nationality is 92.4%, and 97.6% of the population is Buddhist. The major occupation is fishing, which earns them USD 75 to 3,000 per month.

Table 11.7-7 Households and Population in the Survey Area

No.	Sangkat	Mondul	Number of Households *1	Population *1			Households in Survey Area *2	Sample Households *2
				Female	Male	Total		
1	Sangkat 3	Mondul 1	729	1,644	1,539	3,183	Out of area	
2		Mondul 2	1,492	3,408	3,481	6,889	Out of area	
3		Mondul 3	2,102	4,564	4,571	9,135	1,337	
4	Sangkat 1	Mondul 1	1,163	2,756	2,566	5,322	Out of area	
5		Mondul 2	691	1,562	1,538	3,100	Out of area	
6		Mondul 3	2,537	5,735	5,522	11,257	509	
Total			8,714	19,669	19,217	38,886	1,846	329

Source *1: Planning Department of Preah Sihanouk Province, 2016

Source *2: Interview survey on July 2016

(3) Fishing Activity

There are 867 fishing households out of 1,846 in the survey area. Samples for the survey were taken from 90 households.

More than 80% of fishermen have fishing experience of more than five years (see Figure 11.7-3). Most fishermen use gill net or shrimp net (see Field 11.7-4). There are 33 fishing grounds (Table 11.7-8), and six major fishing grounds in Russei Island, Tang Island, Rong Island, Thas Island, Polavai Island, and Pring Island. The fishermen complained that the fish yield is decreasing year by year due to large fishing boats from other countries using illegal fishing gears.

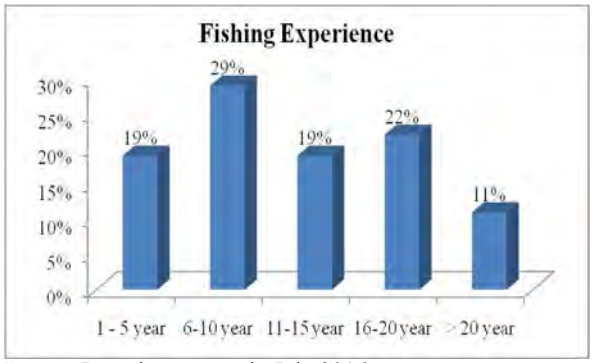
All fishing grounds are far from the Sihanoukville Port; however, travelling routes to visit the fishing grounds are near the proposed project sites, and the fishermen worry for troubles during the construction phase. In addition, fishermen worry about resettlement.

The fishermen's requests and comments on the project are as follows:

- Provision of anchorage points for fishing boats,
- Announcement of construction start, and
- Compensation in case of project impact.

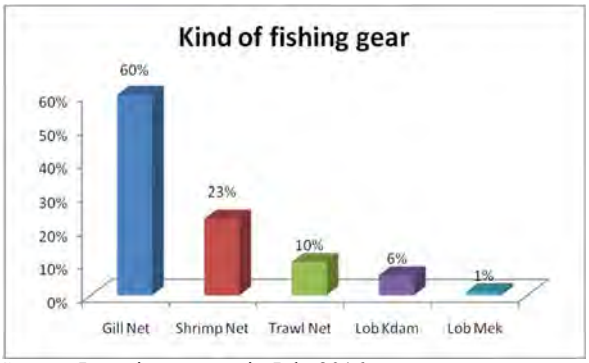
The fishermen's requests to the fishery department of local authority are as follows:

- Prohibition of large fishing boats,
- Difficulty of finding anchorage points for fishing boats, and
- Decreasing fishing yield.



Source: Interview survey in July 2016

Figure 11.7-3 Fishing Experience of Sample Fishermen



Source: Interview survey in July 2016

Figure 11.7-4 Fishing Gear Used by Sample Fishermen

Table 11.7-8 List of Fishing Grounds Used by Fishermen in the Survey Area

No.	Name of Fishing Ground	No.	Name of Fishing Ground	No.	Name of Fishing Ground
1	Russei Island	12	Preap Island	23	Touch Island
2	Tang Island	13	Kos Kong	24	Krorsa Island
3	Rong Island	14	Ream	25	Smach Island
4	Thas Island	15	Red light	26	Pan Island
5	Polavai Island	16	Doung Island	27	Anderk Island
6	Pring Island	17	Poy Lor	28	Kala Island
7	Dekkoul Island	18	Takeav Island	29	Thmar Sor
8	Sdach Island	19	Yor Island	30	Ta Island
9	Ses Island	20	Tres Island	31	Yeay Island
10	Puos Island	21	Chrorlous Island	32	Tonsay Island
11	Lor Tektrey	22	Krorbei Island	33	Be Island

Source: Interview survey on July 2016

(4) Aquaculture

A total of 20 families started fish farming in 2003. A total of 12 families closed their businesses because of fish death, and only eight families remained presently according to the village chief. The average income of families is USD 5,000 per year (see Table 11.7-9).

The fish farmer's requests to the project or government are as follows:

- Protection of fish cages from sediment dispersion during construction,
- Prevention of wastewater inflow from the land to the sea, and
- Compensation of fish death during construction.

Table 11.7-9 Aquaculture Yield in 2015 in the Survey Area

No.	Total Cage Size (m^2)	Total Expend (USD)	Total Sell (USD)	Profit (USD)
1	75	2,900	2,500	-400
2	300	19,262	15,000	-4,262
3	270	33,600	40,600	7,000
4	225	15,000	18,000	3,000
5	18	34,600	58,600	24,000
6	32	20,125	24,225	4,100
7	360	29,000	34,000	5,000
8	360	39,575	41,771	2,196
Average				5,079

Source: Interview survey on July 2016

(5) Tourisms

The number of visitors of Preah Sihanouk Province in the first semester of 2016 was 1,032,881, and its growth rate was 16.65% compared with the first semester of 2015. The number of domestic and international visitors was 809,784 and 223,097, respectively.

Table 11.7-10 Tourism Industry in Preah Sihanouk Province

Type	Number	Type	Number
Hotel	73	Sport tourism	15
Guest house	289	Travel agent	28
Restaurant	152	Tourism boat	62
Health massage	27	Tourism bus company location	12
Karaoke	10	Resort	22
Discotheque	3		

Source: Department of Tourism of Preah Sihanouk Province, 2016

(6) Existing Waste Management of Sihanoukville Port

The main non-hazardous wastes generated from Sihanoukville Port are plastics, wood chips, bottles, tins, and papers. These wastes are collected by a private company (CINTRY Co., Ltd.) and are disposed at the city's waste disposal area. The landfill site is 35 km away from Sihanoukville City with an area of 2 ha. About 88 tons of waste is disposed to this area daily.

On the other hand, oily wastes are the main hazardous wastes generated in the maintenance shop of port. Basically, generated bilges from maintenance shops are also collected by CINTRY Co., Ltd and are treated by them.

11.8. Preliminary Environmental Impact Evaluation

Preliminary evaluation of environmental impact according to the survey is shown in Table 11.8-1. The evaluation is preliminary because some parts of the additional survey which are requested by MOE are not implemented yet.

Table 11.8-1 Evaluation of Environmental Impact

Category	No	Impact factors	Scoping		Evaluation		Reasons of Evaluation
			Before/during construction	During operation	Before/during construction	During operation	
Social Environment	2	Local economies, such as employment, livelihood, etc.	+B/ B-	+B/ B-	+B/ B-	+B/ B-	(During construction) New job creation is projected due to the construction of the project. On the other hand, local fishery might be disturbed by construction works (ex. increase in number of construction ships and increase in turbidity caused by dredging and reclamation works). Eight families who work on aquaculture might be affected by muddy water, but the impact is limited according to the monitoring data from other ongoing project construction works. (During operation) Since this project is a large-scale development, it will provide job opportunities to the locals in Sihanoukville City. The project will result in an overall socioeconomic improvement of Cambodia including people living around the project area. Small boat fishermen should pay attention to large ships transportation in the sea after the project. Eight families can illegally use the cages of aquaculture after the proposed project development.
	3	Land use and utilization of local resources	B-	B-	B-	B-	(During construction/During operation) Local fishermen illegally conduct aquaculture beside the existing breakwater. The impact on fish farming may occur due to mud flow caused by dredging and reclamation works. The boat traffic for aquaculture and fishing outside the port may be obstructed by construction work ships or container vessels. In addition, the traveling route of boats in the port will be changed because of the proposed berth. However, boats can pass under the proposed bridge.
	5	Existing social infrastructures and services	B-	B-	B-	B-	(During construction/During operation) Construction vehicles and container trucks may cause traffic jam along the National Road No.4 and coastal road. Many residents live near the access route in the project site; therefore, environmental impact is expected to occur and will require mitigation measures to reduce the impact.
	6	The poor, indigenous, or ethnic people	C	C	B-	B-	(During construction/During operation) The impact caused by the proposed project is limited because no one lives inside the project site. However, illegal occupants including poor who live in surrounding area will be affected by the proposed project. No indigenous/ethnic people regulated under Cambodian laws were found in the proposed project area.
	7	Misdistribution of benefits and damages	B-	B-	B-	B-	(During construction/During operation) The project might cause misdistribution of benefits and damages between the person concerned with the port and fisherman both construction/operation phases. Mitigation measures are needed to minimize damage to fishermen and avoid large misdistribution of benefits.
	11	Local conflicts of interest	B-	B-	B-	B-	Local conflict might occur due to the proposed project, for example, between construction workers and local people during construction phase, and between crew of container vessels and fishermen riding small boats during operation phase. The conflict is not so serious because the proposed mitigation measures, such as the proposed new bridge, construction worker's training, and others, can manage the situation adequately.

Social Environment	12	Water usage or water rights and communal rights	B-	B-	B-	B-	(During construction/During operation) Eight families conduct aquaculture beside the existing breakwater illegally. In addition, fishermen are conducting small-scale fishery in the coastal area and it is expected that some impact will occur based on the layout of port facilities. The access route of small- and medium-size fishing boats to the mooring site is changed and new route is reserved under the proposed bridge.
	13	Public health	B-	D	B-	D	(During construction) Risk of the item would increase in fixed probability due to influx of laborers into the proposed project area. In addition, risk of STD/STI and HIV/AIDS between construction workers and local people would increase. Adequate mitigation measures, such as construction worker's training, are required during construction phase.
	14	Hazards (risks) of infectious diseases such as HIV/AIDS	B-	D	B-	D	(During construction) There might be some possibility for disease to be introduced at the site because of the expected migration of many workers from other regions. It is recommended to implement educational training for construction workers during construction phase.
Natural Environment	19	Coastal zone	B-	D	D	D	(During construction) The proposed port container terminal is planned inside the existing port area. In order to construct an access channel for vessels, dredging and disposal of dredged soils are anticipated; and some impact to the water quality is expected. However, no significant negative impact to the coastal zone is anticipated in the project according to the result of monitoring for the MPT Project.
	20	Flora, fauna, and biodiversity	B-	D	B-	D	(During construction) The project site is not located within a preserved zone or conservation area for biodiversity regulated by international treaties or national laws. According to the interview survey with the local people, some important species might be living in the surrounding area. In that case, the species has the possibility experience negative impact due to the proposed project. However, the impact might be limited because new development area of the project in the terrestrial area is not so large.
Pollution	22	Air pollution	B-	B-	B-	B-	(During construction) Some impact of exhaust gas and dust generated by the construction equipment and material transportation vehicles are anticipated. Local residents inhabit the coastal area beside the proposed construction site and necessary countermeasures and mitigations are needed. (During operation) Exhaust gas and dust due to increase of container truck traffics will cause air pollution.
	23	Water pollution	B-	D	B-	D	(During construction) Dredging and disposal of dredged soils are required for the port and access channel so it is possible that soils and sediments will be disturbed. However, no significant negative impact to the coastal zone is anticipated in the project according to result of the monitoring for the MPT Project. In addition, large scale land reclamation is planned in the proposed project. The water discharged from spillway in the reclamation area will require adequate environmental preservation measures to prevent diffusion of pollutants.
	24	Soil contamination	C	C	D	D	(During construction/During construction) If soil source for reclamation works of the proposed project is contaminated, the project will cause soil contamination in the project site. The proposed project would not cause soil contamination because the project will use two type of soil for the reclamation work; one is perchance from official licensed supplier, and another is reused dredging soil from the seabed. Dredging soil quality has already been ensured through soil analysis in the EIA survey.

Pollution	25	Waste	B-	B-	B-	B-	(During construction) It is expected that garbage from workers' camps and solid waste generated from the construction works will cause some impact. Hazardous, non-hazardous, and domestic wastes generated during the construction phase will be transported off-site by appropriately licensed contractor to an approved disposal site. Also, septic wastes on site will be collected and disposed off-site by the same company. The amount of hazardous wastes generated in this project would be limited. (During operation) The oil leaked from bilge of vessels has potential significant impacts. In case there is no oil treatment facilities in the port, oil leaked from bilge of vessels should be treated by a waste treatment company (CINTRY Co. Ltd.) outside the port.
	26	Noise and vibrations	B-	B-	B-	D	(During construction) It is expected that the noise during construction is from piling work and equipment; however, all construction works will be done inside the project site. Some construction works will be carried out near the residential area. Transportation of machineries and materials will be via sea; however, transportation in land such as construction vehicles and machines will cause impacts such as traffic, noise, and vibrations. (During operation) Based on project plan, no serious noise/vibration source are included in the proposed project.
	29	Bottom sediment	C	D	B-	D	(During construction) During disposal of dredged soils in the disposal site in the sea area, there is a possibility of soil sedimentation. However, only limited impact would be expected based on monitoring data from the MPT Project and SSCD Project. The disposal site will be monitored by a GPS system installed in the vessel. The proposed disposal site has been utilized by PAS.
Other	30	Accidents	B-	B-	B-	B-	(During construction) Traffic due to transportation of construction machinery by sea and land is expected to cause some impact to the local communities. (During operation) Approximately 1,300 vessels per year are using the existing Sihanoukville Port. In 2040, the number of vessels would increase 3 times of the existing number (approximately 4,200 per year). An increase in cargo transportation trucks increases the possibility of accidents, and appropriate mitigation is required.

Source: JICA Survey Team

11.9. Environmental Management Measurements (EMP) and Cost

The proposed environmental management plan (EMP) and draft cost estimate for implementation of the EMP are indicated in Table 11.9-1. The cost estimate is based on interview with local environmental consultants.

Table 11.9-1 Proposed Environment Management Plan (EMP)

No.	Impacts	Mitigation Measures	Implementing Institutions	Responsible Organization	Cost (USD)
During construction					
2	Local economies such as employment, livelihood, etc.	➢ To select a bridge design from land to new terminal as best alternative. ➢ To establish a grievance desk in PAS and contractor's office for local people to discuss environmental issue during construction phase. ➢ To bring to local people's attention the time of construction vessel calling at port/departure time. ➢ Safety navigation by pilot of transportation vessels for construction material. ➢ To install the safety buoys to prevent the entrance of fishery boat to construction area	Contractor/PAS	PAS	
3	Land use and utilization of local resources	➢ To conduct water quality monitoring around the fish farming area and housing area of local residents in Sankgat3.	Contractor	PAS	
5	Existing social infrastructures and service	➢ To train construction workers about safety and sanitation regularly. ➢ To raise drivers' awareness on traffic safety through educational training. ➢ To prepare a notice board at the construction site for enlightenment on safety first as the most priority, and fix necessary facilities and inspect it regularly. ➢ To select a bridge design from land to new terminal as best alternative.	Contractor/PAS	PAS	
6	The poor, indigenous, or ethnic people	➢ Communication with local community through stakeholder meetings. ➢ To establish a grievance desk in PAS and contractor's office for local people to discuss environmental issue during construction phase.	Contractor/PAS	PAS	
7	Misdistribution of benefits and damages				
11	Local conflicts of interest				
12	Water usage or water right and communal right	➢ To distribute information about the construction project by signboards and circulars. ➢ To install marker buoy in the dredging and disposal areas. ➢ To establish a grievance desk in PAS and contractor's office for local people to discuss environmental issues during construction phase.	Contractor/PAS	PAS	
13	Public health	➢ To regularly provide an education program for construction workers about infectious diseases.	Contractor	PAS	
14	Infectious diseases such as HIV/AIDS	➢ To regularly provide an education program for construction workers about infectious diseases. ➢ To prepare pamphlets and signboards on HIV/AIDS awareness.	Contractor	PAS	
20	Flora, fauna, and biodiversity	➢ To minimize development area during design phase.	PAS	PAS	

No.	Impacts	Mitigation Measures	Implementing Institutions	Responsible Organization	Cost (USD)
22	Air pollution	➢ To maintain construction vehicles and construction machines properly. ➢ To avoid intensive operation of construction machines. ➢ To sprinkle water around the project site and proposed road.	Contractor	PAS	
23	Water pollution	➢ To conduct water/sediment quality monitoring during dredging works. If sediment dispersion level during daily monitoring exceeded the standard value, the contractor should stop the construction work. The contractor should identify the causes of the pollution to restart their construction work. ➢ To set up a silt fence, if needed. ➢ To carry out monitoring of discharged water with appropriate countermeasures of spill water during landfill works. ➢ To establish a grievance desk in PAS and contractor's office for local people to discuss environmental issue during construction phase.	Contractor/PAS	PAS	
25	Waste	➢ To carry out solid waste management properly by promoting 3R (reduce, reuse, and recycle). ➢ To manage hazardous wastes (oil and chemicals) including construction soil and consign it to a specialized company for collection and treatment. ➢ To install waste bins to strategic areas in the workers' camp and construction site properly.	Contractor	PAS	
26	Noise and vibrations	➢ To carry out monitoring at the construction site and access road to the site. ➢ To control and manage the number of construction vehicles and construction equipment properly. ➢ To avoid construction work at nighttime.	Contractor	PAS	
29	Bottom sediment	➢ To monitor impact on sediment during construction phase.	Contractor	PAS	
30	Accidents	➢ To train construction workers about safety and sanitation regularly. ➢ To raise drivers' awareness on traffic safety through educational training. ➢ To prepare a notice board at the construction site for enlightenment on safety first as the most priority, and fix necessary facilities and inspect it regularly. ➢ To bring to local people's attention the time of construction vessel calling at port/departure time ➢ Safety navigation by pilot of transportation vessels for construction material. ➢ To install the safety buoys to prevent the entrance of fishery boat to construction area	Contractor/PAS	PAS	
During Operation					
2	Local economies such as employment, livelihood, etc.	➢ To establish a grievance desk in PAS and contractor's office for local people to discuss environmental issue during operation phase. ➢ To bring to local people's attention the time of vessel calling at port/departure time. ➢ Safety navigation by pilot for vessels calling at port/departure.	Contractor/PAS	PAS	

No.	Impacts	Mitigation Measures	Implementing Institutions	Responsible Organization	Cost (USD)
3	Land use and utilization of local resources	➢ To conduct water quality monitoring around fish farming areas and housing areas of local residents in Sankgat3.	PAS	PAS	
5	Existing social infrastructures and service	➢ To train workers about safety and sanitation regularly. ➢ To raise drivers' awareness on traffic safety through educational training. ➢ To prepare a notice board at the construction site for enlightenment on safety first as the most priority, and fix necessary facilities and inspect it regularly.	PAS	PAS	
6	The poor, indigenous, or ethnic people	➢ To establish a grievance desk in PAS for local people to discuss environmental issue during operation phase. ➢ Communication with local community through stakeholder meetings. ➢ To bring to local people's attention the time of vessels calling at port/departure. ➢ Safety navigation by pilot for vessels calling at port/departure.	PAS	PAS	
7	Misdistribution of benefits and damages				
11	Local conflicts of interest				
12	Water usage or water right and communal right	➢ To distribute information about the construction project by signboards and circulars. ➢ To install marker buoy in the dredging area and disposal area.	PAS	PAS	
22	Air quality	➢ To maintain vehicles and operation machines properly.	PAS	PAS	
23	Water pollution	➢ To conduct periodic water quality monitoring in the port area including fish farming and housing areas of local residents.	PAS	PAS	
25	Waste	➢ To carry out solid waste management properly by promoting 3R. ➢ To manage hazardous wastes (oil and chemicals) and consign it to a specialized company for collection and treatment. ➢ To dispose solid waste generated in operation yard of terminal properly.	PAS	PAS	
30	Accidents	➢ To carry out safety training to operation workers regularly. ➢ To carry out traffic safety training to the drivers. ➢ To set up traffic signboards based on the traffic rules and to dispatch traffic control staff properly. Training about international laws of vessels (MARPOL). ➢ Safety navigation by pilot for vessels calling at port/departure.	PAS, Transportation Company	PAS	

Source: JICA Survey Team

11.10. Proposed Environmental Monitoring Plan (EMoP)

Unexpected problem may possibly appear in the stage of planning and also during operation. The monitoring plan aims to provide the detailed monitoring program which covers the whole project and to prepare for the problems timely when it happens. It is important to monitor and record the environmental change continuously since unforeseeable matters could happen in this large-scale development project. Monitoring plans suitable for the project implementation are displayed in Table 11.10-1.

Table 11.10-1 Proposed Environmental Monitoring Plan

Classification of Monitoring /Sampling Points		Items	Detailed Condition		
			Implementing Institutions	Responsible Organization	Frequency
During Construction					
1	Water quality in the dredging and disposal sites	Turbidity (NTU)	Contractor	PAS	Every working day during construction
2	Water quality in the reclamation site	Turbidity (NTU)	Contractor	PAS	Every working day during construction
3	Soil erosion in the reclaimed site	Including monitoring on reclamation and leveling of ground, and mitigation plans on work process and technology	Contractor	PAS	Every working day during construction
4	Sediment soils in the dredging area, access channel, and inside of breakwater	pH, T-S, T-N, T-P, T-Hg, Cd, CN, Cr, Cr+6,Pb, As, PCB, Cu, and Zn	Contractor	PAS	Reclamation soil: twice a year
5	Air quality	Particulate matter (aerodynamic diameter PM10 Size < 10 μm in size), Particulate matter (aerodynamic diameter PM2.5 Size < 2.5 μm) NO2, SO2,Pb, and CO	Contractor	PAS	Once during dry season and once during rainy season
6	Waste from the construction site and dumping site	Amount of garbage collected at the site, collecting situation, and dumping situation	Contractor	PAS	Everyday
7	Compliance about health management and safety of construction workers	Implementation status of education program for construction workers and understanding level of the workers	Contractor	PAS	Everyday
8	Noise and vibration (1) Construction noise level	Residential area	Contractor	Contractor	Once during dry season
9	Noise and vibration (2) Number of construction vehicles	Construction machineries and vehicles	Contractor	Contractor	Everyday
10	Traffic congestion	Traffic volume counted by the categories on access road to the construction site during peak time	Contractor	Contractor	Every month
11	Safety navigation for fishermen	Status of safety navigation for construction vessels	PAS	PAS	Everyday
Operation Phase					
1	Water quality in the reclamation site	Turbidity (NTU)	PAS	PAS	Once a year (first year during operation phase)
2	Sediment soils in the dredging area, access channel, and inside of breakwater	pH, T-S, T-N, T-P, T-Hg, Cd, CN, Cr, Cr+6,Pb, As, PCB, Cu, and Zn	PAS	PAS	Once a year (first year during operation phase)
3	Water quality in the dredging area, access channel, and inside of breakwater	Water temperature, salinity, turbidity, TSS, pH, DO, BOD5, COD, T-N, oil and grease, and coliforms MPN/100 mL	PAS	PAS	Once during dry season and once during rainy season (first year during operation phase)
4	Safety navigation for vessels	Status of safety navigation for vessels	PAS	PAS	Everyday (operation phase)

Source: JICA Survey Team

11.11. Public Consultation

11.11.1 Stakeholder's Meeting

Stakeholder's meeting is important for the preparation of EIA. The purpose of the stakeholder's meeting is to promote residents' understanding by providing project information and exchange of ideas among residents, stakeholders, and implementing bodies. The JICA project requires close communication with the stakeholders during construction and operation stages based on the JICA Guidelines.

The project is required to conduct information disclosure, public consultation, and public participation during the planning and implementation stages in the form of stakeholders meetings.

The stakeholder's meetings are planned to be carried out three times by PAS based on the Cambodian law and JICA Guidelines during the implementing stage of the field survey, EIA stage, and after the completion of draft EIA. The schedule of the third stakeholders meeting, however, is not fixed at present. In accordance with the Law on Environmental Protection, comments collected during public consultation are to be reflected into the EIA and basic design of the proposed project.

(1) Summary of the Stakeholder's Meeting

The summary of the stakeholder's meeting is shown in Table 11.11-1. PAS called for women and other vulnerable people's participation through the village leaders and paid special attention to decide the time, venue, and methods of the meeting for them to join easily.

Table 11.11-1 Summary of the Stakeholder's Meetings

No	Date	Participant		Venue	Notes
		Number	Type of Participant		
1	08 April 2016	40 (Male 37,Female 3)	Local residents (34), people concerned construction (6)	Sihanoukville New Beach Hotel	Attended by the chairman and CEO of PAS
2	03 June 2016	44 (Male 31,Female 13)	Local residents (31), people concerned construction (8), government officials (5)		
3	07 Dec 2016	45 (Male 38,Female 7)	Local residents (23), Local media(4), people concerned construction (5), government officials (13)		-

Source: JICA Survey Team

(2) Stakeholder Groups

The target groups of the meeting include government officers at the provincial levels, chief of the fishing village, fishermen, local residents (Sankgat 1 and Sankgat 3), citizens of Sihanoukville City, PAS, and the JICA Survey Team. The complete list of participants is listed in the Appendix.

PAS urged the attendance of women to the meeting with the local leaders. As a result, a total of 18 females attended the stakeholder's meetings due to the PAS's special request.

(3) Invitation to the Stakeholder's Meetings

Local residents in Sihanoukville City, including fishermen near the project site, were invited to all of the stakeholder's meetings. PAS informed the date and capacity of the venue to the village chiefs or community leaders, and the chiefs or leaders selected the participants. The invitation letters are attached in Appendix.

Newspaper was not applied as a mean in announcing the stakeholder's meeting because only few people read newspaper especially in the fishing villages.

(4) Topics and Discussions in the Stakeholder's Meetings

The Minutes of the Stakeholder's Meetings are attached as Appendix.

1) First Stakeholder's Meeting

The first stakeholder's meeting was held on 08 April 2016 to introduce the proposed project and to announce the schedule of site surveys on topography, geology, and others.

No contrary opinion for the implementation of the proposed project is mentioned in the stakeholder's meeting. A summary of the question and answer portion of the stakeholder's meeting is shown in Table 11.11-2.

Table 11.11-2 Summary of Q&A in the First Stakeholder's Meeting

	Question	Answer
1	There is present traffic jam, and will be more severe due to increasing cargo volume. Does PAS have a countermeasure plan for the traffic jam in the front gates?	The options are 1) reduction of waiting time for gate pass, 2) introduction of exclusive lane to access the new container terminal, and 3) enhancement of container transport by railway.
2	Is the land acquisition of the residential area for road expansion expected?	The land of PAS will be used for road expansion. PAS will make an effort to minimize impacts on residential areas.
3	The damping site for dredged soil seems to have strong current. Will the soil spread to the sea?	The damping works will be conducted considering the direction of the current. The soil will be damped in the planned damping site with strict monitoring.
4	Can PAS decide to allow or disallow building constructions on the water inside the port?	The area inside the breakwaters is the territory of PAS. In general, PAS can manage building construction in the port area.
5	The cultured fishes recently died, and the ongoing project seems to have caused the fish death.	The cause of death according to newspaper is parasites, which is not related to the construction works. The potential impact by dredging is only muddy water. The contractor monitors the level of turbidity of the seawater everyday.
6	Is impact on fish farming expected during the construction phase of the proposed project?	The potential impact by dredging is only muddy water. In case high turbidity is detected by monitoring, the dredging works will be stopped.

Source: JICA Survey Team

2) Second Stakeholder's Meeting

The second stakeholder's meeting was held on 03 June 2016 to explain the progress of facility designs and the scoping of EIA. No contrary opinion for the implementation of the proposed project is mentioned in the stakeholder's meeting. The major questions and answers in the meeting are shown in Table 11.11-3.

Table 11.11-3 Summary of Q&A in the Second Stakeholder's Meeting

	Question	Answer
1	Is there any compensation to the people affected by the proposed road widening?	No resettlement and land acquisition are planned.
2	What is the size of the proposed container terminal?	The proposed berth is 350 m x 550 m^3.
3	Where is the source of soil for the proposed land reclamation? How many cubic meters of soils are required?	The soil will be taken from the sea and land. The reclamation volume is 2-3 million m^3 [4].
4	Was the sediment quality test conducted to check harmful substances considering the proposed dredging works?	The sediment samplings were conducted in the ongoing MPT Project, and those samples passed the standards.

Source: JICA Survey Team

3) Third Stakeholder's Meeting

The third stakeholder's meeting was held on 07 December 2016 to explain the progress of facility designs and EIA analysis. No contrary opinion for the implementation of the proposed project is also mentioned in the stakeholder's meeting. The major questions and answers in the meeting are shown in Table 11.11-4.

[3]This answer included the proposed berth box. The size of proposed new container terminal is 350 m x 500 m.
[4]This answer was based on the on-going design works, and the design was changed to 1.5 million m^3 later.

Table 11.11-4 Summary of Q&A during the Third Stakeholder's Meeting

	Question	Answer
1	Where is the location of the soil used for reclamation works?	The reclamation material must meet three main criteria, including: (1) quality suitability for the said purpose, (2) the locations shall not have or have a slight impact on social and environment, and (3) the soil transportation shall not cause any severe impact to public order and/or living conditions of local residents.
2	Dredging works might cause some impacts to fishing farm near the project site, what is the compensation to the fishing farmers in case of fish death?	During the construction phase, the contractor has to monitor the turbidity/sediment quality within the diameter of 100 m, 500 m, and 1,000 m from the dredging area as well as dumping area everyday. If the dispersion of the water turbidity/sediment monitored exceeds the standard level, the Contractor shall postpone their dredging works and shall install silt fence to avoid any impact to local residents and fishing farms.
3	All soil and rock suppliers must obtain transportation permission letter from relevant department(s) before they could transport these materials to supply PAS.	Soil and rock transportation will be done by sub-contractors and they have to abide with the laws and regulations of Cambodia. If they fail to apply it, everybody can help in enforcing the laws and regulations.
4	Whether or not PAS conducts the studies on the natural disaster of seawater level rise, tsunami, etc.?	We have analysed seawater level in the past ten years and found that there is no significant rise of seawater level. In addition, Cambodia has not been affected by tsunami.
5	When will you request us to relocate from our current residence to a new location considering the project will start to construct in 2019? What would be the resettlement mechanism?	This project will not conduct resettlement.

Source: JICA Survey Team

11.11.2 Recommendation of Work Items for Environment and Social Considerations in the Next Project Stages

The proposed work items for environmental and social considerations in the following project stages are described below based on the observations on stakeholder's meetings.

Before starting the project (construction works for dredging and land reclamation), information on the proposed construction work should be distributed to local residents including fishermen who live in adjacent areas near the port. The water quality monitoring in the ocean area for dredging work and study of countermeasures for dredging and disposal of dredged materials are required to prevent water pollution due to construction works. Impact on fishing activities of local residents should be removed or mitigated.

Table 11.11-5 Summary of Recommended Work

Required Activity	Target to be Achieved	Input	Responsible Organizations
(1) Explanation to stakeholders (fishermen) during construction phase	Distribution of information -Period of dredging work -Area of dredging work	-Meeting and pamphlet	By PAS/Contractor
(2) Explanation to stakeholders (fishermen) before starting construction	Distribution of project information -All project information	-Pamphlet	By PAS (information should be distributed by the chief of the local community/or local government organizations)
(3) Explanation of monitoring result of water quality (aquaculture beside of breakwater) during construction phase	-Monitor the impact on environment caused by the project to take actions if required	-Water sampling -Water quality analysis	By PAS/Contractor

Source: JICA Survey Team

11.12. Long Term Plan for Environmental and Social Consideration

11.12.1 Background

Currently, large-scale illegal occupants, approximately 8,000 people, are found inside of Sihanoukville Port area. The illegal communes became a significant problem for PAS from the viewpoint of safety on the use of the port. Most illegal occupants are fishermen and their families. They live on fishing using small-/middle-sized boats. As port development expands in the near future, they will be exposed to risk in sea.

PAS discussed with the illegal occupants to relocate from the area; however, the discussion has remained stagnant. Because of the request from PAS, the issue might be solved by the provincial government. In the second stakeholder's meeting of the proposed project, the provincial governor stated that the provincial government will implement the relocation responsibly under the situation.

The proposed project does not include any resettlement. However, the issue is significant for the project considering the long-term plan for the Sihanoukville Port. Therefore, the vision and challenges about the future resettlement are mentioned as follows:

11.12.2 Proposed Resettlement Plan by PAS

PAS proposed two alternative resettlement sites: i) alternative site inside PAS jurisdiction and ii) PAS's land near the airport. Detailed proposals of each plan are summarized as follows:

(1) Alternative Area Inside PAS Jurisdiction

PAS has long-term development plan for the Sihanoukville Port（see Figure 11.12-2）.

The plan mentions that a new port will be extended outside of the existing breakwater. The proposed resettlement site for Sankgat3 is planned beside the port facility under the proposed bridge along the access road to the new container terminal and faced to the sea area. The preliminary resettlement plan proposed by PAS considered the following three options:

- The residents who live in Sankgat 3 (shown in red color) could move to the area along the existing bridge. In this case, fishermen can utilize the port same as existing conditions.
- The residents who live in Sankgat3 and owners of small shops along the existing road could be moved beside of Hun Sen Beach Road side of SEZ area. In this case, PAS will set back the SEZ area to ensure resettlement site for the shops.
- In case the resident would like to move to other place out of the port area, PAS will arrange compensation for the person based on government regulations.

Source: JICA Survey Team

Figure 11.12-1 Current Situation of the Proposed Resettlement Site Inside PAS Jurisdiction

Source: PAS future plan

Figure 11.12-2 Location Map of the Proposed Resettlement Site Inside PAS Jurisdiction as of October 2016

The expected challenges for the resettlement are the following:

- No provision for detailed resettlement action plan including detailed measurement survey,
- Remaining illegal occupants inside PAS jurisdiction,
- Possibility of increasing risk of sea accident due to narrow waterway for fishery boat in sea, and
- Loss of livelihoods for aquaculture.

(2) PAS's Land near the Airport

Currently, PAS is developing a second SEZ area (See Figure11.12-3 and Figure 11.12-4) and has a plan to relocate two communes, which had occupied the existing port area illegally, from the port area to inside of the planned SEZ area. PAS already has an advanced outline of the resettlement plan to the illegal occupants; however, they disagreed with the resettlement site. Currently, the detailed resettlement plan for illegal settlers along the coastal area is not prepared yet.

The proposed relocation site is located approximately 20 km north from the existing port. At present, most of the site (approximately 150 ha) is bare land. However, PAS already started land reclamation works in the area. In addition, the connecting road to the Otres Beach is also being developed.

A small canal along the proposed resettlement site can be used as access waterway to the sea for small fishery boats.

Source: JICA Survey Team

Figure 11.12-3 Location Map of the Proposed Resettlement Site near the Airport as of October 2016

Source: JICA Survey Team

Figure 11.12-4 Current Situation of the Proposed Resettlement Site near the Airport

The expected challenges for the resettlement are the following:

- No provision for detailed resettlement action plan including the detailed measurement survey,
- Inadequate infrastructure such as water and electricity,
- Degradation of access possibility to the sea (especially middle/large fishery boat), and
- Loss of livelihoods for aquaculture.

11.12.3 Recommendation

The resettlement of illegal occupants from official land is one of the most sensitive issues for environmental and social consideration. In addition, the Cambodian land title system is very complicated under historical background. The resettlement issue inside the Sihanoukville Port is too difficult to solve by PAS alone. Therefore, PAS should collaborate with the provincial government to discuss the solution. The main responsible authority of the issue is the provincial government. PAS needs push and support for their action.

PAS should provide the following necessary information to the provincial government:

- Future development plan of the port,
- Future development plan of PAS's land near the airport,
- Compensation policy from PAS to resettlement people (title of land, house, and others),
- Detailed condition of the resettlement site,
- Proposal of support to resettlement people from PAS, and
- Future schedule of resettlement.

In addition, lifestyle/livelihoods of people target for resettlement might be changed drastically by the relocation. PAS and the provincial government should support them to recover their livelihoods same as their existing status. In view of gender consideration, PAS and the provincial government are recommended to pay special attention to women, if needed. For example, installing job training system and transition support for employment can be proposed as mitigation measures for women in the long-term plan.

12. BUSINESS SCHEME FOR NEW CONTAINER TERMINAL

12.1. Alternatives for the Development of the New Container Terminal

A container terminal operator may be 1) a private terminal operator who is granted an operation concession from the port authority or who has a lease contract with the port authority, 2) a private terminal operator who builds the container terminal and installs cargo handling equipment, 3) the operation department of the port authority, 4) a state owned enterprise or joint stock company which is owned by a public corporation, local or central government, 5) a private corporation which is derived from the privatization of the port authority, and other corporate bodies.

One option is for PAS to lease out the new container terminal to private operators, however, another option would be for PAS to operate the container terminal itself and thereby acquire the know-how to effectively operate a container terminal. This would entail establishing a terminal operation company.

Careful consideration shall be given to the scheme of container terminal operations from the viewpoint of productivity of container cargo handling, good services to shipping lines and consignees, sufficient revenue to redeem the port investment, and development of its hinterland to contribute to the national economy. Advantages and disadvantages of the abovementioned types of terminal operation are shown in Table 12.1-1.

Table 12.1-1 Advantages and Disadvantages of Terminal Operation Types

	Types of Terminal Operation	Advantages	Disadvantages
1	Lease to Terminal Operator	International container terminal operator will improve the productivity of operation instantly.	The income of PAS is reduced. Terminal operation skills are not transferred to PAS.
2	Development and Operation Concession to Terminal Company	PAS has no need to invest in port development and port capacity will be expanded.	PAS will receive only port dues and concession fee.
3	Development and Operation by PPP	PAS can reduce investment in new port development. Private operation will reduce operation cost.	Revenues are shared between PAS and private operator. Terminal operation skills are not transferred to PAS.
4	Terminal operation company established by PAS and private operator	PAS will have shares of the terminal operation company, and receive dividend and concession fee. PAS can reduce investment. Port labor will move to the terminal operation company.	PAS's revenue will reduce due to separation of container handling service. General cargo handling is not profitable but important for maritime transportation.
5	Direct management by PAS	PAS can improve its capacity of terminal operation. All port income belongs to PAS.	Operation cost remains at a high level. Decision-making for investment, human resources, and managerial issues requires government approval.

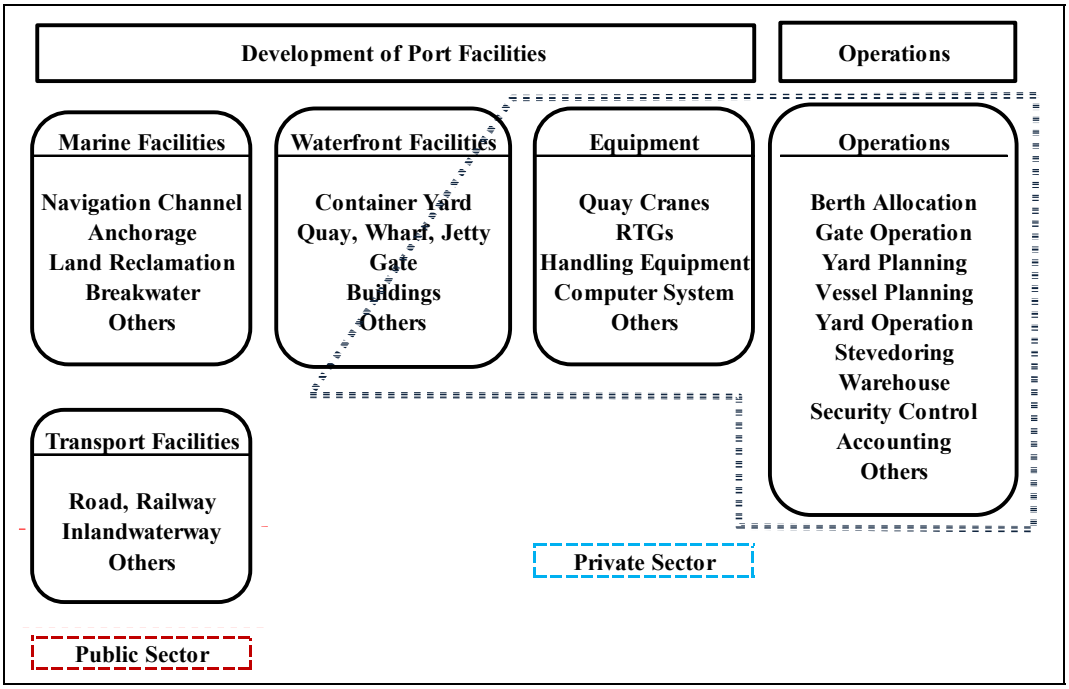
Source: JICA Study Team

12.2. PPP for Port Development and Operations

Typical demarcation of public and private facilities is illustrated in Figure 12.2-1. The public sector is usually in charge of marine facilities, land reclamation and access roads/railways, while the private sector installs cargo handling equipment and operates the terminal. Waterfront facilities such as quay walls, jetties and pavement and terminal facilities can be developed by either the public or private sector. This study will examine project implementation alternatives and financial schemes (PPP

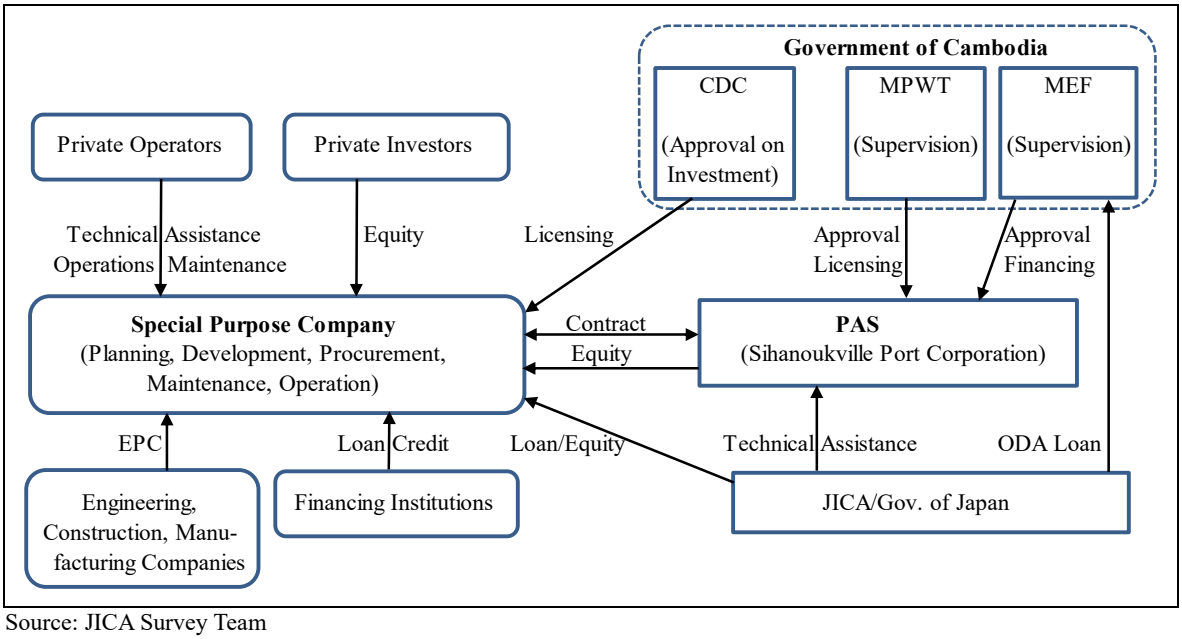
schemes) in consideration of reducing projects risks for the public sector and encouraging private sector participation in the project.

In case of the development by PPP Scheme, financial and technical assistance will be available as shown in Figure 12.2-2.



Source: JICA Survey Team

Figure 12.2-1 Demarcation between the Public and Private Sector in Port Development



Source: JICA Survey Team

Figure 12.2-2 Financial and Technical Assistance in Case of PPP Scheme

12.3. Possible Development and Operation Scheme for the New Container Terminal

There are two possible financial schemes for the development of the new container terminal in Sihanoukville Port. One is the ordinary scheme where PAS develops and operates the new container terminal by its own capacity through financial assistance of international or bilateral aid agencies. The other is the PPP scheme where PAS develops basic infrastructure and invites private operators to develop and operate the new container terminal. In the latter scheme, port facilities to be developed by PAS and private operators are decided according to the financial capacity of private operators and necessity of public involvement. Possible alternatives for the development of the new container terminal are shown in Table 12.3-1.

After the inauguration of the new container terminal, a considerable amount of containers will shift from the present terminal to the new terminal, and revenues from the present terminal will decrease. The new terminal shall compensate for the anticipated decline in revenues of the present facilities.

In this connection, it is appropriate to operate the present terminal and new terminal under one operator. If the present terminal and the new terminal compete with one another, it would be difficult to manage either terminal in a financially sound manner.

Supposing one operator manages the present and new container terminals, types (I) and (IV) are alternatives for the development and operation. In case of two operators, types (II) and (III) are possible alternatives subject to the establishment of port authority as a regulator.

Table 12.3-1 Port Investment Alternative Plans for the Development of New Container Terminal

	Types	Investment and Operation Body	Advantages and Disadvantages
(I)	Direct Management (Public development, Operation by PAS as a joint stock company)	1) PAS develops all infrastructures and superstructures. 2) PAS operates all container terminals.	A) PAS can manage all terminals. A) PAS can maximize its revenue. D) PAS needsto make a large investment. D) No competitive operation will continue for the time being.
(II)	PPP (1) (Public infrastructure, Private superstructures, and Private operation)	1) PAS develops channel, road and land reclamation, 2) Private body develops quays, paves yard, and installs QCs, RTGs and other equipment. 3) Private body operates a new terminal.	A) PAS can considerably reduce investment. A) Competition between new and old terminals may improve productivity of both terminals. D) Competition between new and old terminals may bring large deficit to the old terminal. D) Private operator needs to make a profit and recover its investment. PAS's revenue will thus be reduced.

	Types	Investment and Operation Body	Advantages and Disadvantages
(III)	PPP (2) (Public infrastructures and superstructures, Private operation)	1) PAS develops channel, road, land reclamation, quays, and yards, and installs QCs, RTGs. 2) Private body manages new container terminal under operation concession.	A) Private operator prepares operation system and maintains equipment. A) Competition between new and old terminals may improve productivity of both terminals. D) PAS needs to make a large investment, D) PAS's revenue will be reduced. D) Competition between new and old terminals may bring large deficit to the old terminal. D) It may be required to invite another private operator for the existing terminal.
(IV)	PPP (3) (Public infrastructures, Leased superstructures, Operation by PAS as a joint stock company)	1) PAS develops channel, road, land reclamation, quays, and yards. 2) Private lease company installs QCs, RTGs. 3) PAS operates all container terminals.	A) PAS can manage all terminals. A) PAS can fairly reduce investment and amount of long-term loan. D) PAS makes a contract with a lease company and shares some part of revenue. D) Profit of PAS will be lower than a case of Type (I) D) No competitive operation will continue for the time being.

Source: JICA Survey Team

As a result of discussions between PAS and the Survey Team, the first priority is given to Type (I) which is full development by PAS and direct operation by PAS as a joint stock company. The second priority is given to Type (IV), which is infrastructure development by PAS and direct operation by PAS using leased superstructure.

This priority is based on the fact that PAS will change to a joint stock company in the near future and be able to function as a private operator. It is also recognized that the present container terminal and new container terminal shall not be operated under competitive conditions but in a cooperative manner to make maximum use of their capacity.

Therefore, the development and operation scheme indicated in Type (I) is applied in this study.

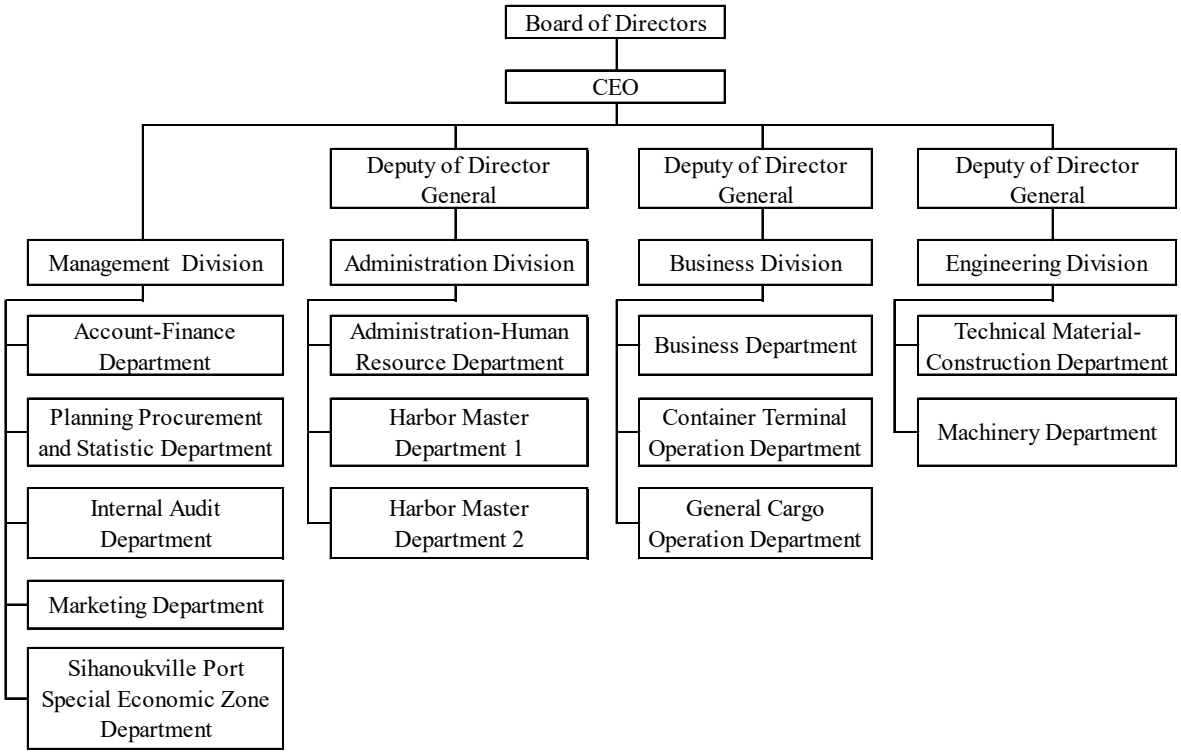
13. PORT OPERATION AND MANAGEMENT

13.1. Confirmation of Present Condition

13.1.1 PAS Organization and Business

PAS provides a comprehensive range of services including bringing vessels in and out for offloading and loading and storage and transport of cargo for customers from all social circles.

The organizational chart of PAS is shown in Figure 13.1-1. The organization consists of four Divisions with thirteen departments arranged under these Divisions.



Source: PAS

Figure 13.1-1 PAS Organization

The Management Division is superintended directly by the CEO. Other Divisions are supervised by Deputy Director Generals.

Officials at April of 2016 are as follows:

HE Lou Kim Chhun	: Chairman and CEO
Mr. Thay Rithy	: Deputy Director General (Business Division)
Mr. Chhun Hong	: Deputy Director General (Administration Division)
Mr. Chea uthdika	: Deputy Director General (Technical and Engineering Division)
Mr. Rath Sela	: Director of Administration-Human Resource Department
Mr. Path Seth	: Director of Accounting-Finance Department
Mr. So Seang	: Director of Planning Procurement and Statistic Department
Mr. Ty Sakun	: Director of Technical Material & Construction Department
Mr. Chiv Chansophal	: Director of SEZ Department
Mr. Chey Sokunthea	: Director of Marketing Department
Mr. Pith Prakath	: Director of Business Department
Mr. Srey Narin	: Director of Container Terminal Operation Department
Mr. Lou Lykheng	: Director of General Cargo Operation Department

Mr. Thong Viro : Director of Harbor Master Department
Mr. Nak Sophyan : Director of Machinery Department
Mr. Men Chann : Director of Internal Audit Department

The number of employees and workers totals 960 as of April 2016. The number of staff by Department and Office is shown in the table below.

Table 13.1-1 PAS Staff Formation and Numbers (April, 2016)

	Department	Office	No. of staff
Top Management (CEO, DDG)			4
Management Division			
	Accounts -Finance Department		12
	Planning Procurement and Statistic Department		11
	Internal Audit Department		4
	Marketing Department		7
	Sihanoukville Port Special Economic Zone Department		11
	sub- total		45
Administration Division			
	Administration-Human Resource Department	Administration Office	32
		Health Center Office	6
		Human Resource -IT Office	13
		Clean Section	39
		Security Office	49
	Harbor Master Department 1		8
	Harbor Master Department 2		56
	sub- total		203
Business Division			
	Business Department		11
	Container Termianl Operation Deparment	Office	2
		System (CMTS) Operation Section	61
		Container Terminal Operation Section	53
		QC Section	21
		RTG Section	45
		Platform of CT Section	48
		Stacker Elvator of CT Section	44
	General Cargo Operation Department	Office	4
		Tally of GC	22
		Machinery Section of GC	57
		Workers Group 1	36
		Workers Group 2	36
		Workers Group 3	34
	sub- total		474
Technical and Engineering Division			
	Technical Material-Construction Department	Technical Construction Department 1	26
		Technical Construction Department 2	97
		Garage Section	41
		Machinery Construction Section	23
	Machinery Department		6
	sub- total		193
Total 1			919
Contarction Staffs			31
Advisor to Chairman & CEO			10
Total 2			960

Source: PAS

The number of degrees held by PAS employees (2014-2016) is shown in Table 13.1-2. Total number of PHD degrees, master's degrees, bachelor's degrees, high school diplomas and technical skill degrees is 245 which mean that 25.5% of the total employees of PAS hold some type of degree.

Table 13.1-2 Number of Degrees Held by PAS Employees (2014-2016)

No.	Type of Degrees	2014	2015	2016	Others
1	PHD Degree	4	4	4	
2	Master Degree	102	102	104	
3	Bachelor Degree	132	135	137	
4	High School Degree	45	45	45	
5	Techinical Skill Degree	8	8	8	

Source: PAS

13.1.2 Staff Training Program

Table 13.1-3 shows the staff training program plan in 2016. Local training program and a training program abroad are being implemented every year.

Table 13.1-3 PAS Staff Training Program (2016)

No.	Training Courses	Training Plan for 2016	Target Department
I	**Local Training Program**	**3,195**	
1	Work Safey for Port Operation	500	CTO,GCO
2	Driving of Heavy Machinery (QC, RTG, Stacker…)	80	CTO,GCO
3	Container Terminal Operation Management	120	CTO
4	Unloading and Loading of Cargo	150	GCO
5	Handling of Dangerous Goods	200	CTO,GCO
6	General Cargo Handling Procedure	170	GCO
8	Port Safety, Health, and Environmental System	1,150	All Department
10	Initial Public Offering (IPO)	30	AC-FN
11	Cambodia International Financial Reporting Standard	8	AC-FN
12	Certify Public Accountant (CPA)	1	AC-FN
13	Chartered Financial Analyst (CFA)	1	AC-FN
14	Short Term and Long Term Planning	2	PP-ST
15	General course for statistics	12	PP-ST
16	Use of statistic softwares	8	AC-FN,AD-HR
17	Information Technology	8	AD-HR
18	Ship and Marine Laws	15	HM
19	Ship Gear Operation	35	CTO,GCO
20	Port Security Enforcement	50	AD-HR
21	Use of radioactive finder equipment	20	AD-HR
22	Draft Surveyor	5	CTO
23	Driving Tugboat	10	HM
24	Tugboat Machine	10	TMC,HM
25	Tugboat Electronic	10	TMC,HM
26	Pilotage	20	HM
27	Procedure for machinery check (daily check, montly check…)	180	CTO
28	Other workshops and seminars	400	All Department

No.	Training Courses	Training Plan for 2016	Target Department
II	**Abroad Training Program**	**147**	
1	Port Logistic	5	Management
2	Conference and Exhibition	5	All Department
3	Marketing and Promotion	5	MK
4	Container Terminal & Operation	12	CTO
5	Dangerous Goods	8	CTO,GCO
6	Port Security Enforcement	6	AD-HR
7	Sustainable Port Development	4	Management
8	Administration for ODA Loan	2	PMU
9	Maritime Seach and Rescue, Safety	2	HM
10	Strategic Port Management	5	Management
11	APA Meeting	20	APA Team Members
12	Port Safety, Health, and Environmental System	10	All Department
13	Port Management and Operation	6	Management
14	Port Finance and Stock Exchange	5	AC-FN
15	Gerneral course for statistics	1	PP-ST
16	Supply Chain Management,KPI	2	BS
17	General Maintenance and Repair	4	TMC
18	PLC & Simover Master Drive	4	TMC,HM
19	Information Technology	5	AD-HR
20	Ship planner and Yard Planner	5	CTO
21	Maintenance and Repair of QC, RTG,HMC, Stacker	5	TMC
22	Port Facility Security	5	AD-HR
23	Marine Navigation Aids	1	HM
24	Other workshops, seminars, and site visits	20	All Department

Abbreviation	Department
AD-HR	Adiministration-Human Resouces Department
AC-FN	Accounting -Finance Department
PP-ST	Planning Procurement and Statistic Department
MK	Marketing Department
BS	Business Department
IA	Internal Audit Department
SPSEZ	Sepecial Economic Zone Department
HM	Harbour Master Department
MC	Machinery Department
TMC	Technical Material and Construction Department
CTO	Container Terminal Operation Department
GCO	General Cargo Operation Department
PMU	Project Management Unit
Management	Deputy Director General, Head of Department, Chief Officer, etc

Source: PAS

13.1.1 Maintenance and Repair

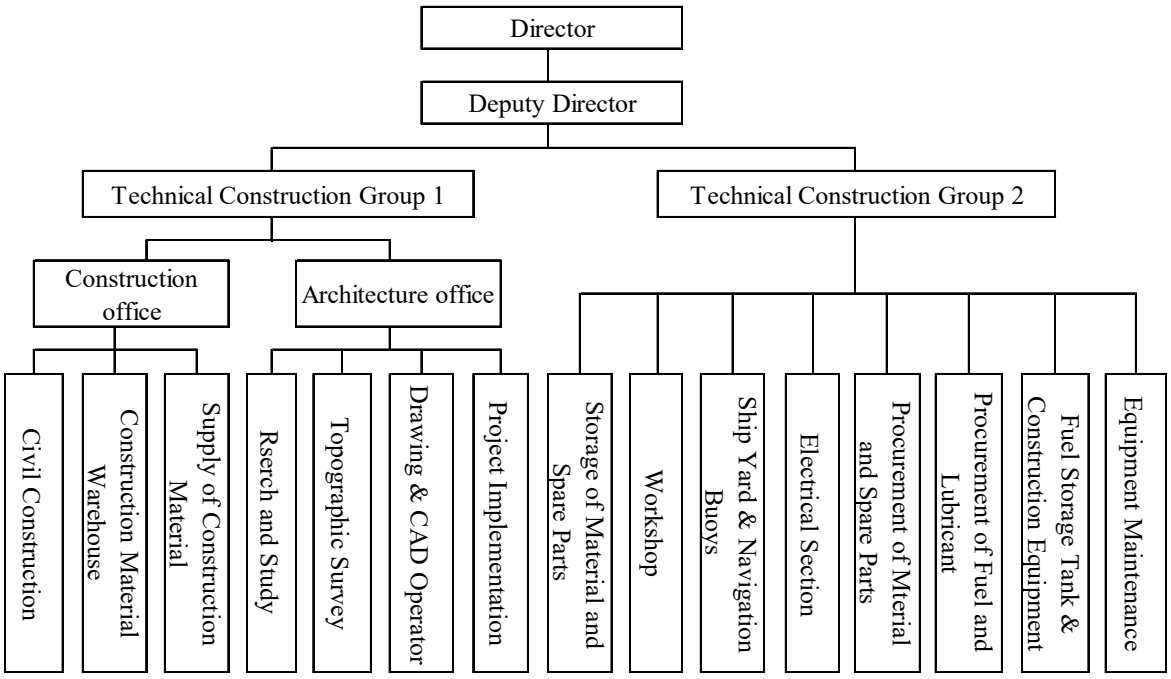
(1) Present Situation and Issues of Maintenance and Repair for Port Facilities

1) Department Responsible for Maintenance and Repair

Technical Materials and Construction Department (TMCD) is responsible for maintenance and repair of port facilities and cargo handling equipment, as well as the construction of port facilities.

TMCD organizationally consists of two groups: Technical Construction Group1 and Technical Construction Group 2. Technical Construction Group 1 is responsible for civil and building construction and maintenance while Technical Group 2 is responsible for cargo handling equipment procurement and maintenance.

Figure 13.1-2 shows present organization and staff number of the Technical Material Construction Department（as of August, 2016）.



Source: PAS

Figure 13.1-2 TMCD Organization (August, 2016)

The Equipment Maintenance Section is responsible for maintenance of Quay Crane (QC), Rubber Tired Gantry Crane (RTG) and Reach Stackers. On the other hand, the Workshop is responsible for other remaining cargo handling equipment maintenance work. Ship Yard and Navigation Section is responsible for maintenance of tug boat, patrol boat and navigation buoys.

2) Present Situation of Maintenance and Repair

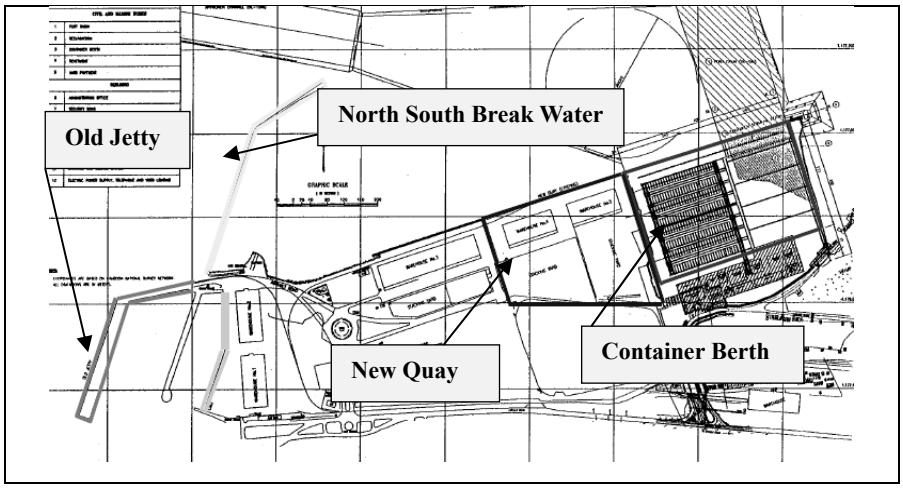
a) Port Facilities

The guidelines created by an ASEAN-Japan Port Technology Group meeting serve as the basis for port facilities maintenance and repair. However, regular inspections of port facility have not been implemented. Inspections are only conducted when TMCD receives a report of an abnormality or damage from port users. Then appropriate repair works are carried out as necessary.

Sihanoukville port enjoys good oceanographic conditions (current condition, sea bed condition, etc.), and sand drift and sedimentation hardly occur. Therefore, PAS does not have to implement regular maintenance dredging.

Regular inspections and maintenance of the access road is not currently conducted. Repair work is only carried out when PAS receives a report that a section of the road is damaged or vehicles are having difficulty passing.

The layout of port facilities at the PAS is shown in Figure 13.1-3. The main facilities include the Old Jetty, the New Quay, the Container Berth, and the north and south breakwaters.

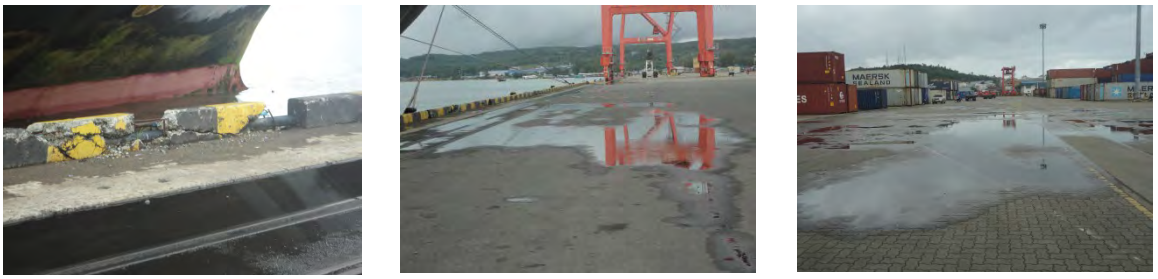


Source: JICA Survey Team

Figure 13.1-3 Layout of Main Facilities in the Port of Sihanoukville

The Old Jetty has a total length of 290 m and an alongside water depth of 9 m. It was constructed almost half a century ago, in 1964, and has degraded over time. Thus, it is necessary to study the degree of deterioration to determine future use options. If specific reinforcements are to be carried out, detailed studies will be conducted and specific plans considered.

The New Quay is a berth with a total length of 350 m which came into service in 1969, more than 40 years ago. It had been used as the principal berth until the Container Berth was constructed. Currently, it is used for loading/unloading container cargo, general goods and bulk cargoes. It is a wharf of a block structure alongside waters of a depth of 9 m. The fenders are degraded, water pipe covers are damaged, and subsidence in the yard on the back of the wharf is observed. Repair measures should be taken promptly.



Source: JICA Survey Team

Figure 13.1-4 Situation of Deterioration of New Quay and Container Terminal

The Container Berth, in operation since 2007, has a length of 400 m and an alongside water depth of 11.5 meters. It has two gantry cranes built in 2008. The wharf is maintained in good condition, but the yard is degraded is some areas. That type of deterioration is commonly seen where heavy machines such as RTGs and container trucks move around. It should be repaired before the damage expands and hinders the traffic of RTGs and container trucks. The north yard was constructed at the end of 2011 and is used as a new marshaling yard.

b) Cargo Handling Equipment

For the maintenance and management of cargo handling machines/equipment, the cargo handling machines/equipment other than vehicles are subjected to general start-up checks, weekly/monthly checks, or regular checks every two or three months. The vehicles are subjected to regular checks every travel distance of 5,000 km. They are basically maintained and managed well, e.g., lubrication and greasing are properly applied.

However, some cargo handling machines including QGCs, reach stackers and straddle carriers are not sufficiently maintained and managed. In some cases, failed items of equipment were left

unrepaired for long periods of time. Such cases have not resulted in any conspicuous problems due to the current scale of cargo operation. However, when more efficient cargo handling is required to cope with increased cargo volumes, the current maintenance practices could adversely affect operation.

The departments for the maintenance and management of cargo handling machines/equipment implement effective training programs for their staff. The Machinery Department (MD) takes the lead in holding regular training sessions, and the staff of MD creates training materials and gives lectures by themselves. They hold a two-day or three-day session twice or three times every year for the operators or repair workers of machines/equipment. Such training is important to maintain the skills of repair workers up to standard, and the training is implemented well.

3) Necessity of Creating a Manual for Strategic Maintenance and Repair

Port facilities are generally required to maintain the necessary functions in service for a long time. Not only the initial structural designs are important to meet this requirement, but also appropriate maintenance and repair of those facilities in service are essential for satisfying it.

In order to maintain/improve the level of service at the port facilities, it is necessary to reduce maintenance and repair costs. However, with a limited budget, it would be impossible to meet the expected demand for repairs in the future under the current system in which failures are only addressed once they occur. It is therefore important to implement more efficient maintenance and repair on a preventive basis to minimize the life-cycle costs of machinery/equipment. Accordingly, a manual for strategic maintenance and repair should be created.

13.2. Examination of Required Standard Regarding Safety and Security

13.2.1 Present Condition

(1) Compliance with International Code for the Security of Ships and of Port Facilities (ISPS Code)

Cambodia is a contracting state to the International Convention for the Safety of Life at Sea Protocol of 1974 (SOLAS 74), but Cambodia has not fully complied with the requirements of the ISPS Code, even though the prime minister instructed the Minister of Transport to work towards compliance in 2007.

1) SOLAS Convention and ISPS Code

The first version of SOLAS was passed in 1914 in response to the sinking of the Titanic. It prescribed numbers of lifeboats and other emergency equipment along with safety procedures, including continuous radio watches. The 1914 treaty never entered into force due to the outbreak of the First World War. Further versions were adopted in 1929 and 1948.

The International Ship and Port Facility Security (ISPS) Code is an amendment to the Safety of Life at Sea (SOLAS) Convention on minimum security arrangements for ships, ports and government agencies. Having come into force in 2004, it prescribes responsibilities to governments, shipping companies, shipboard personnel, and port/facility personnel to "detect security threats and take preventative measures against security incidents affecting ships or port facilities used in international trade.

a) PFSA & PFSP

PFSA (Port Facility Security Assessment)

The port facility security assessment is an essential and integral part of the process of developing and updating the port facility security plan. The port facility security assessment shall include, at least, the following elements:

1. identification and evaluation of important assets and infrastructure it is important to protect
2. identification of possible threats to the assets and infrastructure and the likelihood of their occurrence, in order to establish and prioritize security measures
3. identification, selection and prioritization of countermeasures and procedural changes and their level of effectiveness in reducing vulnerability
4. identification of weaknesses, including human factors, in the infrastructure, policies and procedures

PFSP (Port Facility Security Plan)

The port facility security plan is a plan developed to ensure the application of measures designated to protect the port facility and ships, persons, cargo, cargo transport units and ship's stores within the port facility from the risks of a security incident. The port facility security plan shall be developed and maintained, on the basis of a port facility security assessment for each port facility, adequate for the shop/port interface. The plan shall address, at least, the following.

1. measures designated to prevent weapons or any other dangerous substances and devices intended for use against persons, ships or ports, and the carriage of which is not authorized, from being introduced into the port facility or on board a ship
2. measures designated to prevent unauthorized access to the port facility, to ship moored at the facility, and restricted areas of the facility
3. procedures for responding to security threats or breaches of security, including provisions for maintaining critical operations of the port facility or ship/port interface
4. procedures for responding to any security instructions the Contracting Government in whose territory the port facility is located may give at security level3
5. procedures for evacuation in case of security threats or breaches of security
6. duties of port facility personnel assigned security responsibilities and of other facility personnel on security aspects
7. procedures for interfacing with shop security activities
8. procedures for the periodic review of the plan and updating
9. procedures for reporting security incidents
10. identification of the port facility security officer, including 24 hour contact details
11. measures to ensure the security of the information contained in the plan
12. measures designated to ensure effective security of cargo and the cargo handling equipment at the port facility
13. procedures for auditing the port facility security plan
14. procedures for responding in case the ship security alert system of a ship at the port facility has been activated
15. procedures for facilitating shore leave for ship's personnel or personnel changes, as well as access of visitors to the ship, including representatives of seafarers' welfare and labor organization

2) Appointment of Designated Authority (DA)

The Cambodian Government has not officially appointed a Designated Authority (DA) to comply with the ISPS Code. Since 2006, the officers of the Ministry of Public Works and Transport (MPWT) have been requesting their Minister to appoint the General Director of Transport as the Designated Authority, but the Minister has not yet approved that request. The legislation and regulations of the Cambodia Port Act, Cambodia Merchant Law and Inland Water Transport Law as domestic regulation are currently given priority over compliance with the ISPS Code. The appointment of a Designated Authority (DA) is an urgent issue.

3) Preparation for Domestic law for Maritime Transport

The current progress of legislation and regulations of the Cambodia Port Act, Cambodia Merchant Law and Inland Water Transport Law as domestic regulation are as follows. These three domestic laws have no relationship with ISPS Code.

a) Cambodia Port Act (Regulation for Port Development)

Draft of the Cambodia Port Act is being reviewed by MPWT; it is expected to be approved by the Minister soon. This Act shall aim at establishing a rational port system in the Kingdom of Cambodia. The Act defines Port classification, Role of Port Management Body, Duty and authority of MPWT, Port Development Planning, Port logistics business and the others.

b) Cambodia Merchant Law (Regulation for Ship)

Draft of the Cambodia Merchant Law has been sent to International Maritime Organization（IMO）Headquarters where it is expected to be approved. After approval, IMO will send a mission to Cambodia to hold final discussions with the Cambodian government. This law defines Merchant Transport Policy and Merchant Maritime Law.

c) Inland Water Transport Law (Regulation for Inland Shipping)

Draft of the Inland Water Transport Law is being reviewed by the Minister. It defines Ship license, Technical inspection, Water transportation business license, License fee and others.

4) PFSA and PFSP of Sihanoukville Port

PFSP of Sihanoukville port is not registered at International Maritime Organization（IMO）since the Cambodian government has not appointed a Designated Authority (DA). Therefore, MPWT has accepted PFSA and PFSP of Sihanoukville port in their own right.

(2) Negative Impact Caused by Insufficient Compliance with ISPS Code

The United States Coast Guard visited Cambodia from 9-13 September 2013 and reviewed security measures related to the ISPS Code. The Coast Guard concluded that Cambodia is not implementing the ISPS Code and is not maintaining effective anti-terrorism measures. The Coast Guard decided to remove the exemption from condition of entry to their Port Security Advisory.

The Port Security Advisory (3-14) from the United States Coast Guard went into effect for all vessels that arrive in the United States on or after 26 September 2014 after visiting ports in Cambodia as one of their last five ports of call. All vessels arriving in the United States that visited ports which do not have effective anti-terrorism measures during their last five ports calls must take actions to raise their ship security level during their stay in those countries as a condition of entry into US ports. There has been no obvious damage to Cambodian maritime trade to date as Cambodian ports do not have liner service between US ports. However, if Cambodia does not comply with the ISPS Code in the future, negative impacts could occur.

1) Unites States Coast Guard Port Security Advisory (3-14)

a) Background

The Maritime Transportation Security Act of 2002 (MTSA) mandated the United States Coast Guard to evaluate the effectiveness of anti-terrorism measures in foreign ports and provides for the imposition of conditions of entry on vessels arriving to the United States from countries that do not maintain effective anti-terrorism measures (MTSA, 45USC 70108-70110).

The Coast Guard has determined that the Phnom Penh Autonomous Port and the Sihanoukville Autonomous Port are no longer maintaining effective anti-terrorism measures. The previous exceptions of these ports from the actions required in paragraph C, below are

rescinded. Actions required as listed in paragraphs C and D of this Port Security Advisory take effect for all vessels that arrive in the United States on or after September 26, 2014 after visiting ports in Cambodia as one of the their last five ports of call.

b) Countries Affected

The Coast Guard has determined that ports in the following countries are not maintaining effective anti-terrorism measures.

Cambodia, Cameroon、Comoros、Cote d' Ivoire、Cuba、Equatorial Guinea, Guinea-Bissau、Iran, Liberia、Madagascar、Nigeria、Sao Tome and Principe、Syria、Timor-Leste、Venezuela、Yemen

c) Actions Required by Vessels Visiting Countries Affected

All vessels arriving in the United States that visited the countries listed in paragraph B during their last five ports of call must take actions 1 through 5 listed below while in the countries listed in paragraph B as a condition of entry into US ports.

C1. Implement measures per the ship's security plan equivalent to Security Level 2

C2. Ensure that each access point to the ship is guarded and that the guards have total visibility of the exterior (both landside and waterside) of the vessel. Guards may be:
- provided by the ship's crew, however, additional crewmembers should be placed on the ship if necessary to ensure that limits on maximum hours of work are not exceeded and/or minimum hours of rest are met, or
- provided by outside security forces approved by the ship's master and Company Security Officer.

C3. Attempt to execute a Declaration of Security

C4. Log all security actions in the ship's security records; and

C5. Report action taken to the cognizant US Coast Guard Captain of the Port prior to arrival in US

Vessels that visited the countries listed in paragraph B on or after the effective date in paragraph A, their last five port calls will be boarded or examined by the Coast Guard to ensure the vessel took the required actions. Failure to properly implement the actions listed in paragraph C1 and C5 may result in delay or denial of entry into the US.

d) Actions Required by Vessels in US Ports

Based on the findings of the Coast Guard boarding or examination, the vessels that visited the countries listed in paragraph B on or after the effective date in paragraph A may be required to ensure that each access point to the ship is guarded by armed security guards and that they have total visibility of the exterior (both landside and waterside) of the vessel while in US ports. The number and location of the guards must be acceptable to the cognizant US Coast Guard Captain of the Port. For those vessels that have demonstrated good security compliance and can document that they took the measures called for in C1 above, the armed security guard requirement will normally be waived.

2) Liner Services Calling at Sihanoukville Port

Sihanoukville port does not have liner services with US ports currently as shown in Table 6.1-1 (Liner Shipping Services from Sihanoukville Port). Container cargoes from Cambodia to US ports are transshipped to a mother vessel of the North America route at Singapore port, Hong Kong port and Kaohsiung port.

3) Negative Impact to Sihanoukville Port Caused by Insufficient Compliance with ISPS Code

It is unlikely that a ship which carries Cambodian cargo will be refused to enter US ports or face delays in entering US ports for the time being as Cambodian ports currently do not have any liner service between US ports. Indeed, there has been no obvious damage to Cambodian maritime trade after exemption of the Port Security Advisory (3-14) was rescinded. However, negative impacts such as those described below could result if this situation is allowed to continue.

i) Negative Impact to Manufacturer Seeking New Production Base

Manufacturers seeking an ideal production base to produce export commodities compare and evaluate candidate sites. One of the important conditions in determining which port to select is effective logistics. As a port is distribution center of materials and products, insufficient compliance with the ISPS Code would discourage potential locaters.

ii) Negative Effect on the Competitiveness of Local Exports

To increase the cargo handling volume of Sihanoukville port, export products of Cambodia have to be competitive with those of other countries. An importer selects the most attractive products from several manufacturers from the viewpoint of cost and stable supply. There is a potential risk to the stable supply of export cargo at ports with an insufficient security system. Accordingly, port security along the trade route is one of the important conditions for importers when selecting a source of products.

iii) Reduction in the Number of Ship Calls

All vessels arriving in the United States that visited ports which do not have effective anti-terrorism measures during their last five port calls must take actions to raise their ship security level while in those countries as a condition of entry into US ports. As the strengthening of security requirements increase, ship operation schedule delays and cost increases are likely to occur. Accordingly, there is a possibility that the number of ships calling Sihanoukville port could decrease.

4) Expected Improvement through Appointment of Designated Authority (DA)

Ministry of Public Works and Transport Merchant Marine Department intends to improve the situation by officially appointing a Designated Authority (DA) as follows.

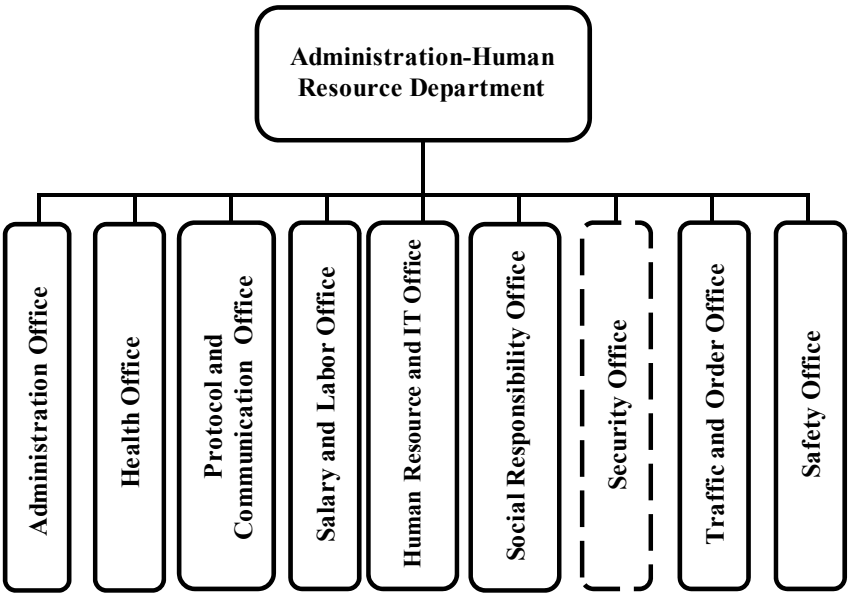
- Designated Authority (DA) will review the PFSA and PFSP officially and follow the necessary procedures to register them with IMO after approval. Present PFSP of Sihanoukville port has not been registered with IMO.
- More effective training is expected to be implemented by the Merchant Marine Department with support from Japan, US and other donors.
- Local port security work will be set to work after international trade port will have complied fully with ISPS code.

(3) Present Situation of Port Security of Sihanoukville Port

1) Tasks and Organization of Security Division of PAS

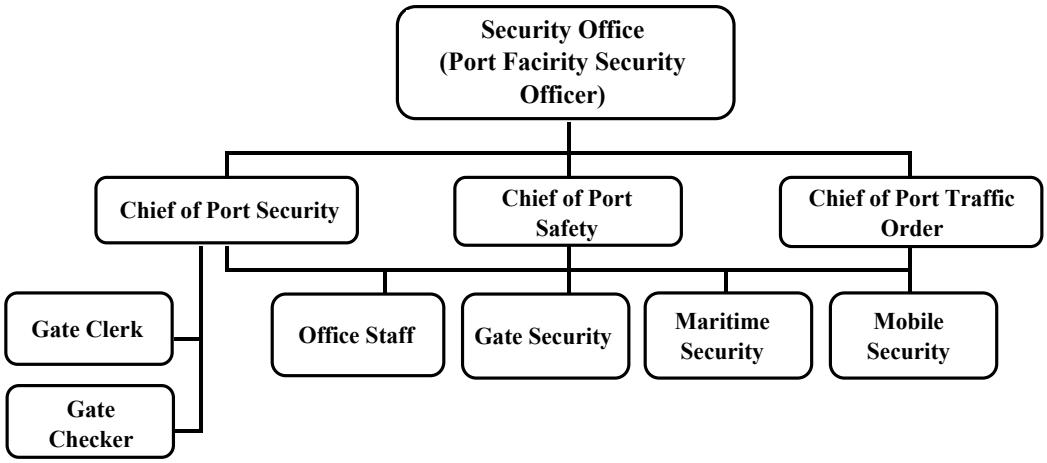
Port security has been carried out according to the PFSP (Port Facility Security Plan) drawn up mainly by the PFSO (Port Facility Security Officer) of the security office. Though MPWT (Ministry of Public Works and Transport) has not appointed a Designated Authority (DA), MPWT approved the PFSP of PAS in their own right in 2006.

The Security Office, which is a part of the Administration-Human Resource Department and has a staff of 50, performs the gate control tasks at three gates and the security tasks for the restricted area at all times.



Source: JICA Survey Team

Figure 13.2-1 Organizational Structure of Administration-Human Resources Department



Source: JICA Survey Team

Figure 13.2-2 Organizational Structure of Security Office

The Security Office is headed by one Port Facility Security Officer (PFSO) under which three Chiefs are in charge of six security tasks. Each of the tasks is outlined with the number of members on the staff in parentheses. The budget for the activities of the Office is managed by the Administration-Human Resource Department on a consolidated basis, and thus the Office has no budget at its discretion.

a) Gate Clerk (9)

Gate clerk examines the export declaration brought by the driver. If the document is in order, truck goes to the booth where the custom officers, CAMCONTROL and immigration police follow the prescribed procedure. After the driver pays the container handling charge of PAS, the truck enters the container yard through the gate. Gate clerk inputs the data of container number and related information in a computer at the gate booth.

b) Gate Checker (6)

Gate checker inspects the external condition of the container by visual inspection. He enters comments on Equipment Interchange Receipt (EIR) when damages of container are detected such as tiny holes, dents and so on.

c) Gate Security (20)

Gate control is conducted at Gate No.1, No.2, No.3 and the administration building. Gate No. 3 is for container cargo, and there is traffic congestion extending from the gate and driveway onto National Road No. 4 from Friday night to Saturday evening. Many members of the Security Office, as well as traffic police, take care of this line.

d) Office Staff (2)

The office staff monitors the port activities, and watch for possible port security threats on surveillance monitors.

e) Maritime Security (4)

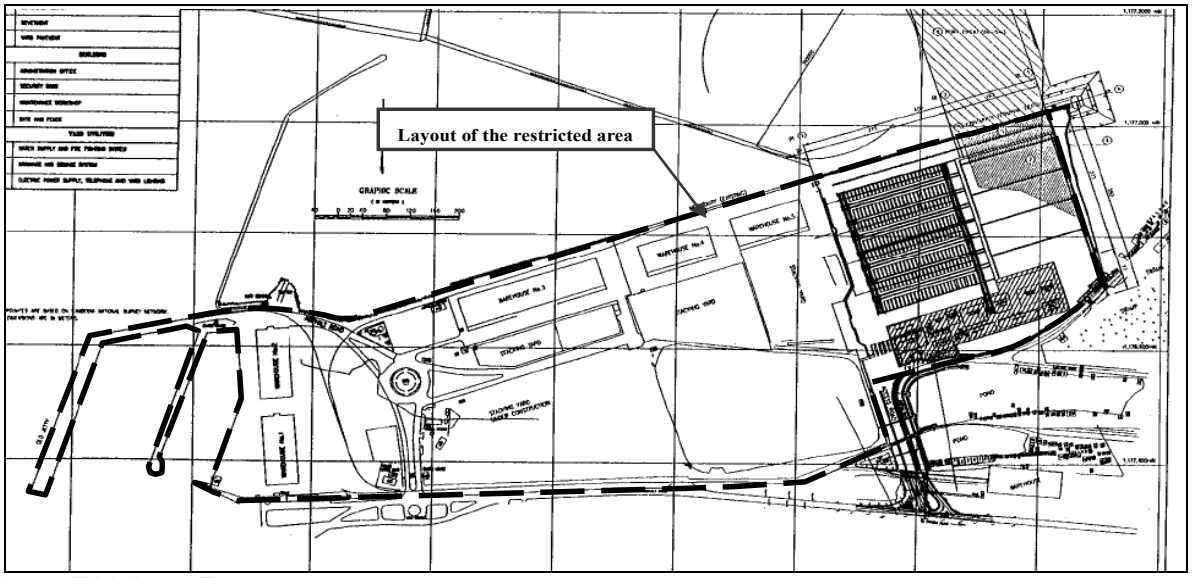
The Security Office patrols the sea area of the port by boat.

f) Mobile Security (5)

The Security Office also patrols the land area of the port, and maintains and manages the traffic signs in the area.

2) Restricted Area

The restricted area of the PAS covers the entire port area from the New Container Berth in the west to the Old Jetty in the east as shown in Figure 13.2-3.



Source: JICA Survey Team

Figure 13.2-3 Restricted Area of PAS

3) Present Situation of Sihanoukville Port Security

a) Gate Control

There are eight gates in the port. PAS controls five gates (the remaining three are railway gates). Gate 1 is for stevedores, passengers and construction vehicles. It is exclusively used for passengers when a cruise vessel arrives. Gate 2 is for general cargo except for container cargoes, while Gate 3 is only for container cargoes. Though a new gate was set up across the road from SEZ gate to transport SEZ cargo efficiently, it has not yet opened. Taxis are not allowed to enter the port premises.

b) Gate Access Control

Gate Access Control system had been introduced in 2007. A photo ID card was issued to each member of the PAS (including the crews of tug boats and pilot boats), and once used for gate control. However, due to the problems with the system and operation, gate access control has been terminated.

i) Problems with the System

According to PAS staff, after the start of gate access control, reading errors frequently occurred resulting in long queues. In addition, the numbers of ID cards fell short for the port related persons and employees. An insufficient stock of spare parts for equipment and printers was also a problem.

ii) Problems Related to Port Operations

Though entry to the container operation area was restricted to authorized persons, many people were able to enter the operation area freely. Documentation works are supposed to be completed before container cargoes enter the operation area. However, due to the time limit and transportation restrictions, many container cargoes for export are brought into the port without the necessary documents. PAS allows consignors or agents to enter the operation area on bikes in order to submit the documents to the custom officers and CAMCONTROL officers in their port office.

c) Security Facility Equipment and Management

The present restricted area is enclosed with fences 2.4 m high. No sensors are installed on the fences. Lighting equipment and surveillance CCTV cameras are installed on the yard, wharf, gates, storehouses, office building and fences. The port is monitored through the surveillance cameras, and the CCTV images are retained for 15 days. However, due to the shortage of security staff, CCTV monitoring staff is not provided regularly. Public announcement systems have been out of use due to the snapping of a wire and breakdown of speakers. VHF radio and mobile phones are used for emergency communication.

d) Guards and Patrols

Total of five members including the chief officer conduct irregular patrols in the port. Patrol boat is available in case of emergency.

e) Identification of Ships that enter the Port, and Surveillance of the Port Sea Area

Necessary information on a ship to enter the port is obtained and checked in advance of its entry. The PAS has a Vessel Traffic Management System (VTMS) with which it conducts traffic control. When a ship is in the port, the security office monitors the wharf through surveillance cameras.

f) Structural Integrity

The PAS has a power generation station and a substation. They are not fenced at some points. They are locked. No refueling equipment for ships is installed in the port. They are not equipped with a device to measure the illuminance inside of warehouse or surveillance cameras.

g) Personnel Protection System

There are emergency evacuation routes and emergency exits in the facilities, but no signs to indicate the emergency exits in the port area.

h) Radio and Telephone Communication Systems including Computer Systems and a Network

Wired telephones and mobile phones can be used in the terminal. Computers are connected to a network and used for purposes of port security, cargo control and communication. Anti-virus measures have been taken for communication systems. The cables are protected with covers.

i) Connected Transportation Infrastructures

There is a railway container station in the port and about 7% of container cargoes are transported by railway. Railway Gates are only opened when trains come in and out. National Road No. 4 passes at the back of the port.

j) Drainage

Drains are open concrete-block structures, and drain water is discharged into the sea. The discharge holes have gratings on them.

k) Presence of Illegal Fishing Village

There is an illegal fishing village in the eastern vicinity of the container berth. Though the village is close to port facilities, the restricted area of port is surrounded by a fence and the water area is monitored by mobile security and patrol boat. Therefore, the presence of the illegal fishing village is not in violation of the ISPS code.

l) Others

The anchorage area and turning water area are patrolled by patrol boats. However, only one patrol boat is utilized as survey boat and pilot boat. The PSC (Port Security Committee) consists of the Security Office of the PAS, Customs, CAMCONTROL, Immigration Bureau and KAMSAB. They discuss and carry out simulations of port security matters.

13.2.2 Improvement Plan

(1) Need for Budget

Currently, the Security Office does not have a budget at its discretion. However, the types of equipment and the numbers of units of items of equipment in use have increased. When a failure or breakdown occurs, operation of PAS could be adversely affected. Repair and maintenance of equipment is also a burden on PAS. As the cargo handling volume is expected to increase, maintenance of equipment will become increasingly important. Therefore, the responsibilities and authority of the Security Office should be clarified, and a budget to carry out its tasks should be established.

(2) Implementation of Gate Access Control

Appropriate gate control needs to be resumed as soon as possible. The current situation in which shipping agents and others are able to freely enter the container yard by motor bike in order to submit required for import/export of container cargoes cannot be tolerated. It is necessary to improve this situation. The Security Office should cooperate with the Container Operation Department to establish and implement a proper gate access control system.

(3) Compulsory Container Weight Measurement

Container cargo consignee will be obliged to measure and declare the weight of a container before loading it to vessel from July 2016 following an amendment to the SOLAS Convention. Total weight of each container cargo will have to be measured and declared to ship captain and terminal operator before loading to vessel. Though, PAS recognizes the necessity of container weight measurement implementation to comply with SOLAS Convention, specific measure has not been taken.

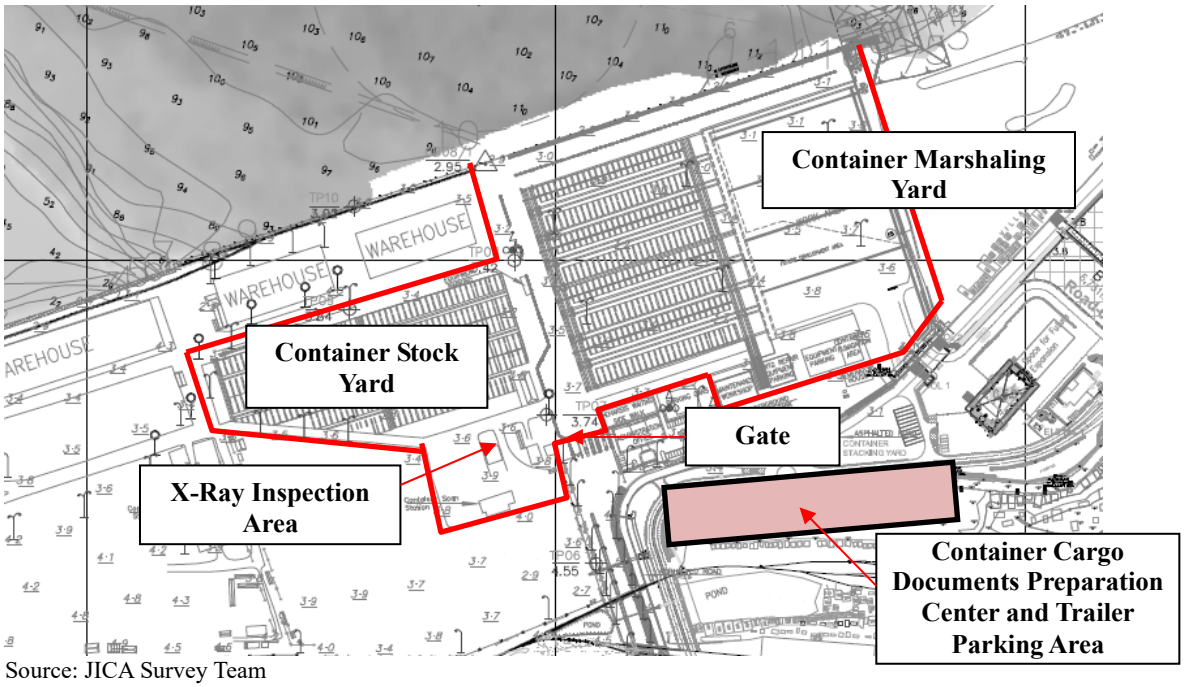
(4) Set Up of Second Restricted Area for Container Cargo Operation

The current restricted area for port security of the PAS covers all the port area as single restricted area. The container operation area shall be dedicated to freight vehicles that transport

export/import cargoes. If vehicles that have no relation to the container operation were allowed to enter, the container operation would be hampered. Container operation area shall be separated with other port operation area as a second restricted area to avoid irregular access of unrelated parties of operation and decrease gate traffic congestion in order to increase efficiency of operation work and security.

Document preparation area and trailer parking area shall be secured to prevent gate congestion and irregular access. All necessary documents for import/export shall be completed before container cargo enters the operation area.

Proposed second restricted area and location of container cargo document preparation center and trailer parking area are shown in Figure 13.2-4.



Source: JICA Survey Team

Figure 13.2-4 Proposed Second Restricted Area for Container Operation

13.3. Confirmation of Electric Supply Plan

The power supply plan of PAS is shown below.

13.3.1 Present Condition of the Existing Container Terminal

1) Power supply for 4 units of QC (Quayside Container Crane)

PAS has 5 units of Diesel-Engine Generator Sets (hereinafter, D-G Set) in the Diesel-Engine Generator House.

At present, the power of two (2) existing QCs is supplied by 2 units of D-G Sets.

The necessary power for 3rd QC (MES-made) and 4th QC (ZPMC-made) can be supplied by the remaining 3 units of D-G Sets.

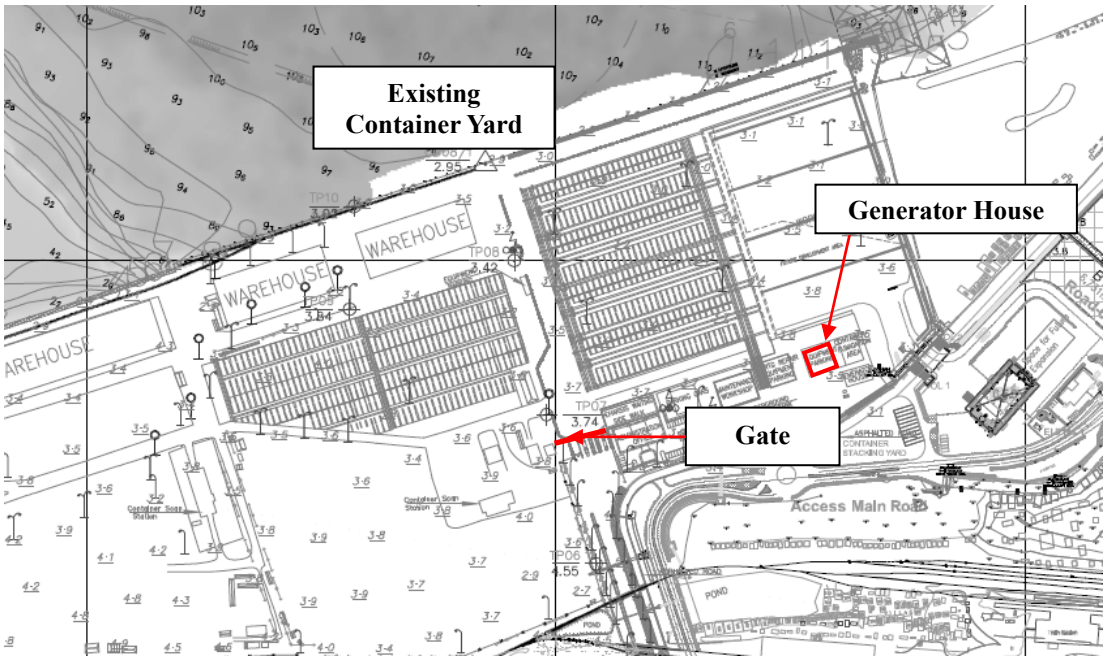
2) Necessary power for the Existing Container Terminal and the Current State of Power Procurement of PAS

The necessary power of the existing Container Terminal is supplied by the Diesel-Engine Generator Sets. PAS has five units of 1,000 kVA Diesel-Engine Generator Set (D-G Set) which supply the power to four sets of quayside container crane (QC).

The Generator House of Container Terminal of Sihanoukville Port is shown in Figure 13.3-1 and the location of Generator House is shown in Figure 13.3-2.

Source: JICA Survey Team

Figure 13.3-1 Generator House of Container Terminal of Sihanoukville Port



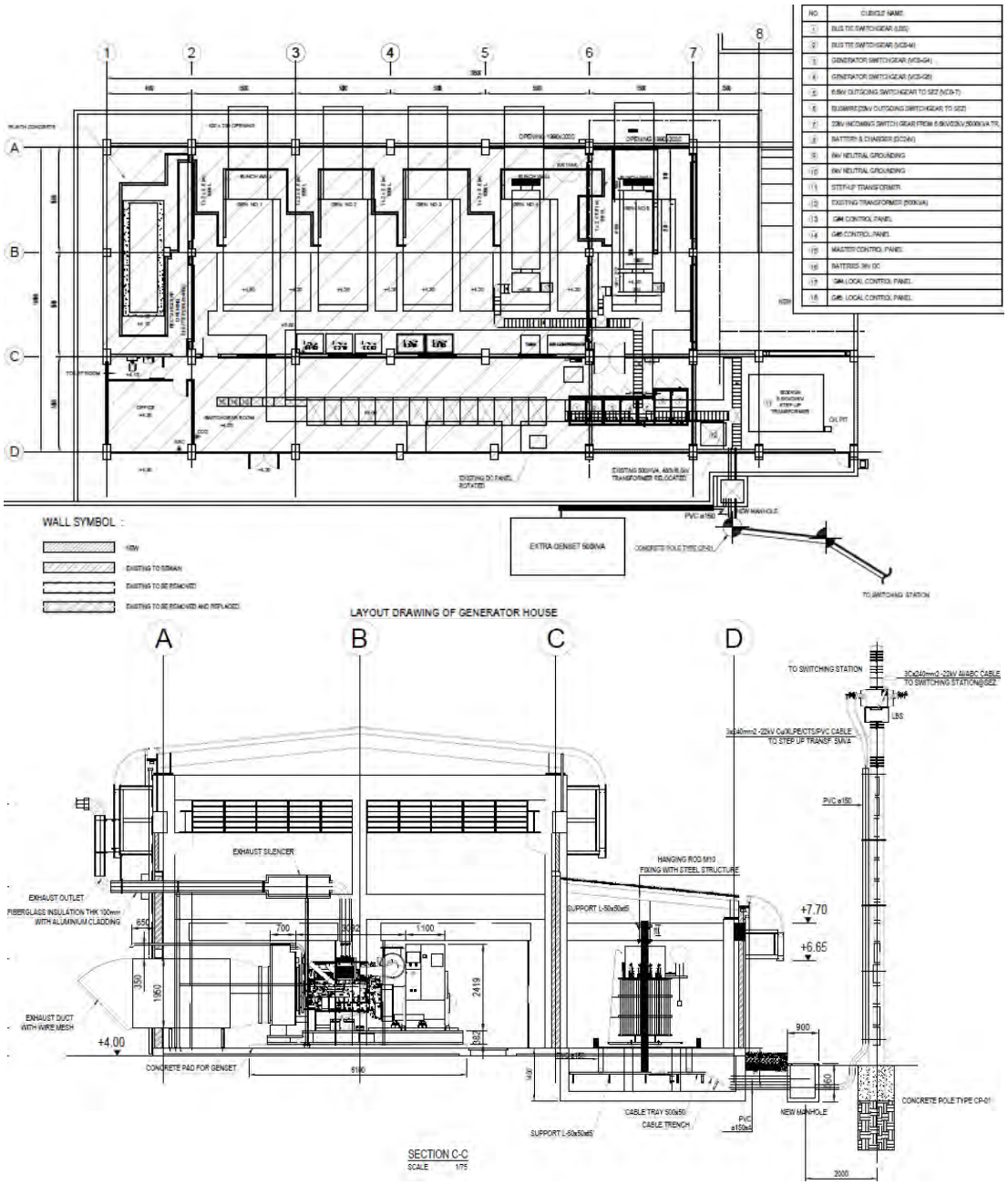
Source: JICA Survey Team

Figure 13.3-2 Location of Generator House

The Layout of the Generator House is shown in Figure 13.3-3 and Figure 13.3-4 shows the D-G Set (5 units) in Generator House.

Figure 13.3-5 shows High-Voltage Incoming Panels Distribution Panels, etc. which are installed in the Electrical Room behind of D-G Set Room. The required power of the entire SHV port including the quayside container cranes (QCs) and the administration building is supplied by the Diesel Engine-Generator sets. The required power for the equipment of SEZ is also supplied by means of D-G Sets.

EDC will supply power to the SEZ facilities and the facilities in the existing container terminal including the quayside container cranes and the administration buildings.



Source: PAS, Technical Materials-Construction Department

Figure 13.3-3 Layout of Generator House

Source: JICA Survey Team

Figure 13.3-4 D-G Set (5 units) in Generator House

Source: JICA Survey Team

Figure 13.3-5 High-Voltage Incoming Panel in the Electrical Room in the Generator House

The current state of the power supply of the existing container terminal is shown below.

- Output Capacity of D-G Set: 1,000 kVA
- No. of D-G Set: 5 units
- Maximum Capacity of 5 sets of D-G Sets = 1,000 kVA x 5 units = 5,000 kVA

a) The Current State of Power Procurement of PAS

- PAS is planning to procure an electric power of 20 MW from EDC, which is a public enterprise under the “Electricity Authority of Cambodia” in Sihanoukville.
- PAS has asked the EDC to supply 20 MW (10 MW for container terminal and 10 MW for SEZ) to PAS.
- EDC has already replied that it can supply power of 20 MW to PAS around April 2017.
- At present, PAS is waiting for official confirmation from EDC.
- 5 D-G sets will be reserved for emergency use.
- PAS is planning to install the High-Voltage Incoming Panel House ("Sub-Station") of 10MW in the Existing Container Terminal and SEZ, respectively.
- High-Voltage Power Source of Power Station: AC 22 kV, 50 HZ, 3-Phase
- High-Voltage Power Source of QC: AC 6.6 kW, 50 HZ, 3-Phase

b) Electric Power Charge of Power Supply

- Electric power charge: 0.174 USD/KWh
- The Central Government of Cambodia is going to ask the EDC to discount the price of electric power. EDC must follow the policy of the Central Government of Cambodia.
- PAS assumes that electric power charge will be reduced to about 0.13 USD/KWh in the near future.

When the EDC starts supplying power to the existing container terminal of PAS, the power will be supplied to the SEZ facilities and the facilities in the existing container terminal including the quayside container cranes, the administration buildings.

PAS estimates that the cost of power supply by the EDC will be cheaper compared to using the Diesel Engine-Generator set.

The location of “Electricite du Cambodge (EDC)” is shown in Figure 13.3-5, and photos of "Electricite du Cambodge (EDC), Shanoukville" are shown in Figure 13.3-6.

Source: JICA Survey Team

Figure 13.3-6 Location of Electricite du Cambodge (EDC)

Source: JICA Survey Team

Figure 13.3-7 Electricite du Cambodge (EDC), Sihanoukville

13.3.2 Electric Supply Plan of the New Container Terminal

1) License Issue

PAS does not have a license to be a power supplier. Therefore, the electrical construction work which can only be conducted by a licensed power supplier will be outsourced to an electrical construction company which has the proper licenses.

2) Power Supply Plan of the New Container Terminal

Regarding the power supply to the new container terminal, PAS is planning to install the power receiving facility and to perform the construction scope for high-voltage wiring work in the same manner as the Multi-purpose Terminal.

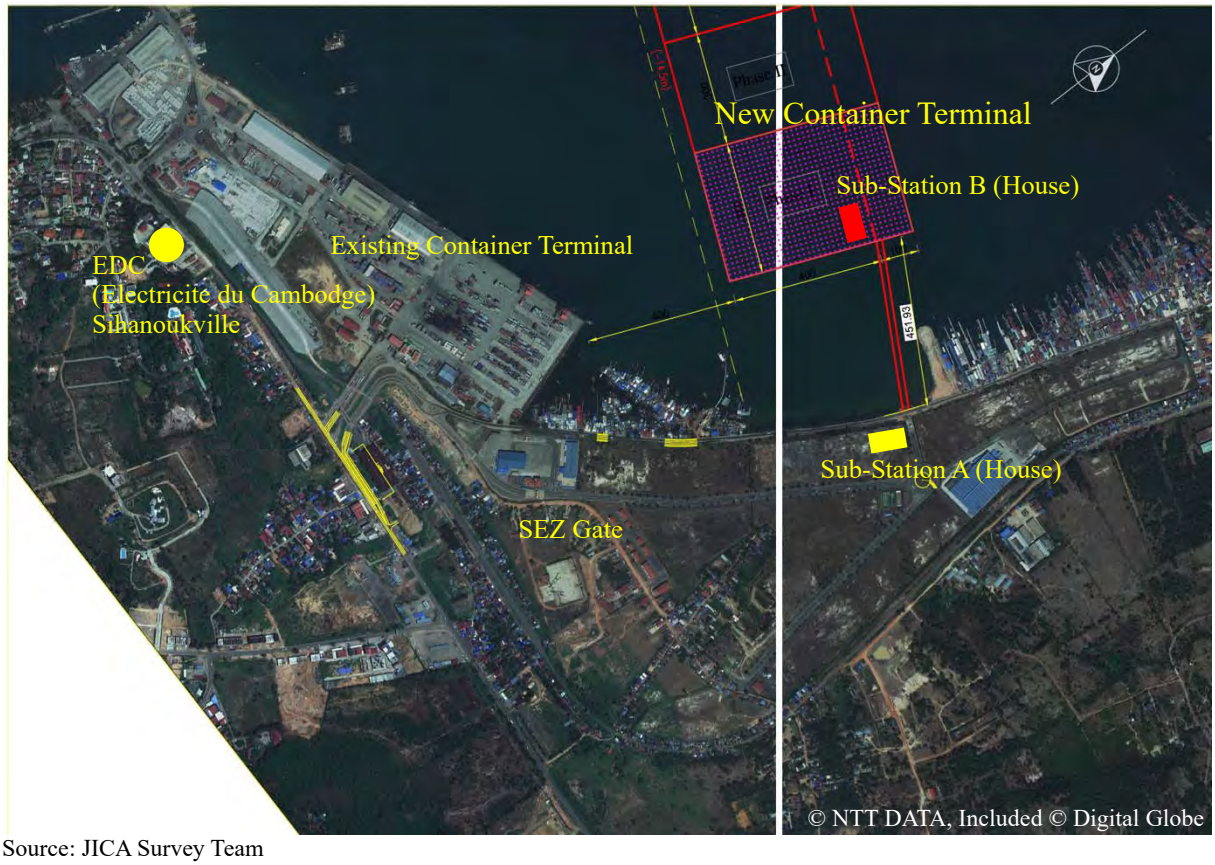
Power is supplied to cargo handling equipment in the terminal via the electric power grid while engine-generator sets using diesel oil are available as a back-up in case of power failure. The

engine-generator set is only used as back-up in the event of a power outage because it is inferior to electricity in terms of cost, environmental load and maintenance & management of the facility.

The Sub-Station A (House) will be installed at the vacant lot of the SEZ in front of the bridge of the access road to the new container terminal, and the Sub-Station B (House) will be installed in the rear corner of the container yard. The wiring from the EDC to the Sub-Station B of the new container terminal is planning to carry out by means of the elevated wiring or underground. The wiring from Sub-Station A to the new container terminal side is planned to perform by means of elevated wiring method using the high-voltage elevated tower or the high-voltage wiring duct using the bridge for the access road. The wiring from Sub-Station B of the new container terminal to the quay container cranes will be placed underground.

The locations of the Sub-Station A, B and EDC are shown in Figure 13.3-7.

Power supply to the Sub-Station B from the EDC is planned to be 22 kVA, 50 Hz, 3-Phase. The power supply from the Sub-Station A to the Sub-Station B of the new container terminal will be 22 kVA high-voltage. The supply power to container cranes will be 6.6 kVA, 50 Hz, 3-Phase.



Source: JICA Survey Team

Figure 13.3-7 Power Supply of the New Container Terminal

14. FINANCIAL PROSPECTS OF PAS

15. PROJECT IMPLEMENTATION PLAN

15.1. Procurement Plan of the Project Fund

15.2. Implementation Schedule

15.3. Organization of Project Implementation

15.3.1 Proposal of Management System

The JICA Survey Team believed that the operation and management system for the new container terminal would be shifted from the present public build and operation system to a public-private partnership system over the long-term.

However, PAS's basic way of thinking is that the public sector should both build and operate port facilities as long as a moderate business profit is secured. Since the result of the financial internal rate of return (FIRR) indicates that it would be feasible for the public sector to build and manage the new container terminal, PAS does not intend to introduce the public-private partnership method for the new container terminal.

(1) Container Cargo Handling Volume and Calling Vessel Number at the New Terminal

The assumption of container cargo handling volume and number of calling vessels at the new container terminal from 2023 to 2027 is shown in Table 15.3-1 for operation formation examination. The JICA Survey Team adopts a conversion ratio from twenty foot equivalent unit (TEU) to box is 1.596.

Table 15.3-1 Container Cargo Handling Volume and Calling Vessel Number of New Terminal

Year		2023	2024	2025	2026	2027
Container Cargo Volume	TEU	100,000	200,000	300,000	400,000	450,000
	Box	62,657	125,313	187,970	250,627	281,955
Calling Vessel Number	/ year	83	167	250	333	375
	/ week	1.6	3.2	4.8	6.4	7.2

Source: JICA Survey Team

(2) New Container Terminal Vessel Call Schedule and Cargo Handling Time

The JICA Survey Team assumes that the vessel call frequency is in equal intervals. Assumed weekly vessel call schedule and berthing hours for 2024 and for 2027 when cargo handling volumes are expected to reach the terminal handling capacity are shown in Table 15.3-2 and 15.3-3, respectively.

The JICA Survey Team assumes that the vessel berthing hours and cargo handling hours are as follows:

Average Container Cargo Handling Volume per Vessel : 125,313 / 167 = 750 box
Average Cargo Handling Hours : 750 / 25 / 3 / 0.70 = 14.3 hours
Quay gantry crane productivity: 25 box / hour
Quay gantry crane number: 3
Work efficiency: 0.7
Average Berthing Hours: 14.3 + 1 + 1 = 16.3 hours
Preparation hour: 1 hour
Clean up hour: 1 hour

Table 15.3-2 Vessel Call Schedule and Berthing Hours in 2024

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Vessel 1	←						
Vessel 2			←				
Vessel 3					←		

Source: JICA Survey Team

Table 15.3-3 Vessel Call Schedule and Berthing Hours in 2027

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Vessel 1	←						
Vessel 2		←					
Vessel 3			←				
Vessel 4				←			
Vessel 5					←		
Vessel 6						←	
Vessel 7							←

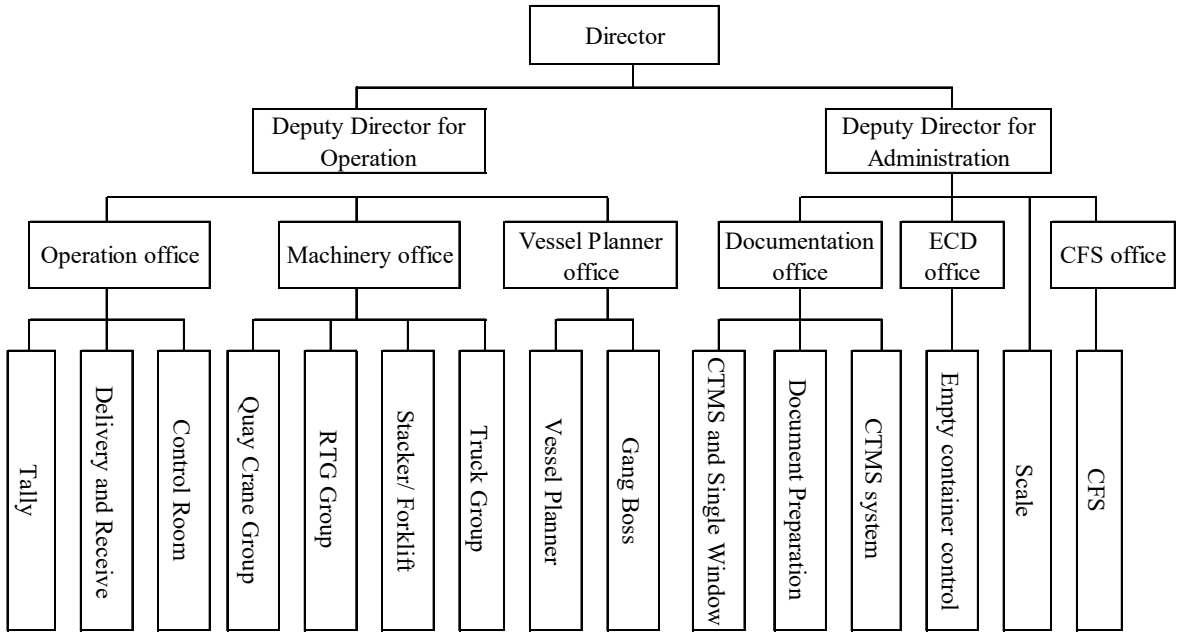
Source: JICA Survey Team

(3) Necessary Organization for New Container Terminal Management and Operation

Necessary organization for new container terminal management and operation mainly consists of a Container Terminal Operation Department, Technical Material Construction Department, and Security Office.

1) Container Terminal Operation

Figure 15.3-1 shows the present organization and number of staff of the Container Terminal Operation Department, as of August 2016. The new container terminal will introduce three quay cranes and nine rubber tired gantry cranes. Sixteen-hour operation of the gate and terminal is assumed using a two-shift system.



Source: PAS

Figure 15.3-1 Container Terminal Operation Department Organization (August 2016)

2) Port Facility Maintenance and Repair

Port facility maintenance and repair is the responsibility of the Technical Material Construction Department. To cope with the maintenance work of the new container terminal, the number of staff engaged in cargo handling equipment maintenance should be increased. Civil and building facility maintenance work will be dealt with by the current staff of Technical Construction Group 1.

3) Port Security Office

The Security Office needs to increase the number of staff for gate clerk, gate checker, gate security, office staff, and mobile security. The necessary number of staff for the new container terminal is shown in Table 15.3-4.

4) Number of Staff

The terminal operation hour is assumed at 16 hours with a two-shift system a day in accordance with the average berthing hours. Tables 15.3-4 and 15.3-5 show the implementation organization and manpower breakdown for the new container terminal management and operation in 2024 and 2027. A total of two teams for each section are needed in 2024 and three teams are needed in 2027 to maintain a seven days a week with two-work shift operation except for the Security Office which requires four teams to cope with a 24-hour operation.

Table 15.3-4 Implementing Organization for the New Container Terminal Operation in 2024

	Shift				Total
	1st	2nd	3rd	Reserve	
Container Terminal Operation Department					
Labour Management Section					
Manager	1				1
Assistant Manager	2				2
Gang Boss	3	3			6
QGC Driver	6	6			12
RTG Driver	9	9			18
Reach Stacker Driver	3	3			6
Truc Driver	15	15			30
Apron Checker	3	3			6
Lusher	24	24			48
total	66	63			129
Planning Section					
Manager	1				1
Assistant Manager	1				1
Ship Planning & Supervison					
Chief	1				1
Staff	2	0			2
total	3	0			3
Yard Planning & Cotroll					
Chief	1				1
Staff	3	2			5
total	4	2			6
Documentaion					
Chief	1				1
Staff	4	2			6
total	5	2			7
Container Terminal Management System					
Chief	1				1
Staff	3	1			4
total	4	1			5
Total					152
Technical Material Construction Department					
Equipment Maintenance Section					
Engineer	1				1
Staff	8	2			10
total	9	2			11
Workshop Section					
Engineer	1				1
Staff	8	2			10
total	9	2			11
Total					22
Security Office					
Office Staff	2	2	2	2	8
Gate Clerk	4	4	2	4	14
Gate Checker	4	4	2	4	14
Gate Security	4	4	2	4	14
Mobile security	2	2	2	2	8
Total	16	16	10	16	58
Total					232

Source: JICA Survey Team

Table 15.3-5 Implementing Organization for the New Container Terminal Operation in 2027

	Shift				Total
	1st	2nd	3rd	Reserve	
Container Terminal Operation Department					
Labour Management Section					
Manager	1				1
Assistant Manager	2				2
Gang Boss	3	3		3	9
QGC Driver	6	6		6	18
RTG Driver	9	9		9	27
Reach Stacker Driver	3	3		3	9
Truc Driver	15	15		15	45
Apron Checker	3	3		3	9
Lusher	24	24		24	72
total	66	63		63	192
Planning Section					
Manager	1				1
Assistant Manager	2				2
Ship Planning & Supervison					
Chief	1				1
Staff	3	1		1	5
total	4	1		1	6
Yard Planning & Cotroll					
Chief	1				1
Staff	3	2		2	7
total	4	2		2	8
Documentaion					
Chief	1				1
Staff	4	2		2	8
total	5	2		2	9
Container Terminal Management System					
Chief	1				1
Staff	4	2		2	8
total	5	2		2	9
Total					227
Technical Material Construction Department					
Equipment Maintenance Section					
Engineer	1				1
Staff	10	2		2	14
total	11	2		2	15
Workshop Section					
Engineer	1				1
Staff	10	2		2	14
total	11	2		2	15
Total					30
Security Office					
Office Staff	2	2	2	2	8
Gate Clerk	5	4	2	4	15
Gate Checker	5	4	2	4	15
Gate Security	4	4	2	4	14
Mobile security	2	2	2	2	8
Total	18	16	10	16	60
Total					317

Source: JICA Survey Team

15.3.2 Necessity of Technical Support

To increase the efficiency of port operation and competitiveness of Sihanoukville Port, the following technical supports are needed:

(1) Improvement of Tide Observation System

There is one temporary tidal station in Sihanoukville Port, which has been maintained and operated for the hydrographic survey on Electrical Nautical Chart (ENC) production from 2014, but this project will end in 2016. Although the operational maintenance has been provided by the dispatched Japanese surveyor during the project period, PAS lacks the necessary skill to maintain and operate the station. It is necessary to install a permanent tidal station and improve tide observation technique and tidal station maintenance.

(2) Establishment of Hydrography Office in PAS

The ENC project contributed significantly in increasing the safety of navigation in port waters and providing PAS with technical knowledge on hydrography. As for the next stage, dredging for deepening and widening of present access channel for the multipurpose wharf development project is ongoing. Further deepening and widening works are expected in the new container terminal development and it is necessary to accurately survey the sea bed elevation and provide vessels with the means to navigate safely on a regular basis. Accordingly, PAS needs to establish a hydrograph office to survey its own sea area regularly and maintain the necessary sea depth.

(3) Creating a Manual for Strategic Maintenance and Repair of Port Facilities

Port facilities are generally required to maintain their required functions for a long period of time. Not only the initial structural designs are important, but also appropriate maintenance and repair of those facilities in service are essential for satisfying this requirement.

In order to maintain/improve the level of service at the port facilities, it is necessary to reduce maintenance and repair costs. However, with a limited budget, it would be impossible to meet the expected demand for repairs in the future under the current system in which failures are only addressed once they occur. It is therefore important to implement more efficient maintenance and repair on a preventive basis to minimize the life-cycle costs of port facility and machinery/equipment. Accordingly, a manual for strategic maintenance and repair should be created.

(4) Introduction of EDI System

Currently, the Electronic Data Interchange (EDI) system for port entry procedures has not yet been developed in Cambodia (with the exception of some document data such as Announcement of Ship Entry which are transferred by email), as those procedures are done in principle with hard copies to obtain original stamps and signatures of government officers. The following merits are expected by introducing an EDI system:

1) Enhancement of competitiveness of Cambodian ports in the international market,
2) Improvement of work efficiency of port users,
3) Improvement of service quality and work efficiency of government bodies, and
4) Acceleration toward National Single Window and ASEAN Single Window

16. PROJECT EVALUATION

16.1. Project Effect

Project effect is assessed in two ways: viz., 1) quantitative effect and 2) qualitative effect. In examining quantitative effect, it is important to set quantitative indices such as operation efficiency, volume of throughput, and other effect indices, with a clear baseline since they will be used to measure the operational target two years after operation commences.

16.1.1 Quantitative Effect

The following items are generally applied to assess operation efficiency and output as performance indicators for evaluation of a port project:

- Volume of containers handled, number of calling and waiting vessels, and waiting time for berthing
- Productivity for container handling per crane per hour
- Revenue and size of labor force of PAS

Performance targets and minimum performance levels are mentioned in table below:

Table 16.1-1 Key Performance Indicators and Target Volume

Annual throughput	200,000 TEUs per annual two years after starting operation * 450,000 TEUs per annual five years after starting operation
Productivity	17.5 moves per hour per crane gross 52.5 (25x2.5) moves per hour per vessel gross
Truck turnaround time	2 hours
Container dwell time	Export: 2 days, Import 3 days

Source: JICA Survey Team

(1) Terminal Capacity (Annual Throughput)

Annual throughput of New Container Terminal is a good indicator of the capacity to evaluate the project effect. When it is high, the PAS has enough capability to operate and manage the terminal effectively. When the PAS increases capacity by increasing productivity, as well as the utilization rate of Quayside Container Crane (QC) rather than in investing in new equipment or facilities, he can maximize profits.

(2) Gross / Net Productivities

Berth productivity is an important performance indicator because it directly relates to capacity. It is set as:

- 17.5 (25x0.7) moves in gross per hour with 1 unit of QC
- 52.5 (25x2.1) moves in gross per hour with 3 units of QC

The assumptions are based on 30.0 lifts/hour/QC as theoretical handling capacity and 25 lifts/hour/QC in net (17.5 lifts/hour/QC in gross) by an individual unit (these are achievable productivity levels). QC and ship-gear productivity of PAS are 20 lifts and 7 lifts per hour, respectively, on average. As a positive note, operational productivity by QC at container terminal on weekdays reached 25 boxes/QC/hour gross in 2014. However, productivity drops to less than 20 at weekends due to the shortage of equipment (QC & Rubber Tyred Gantry Crane (RTG)) as well as RGT CY-space problems of the container terminal.

Estimated container throughput of the New Container Terminal will reach 200,000 TEUs in two years and 450,000TEUs in five years. Thus, productivity per crane and per vessel in that timeframe should reach the targets mentioned above.

(3) Dwell Time

Dwell time of stored containers in the container yard is one of the key issues for every container yard operator even though it is difficult to manage and control dwell time by themselves. Average dwell time of the current container terminal is estimated as 5 days for 2015 and the 4-month period from January to April in 2016 (Export in 2015: 3.5 days / 4-month in 2016: 4days, and Import in 2015: 4.15 days / 4-month in 2016: 5 days). Fortunately, the new terminal has ample yard space compared with the berth capacity; hence, up to 2 days for export and 3 days for import of dwell-time on average is tolerable, including reserved-days for the pre-planning, as mentioned in Tables 2.7-9 and 2.7-10 of the report "The Project Study for Strengthening Competitiveness and Development of Sihanoukville Port (SSCD)". Accordingly, PAS should check the dwell time every quarter of a year and attempt to reduce it to within the targets.

16.1.2 Procedure for Accessing Necessary Data

Indices as mentioned above need to be accessible during the operation period of the new container terminal. PAS will operate the New Container Terminal by himself and his planning procurement and statistics department of management division records and manages the data on a monthly basis.

16.2. Economic Analysis

The purpose of the economic analysis is to assess the economic feasibility of the Project on the target year, from the viewpoint of the national economy. In this clause, the economic benefits and costs are calculated with economic price and to evaluate whether the benefits exceed those that could be obtained from other investment opportunities in Cambodia. Economic benefit concept; items and measurement are applied and used in the economic analysis from the report of SSCD.

16.2.1 Premises and Methodology of Economic Analysis

(1) Base Year

The year of 2017 is set as the base year.

(2) Project Life

The calculation period in the economic analysis is assumed to be forty one years from the year 2017 to the year 2057 which includes thirty five years of physical time.

(3) Foreign Exchange Rate

The exchange rate is the same (USD 1.0 = Yen 104.57) as cost estimation mentioned in the Chapter 10.

(4) "With-case" and "Without-case"

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

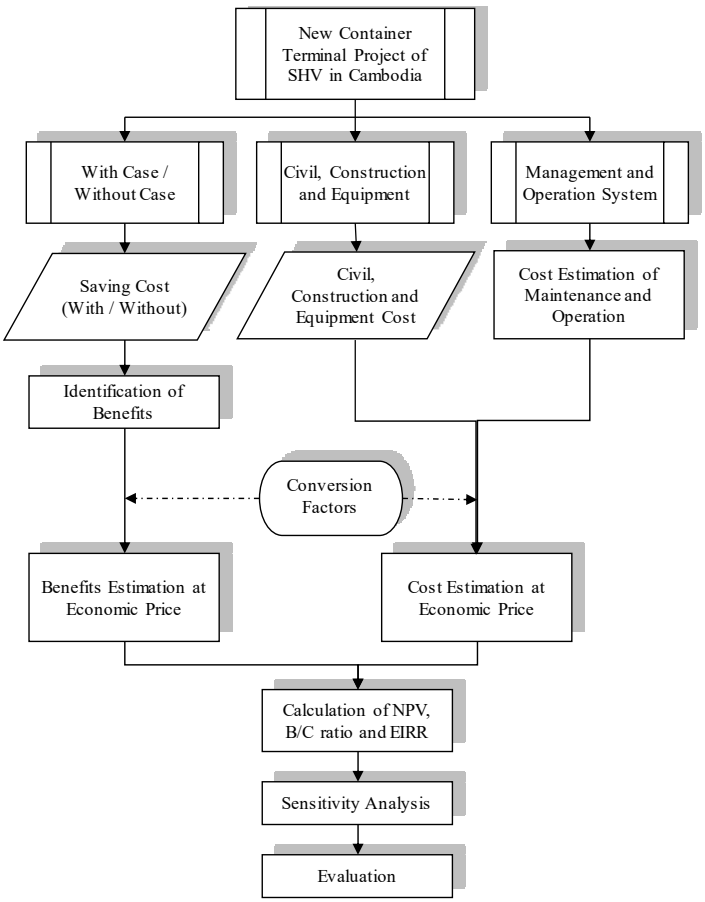
The Sihanoukville Port does not have extra facilities to handle the estimated container cargo volume unless the Projects are implemented. In addition, port congestion including ship waiting and small container ship berthing will continue under the current capacity of the port.

It is assumed that vessels divert to other neighboring ports when capacity of existing berths of Sihanoukville Port are full. An alternative is the transportation of cargoes of the diverting vessels are barged by waterways from Cai Mep Port of Vietnam. Therefore, comparing the difference of cost

between the waterways, land route, and direct service to Sihanoukville Port, direct service is defined as an economic benefit of the Project.

It is generally said that large vessel operations reduce the average cost of sea transportation by a merit of scale, which means entering large vessels into Sihanoukville Port contribute to saving sea transportation costs.

The flowchart for the economic analysis is shown in the figure below.



Source: JICA Survey Team

Figure 16.2-1 Procedure of Economic Analysis

(5) Economic Price

1) General

For the economic analysis, all prices must be expressed as economic prices. In general, the construction costs, the operation costs, and the maintenance costs are estimated at market prices. In addition, the market prices often include transfer items, such as customs duties, subsidies, etc. Therefore, the market prices have to be converted into economic prices by using a conversion factor and eliminating these transfer elements.

2) Standard Conversion Factor (SCF)

Customs duties create a price difference between the domestic market and the international market. The SCF is used to determine the economic price of non-tradable goods that have only market prices.

The conversion factor is set at 0.98 on the basis of trade statistics data of Cambodia, for conversion into the economic price from the project cost estimated based on the market prices, shown in table below.

Table 16.2-1 Trade Statistics of Cambodia and Standard Conversion Factor

Mil. USD		2010	2011	2012
Import (CIF)	M	4,897	6,141	7,062
Export (FOB)	X	5,584	6,702	7,838
Import Tax	Tm	248	251	289
Export Tax	Tx	28	46	42
Export Subsidy	Sx	0	0	0
SCF		97.94%	98.43%	98.37%

Source: IMF World Development Indicator, prepared by JICA Survey Team

16.2.2 Economic Benefits of the Project

(1) Benefit Items

Considering the above mentioned "With-case" and "Without-case", the following economic benefits of the Project are measurable quantitatively.

1) The saving of transportation costs
2) The saving of port congestion surcharges

(2) Calculation of Benefit

The evaluation of benefit is conducted as economic price converted by SCF on the basis of a middle demand forecast scenario.

1) Saving of Transportation Cost

a) Sea Transportation Cost to/from Cai-Mep from/to Phnom Penh

In the case that container throughput at Sihanoukville Port will reach its capacity of 800,000 TEUs and overflowing containers will be transported through Phnom Penh Port or Cai Mep Port, sea transportation cost of overflowing containers will be higher than if they were transported through Sihanoukville Port. Savings of sea transportation cost and time for overflowing containers are deemed as a benefit to the national economy.

Sea transportation cost and time for containers to/from USA and South East Asia have no significant difference between cases through Phnom Penh Port or Sihanoukville Port. Containers to/from Europe and East Asia have to pay higher freight rates if they are transported through Phnom Penh Port or Cai Mep Port. Savings of sea transportation cost and time for containers to/from Europe and East Asia are estimated as a benefit of the "With-case". While savings of sea transportation cost and time for export containers are not of direct benefit to Cambodian shippers, those savings are supposed to be finally transferred to the Cambodian economy. Ocean freight rates used for economic analysis are as indicated in Tables 2.7-15 and 2.7-16 in the report of SSCD. The saving cost is summarized in the table below.

Table 16.2-2 Cost Saving of Transportation per Container

Time cost to EU	25 USD per 20' box	49 USD per 40' box
Freight Difference of EU (Share: percentage)	100 USD of Export (39.5%)	60 USD of Import (2.45%)
Freight Difference of E-Asia (Share: percentage)	50 USD of Export (21.9%)	50 USD of Export (34.3%)

Source: A Study Team of SSCD

b) Land Transportation Cost to/from Cai-Mep from/to Phnom Penh

As the same manor mentioned above, in the case that container throughput at Sihanoukville Port will reach its capacity of 800,000 TEUs and overflowing containers will be transported through Phnom Penh Port or Cai Mep Port from/to Phnom Penh, land transportation cost of the overflowing containers will be higher than if they were transported through Sihanoukville Port. Overflow export containers will be transported by barge based on the statistics data, however, the transportation cost of

barge is at the almost same land transportation cost between Sihanoukville Port and Phnom Penh. While overflow import containers will be transported by truck and the land transportation cost between Cai Mep Port and Phnom Penh have to pay higher freight rates than that of between Sihanoukville Port and Phnom Penh. Savings of land transportation cost and time for the overflowing import containers are deemed as a benefit to the national economy and the saving cost is assumed at 338 USD exclusive of fees such as boarder clearance based on the interview survey.

c) Merit of Scale

All container cargo will benefit by a merit of scale by using large vessels into Sihanoukville Port in the case that larger container vessels will be deployed for services at Sihanoukville Port resulting from the development of the new deep water container terminal, ocean freight rates to/from Sihanoukville Port may be lowered due to merit of scale. Importers' savings of maritime transportation cost are estimated as a benefit of the "With-case". Reduction of maritime transportation cost of export containers may reduce CIF price at foreign ports and not directly contribute to shippers income. However, it may finally promote the production of Cambodian manufactures and contribute to the national economy. Reduction of maritime transportation cost for export containers is also estimated as a benefit of the "With-case".

Assuming a case of typical maritime transportation, unit cost for transportation of a 20'/40' container on a 2,000 TEU ship and a 4,000 TEU ship is estimated in "Manual of Cost Benefit Analysis for Port Development, 2004, MLIT, Japan" as follows:

Table 16.2-3 Maritime Transportation Cost per Container

Case of 2 days voyage	20 feet container box	40 feet container box
2,000 TEU Ship	157.9 USD	236.9 USD
4,000 TEU Ship	123.6 USD	185.3 USD
Difference	34.3 USD	51.6 USD

Source: Manual of Cost Benefit Analysis for Port Development, 2004, MLIT, Japan

2) Saving of Port Congestion Surcharge

Shipping lines levy approximately USD 60 per TEU as port congestion surcharge around Asia ports if port congestion creates additional cost to them. It is assumed that the port congestion surcharge will be levied to the cargo volume of current capacity of Sihanoukville Port because overflow cargo will be handled at other ports if no investment is implemented.

In the case that the new container terminal is not developed, container handling capacity of Sihanoukville Port is assessed at 800,000 TEUs, subject to installing two more quay gantry cranes. When container handling volume reaches that capacity, the overflowing cargo will shift to Phnom Penh Port and will be carried to Cai Mep Port by barge, or will be carried to HCM directly by land transportation. Shipping companies will levy congestion surcharges on shippers due to the situation at Sihanoukville Port. Range of such congestion surcharges is wide but sometimes the surcharges reach over USD 700 per 20' container at congested African ports, the minimum surcharge is supposed to be USD 50 per 20' container (USD 100 per 40' container, cf. Yangon port in 2016). In the case of Karachi Port in Pakistan and Shuwaik Port in Kuwait, congestion surcharges of USD 100 per 20' container and USD 200 per 40' container were imposed in 2014, and in the case of Batangas of Philippines, USD 225 per 20' container and USD 450 per 40' container were imposed in 2015. As congestion surcharges are increased in connection with the extent of ship congestion, this economic analysis is made on the assumption that congestion surcharges will be imposed at a rate of USD 60 per 20' container and USD 120 per 40' container if the demand for container throughput exceeds 800,000 TEUs at Sihanoukville Port, and those will be increased by 15% if the demand exceeds 1,200,000 TEUs.

Supposing that no congestion takes place and no congestion surcharge is imposed in the "with case", the total amount of congestion surcharges to be imposed on import containers is estimated as a benefit of the "With-case".

In the case of export containers, such congestion surcharges will be imposed on foreign consignees as part of CIF price, so the savings of congestion surcharges may not be of economic benefit to the Cambodian economy. However, such surcharges will be transferred to Cambodian shippers as lower FOB prices, and may cause loss of shippers. Taking into account that congestion surcharges on export containers will be finally settled by Cambodian shippers, congestion surcharges to be imposed on export containers is also estimated as a benefit of the "With-case".

16.2.3 Economic Cost of the Project

16.2.4 Economic Evaluation of the Project

(1) Result of EIRR

The result of EIRR is shown in Table 16.2-6. The estimated EIRR is at 15.76%, and a discount rate as threshold of the EIRR is set at 10.0% which is generally used for infrastructure projects. Thus, the Project can be said to be feasible.

Table 16.2-4 EIRR Calculation

(2) Sensitivity Analysis

In order to see whether the project is still feasible if some conditions change, a sensitivity analysis is made for the following three alternatives.

Case 1: Project cost increases by 10%

Case 2: Benefit volume decreases by 10%

Case 3: Both Case 1and Case 2 occur simultaneously

The results of the sensitivity analysis is derived as follows.

Table 16.2-5 Economic Result of Sensitivity Analysis

Case	Base	Case 1	Case 2	Case 3
EIRR	15.76%	13.98%	13.79%	12.06%

Source: JICA Survey Team

Even in Case 3 of sensitivity analysis, the economic feasibility of the Project is exceeding threshold value i.e. EIRRs are above 10.0%. Therefore, the Project is recommended to be implemented as early as possible from the viewpoint of the national economy.

16.3. Financial Analysis

The purpose of the financial analysis is to assess the financial feasibility of the Project on the target year, from the viewpoint of the financial soundness. In this clause, the financial revenues and expenditures as costs are calculated with market price and to evaluate whether the revenues exceed those that could be expended from capital cost of investment of the Project.

16.3.1 Premises and Methodology of Financial Analysis

(1) Base Year

The year of 2017 is set as the base year.

(2) Project Life

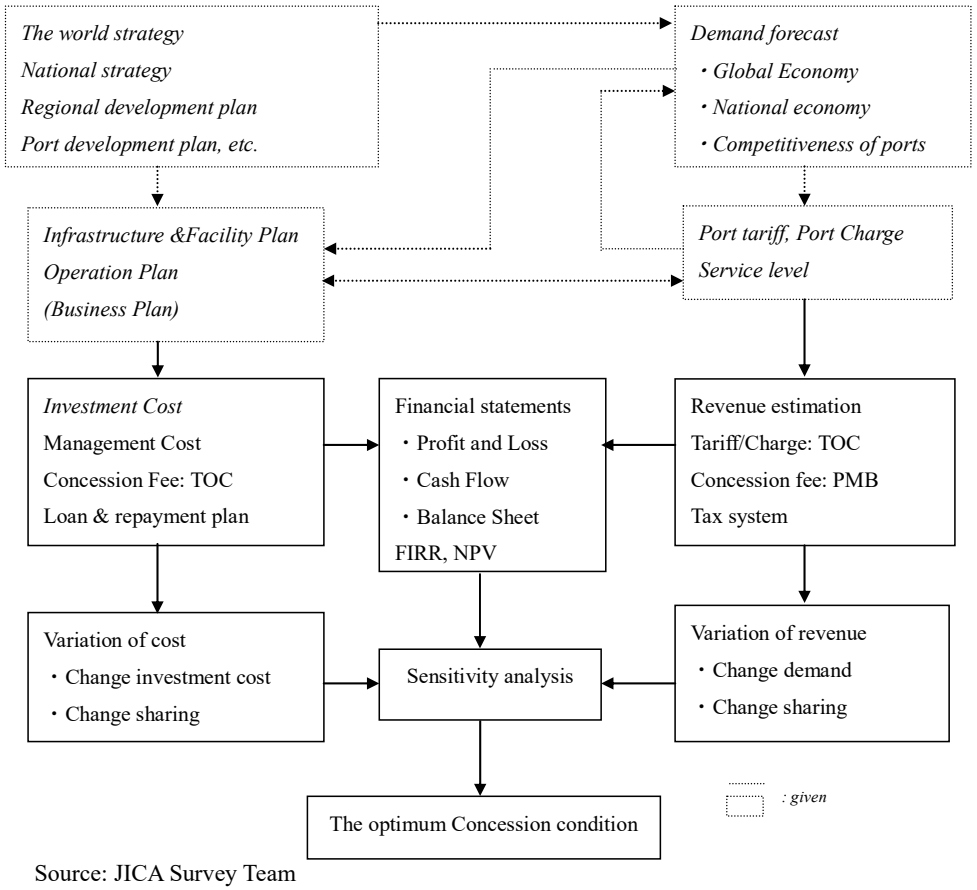
The calculation period in the financial analysis is assumed to be forty one years from the year 2017 to the year 2057 which includes thirty five years of physical time.

(3) Foreign Exchange Rate

The exchange rate is the same (USD 1.0 = Yen 104.57) of cost estimation mentioned in the Chapter 10.

(4) Methodology

In this section, the financial internal rate of return (FIRR) is used to appraise the feasibility of the Project. The procedure used for the financial analysis is shown in the figure below.



Source: JICA Survey Team

Figure 16.3-1 Procedure of Financial Analysis

16.3.2 Revenues of the Project

16.3.3 Financial Cost of the Project

16.3.4 Financial Evaluation of the Project

(1) Conditions of Fund Raising

(2) Result of FIRR

The result of FIRR is shown in Table 16.3-6. The estimated FIRR is at 8.13%.

Thus, the Project can be said to be feasible. This result is estimated under the condition that a QC surcharge which is an additional handling fee levied by PAS since installation of QC will be lifted after the year 2030.

Table 16.3-1 FIRR Calculation

(3) Sensitivity Analysis

In order to see whether the project is still feasible if some conditions change, a sensitivity analysis is made for the following three alternatives.

Case 1: Project cost increases by 10%

Case 2: Benefit volume decreases by 10%

Case 3: Both Case 1 and Case 2 occur simultaneously

In addition, to evaluate the Project the JICA Survey Team set three scenarios taking user's requests of lifting of QC surcharge into considerations as follows:

Base Scenario: supposed that QC surcharge will be lifted after the year 2030,
Scenario 1: lifted after 2023, and
Scenario 2: no reduction in QC surcharge.

The results of the sensitivity analysis are derived as follows.

Table 16.3-2 Financial Result of Sensitivity Analysis

Case	Base	Case 1	Case 2	Case 3
Base Scenario FIRR	8.13%	6.46%	6.28%	4.52%
Scenario 1 FIRR	7.56%	5.94%	5.77%	4.05%
Scenario 2 FIRR	9.11%	7.53%	7.36%	5.74%

Source: JICA Survey Team

Even in Case 3 of sensitivity analysis, the financial feasibility of the Project are exceeding threshold value. Therefore, the Project is recommended to be implemented as early as possible.

Table 16.3-3 Profit and Loss Statement

Unit: 1,000USD

Source: JICA Survey Team

Table 16.3-4 Cash Flow Statement

Unit: 1,000USD

Source: JICA Survey Team

17. RECOMMENDATION

17.1. Recommendation

- Implementation Procedures

PAS has already implemented ODA projects under five Yen loan contracts, namely, CP-P3, CP-P5, CP-P6, CP-P8, and CP-P10. It has enough knowledge on procedures and rules for procurement, and a project management unit (PMU) has been designated as the executing body for ODA projects. Prompt information-sharing among related organizations such as MOE, MEF and MPWT is required. Establishment and coordination of a procurement committee composed of representatives from the aforementioned organizations in a timely manner is recommended to implement the project as scheduled.

- Financial Performance

It is important to reduce the operational cost by improving efficiency of operation and reforming the organization. It is also essential to lower non-operational costs.

The interest rates of MEF sub-loans should also be reduced to the level of ODA interest rates or to a similar level. At the very least, interest rates of sub-loans need to be reduced to the level of ODA rates during the construction period since ODA finances the amount of interest during construction, which means that the borrower does not have to pay interest during that time.

PAS should conduct vigorous promotional activities to attract the attention of the port business community before and after the development of a new container terminal. Moreover, promoting the utilization of the port SEZ and oil supply base/multi-purpose terminal should be given priority because these facilities will play a key role in improving the financial performance of PAS.

- Port Operation and Management

Port facilities are generally required to maintain the necessary functions so it can provide service for a long time. It is important to implement more efficient maintenance and repair on a preventive basis to minimize the life-cycle costs of machinery/equipment. Accordingly, a manual for strategic maintenance and repair should be created.

The International Ship and Port Facility Security (ISPS) Code is an amendment to the Safety of Life at Sea (SOLAS) Convention on minimum security arrangements for ships, ports, and government agencies. Cambodia is a contracting state to the International Convention for the Safety of Life at Sea Protocol of 1974 (SOLAS 74), but the country has not complied with the requirements of the ISPS Code sufficiently. Fully complying with the ISPS Code is required in order to keep its solid status as an international port.

In connection with the above issue, the following are necessary: 1) appropriation of required budget for security, 2) implementation of gate access control, 3) compulsory container weight measurement, and 4) setting up of second restricted area for container cargo operation.

- Social and Environment Issues

Stakeholders' understanding of the project is necessary for smooth project implementation. PAS held stakeholders' meeting for the project, but objection against the project was not confirmed. Disclosure of the project information should be executed continuously.

Before starting the project, information on the proposed construction work such as schedule, area of dredging work, and traffic conditions should be disseminated/distributed to the local residents including fishermen who live adjacent to the port area.

An environmental management plan (EMP) should be prepared, including mitigation measures and an environmental monitoring plan according to approved EIA report following MOE and JICA Guidelines. It is recommended that PAS monitors the environmental monitoring plans during construction work according to the approved EMP. The results of monitoring should be reported to MOE.

17.2. Potential Risks in the Project Implementation