

## **4. Selection of Power Plant Site**

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### **4.1. Investigated Sites**

As the result of the preliminary site investigation on the selected four (4) candidate sites, which were done from February to March, 2000, OP-3 was considered to be the optimum site provided that there is no restriction on the land acquisition, and the second ranked site was OP-4. And this result was accepted by MIME/EDC in March, 2000.

However, in the meeting held in June, 2000 prior to the final site investigation, MIME/EDC informed the JICA Study Team that the land acquisition of OP-3 is impossible as the final decision of ministerial level. This decision was confirmed in the meeting with the First Vice Governor of Sihanoukville during the final site investigation. Therefore the JICA Study Team was compelled to delete OP-3 from the list of candidate sites.

Site OP-5 sited between Sokimex Oil Terminal and OP-3 was proposed by MIME/EDC newly as an alternative option site.

Location of each candidate site is indicated in Fig.4.1-1.

In the 2nd Field Investigation the final site investigation was carried out for four (4) sites except OP-3.



**Fig.4.1-1** *Location of Candidate Sites*

## **4.2. Investigation Results of Candidate Sites**

Details of investigation results of OP-1, OP-2, OP-4 and OP-5 sites is shown in the Table 4.2-1.

Summarized characteristics of each site are as follows:

OP-1 : OP-1 site is located in the easternmost area among the sites and farthest from Sokimex Oil Terminal. There is mangrove forest and wet land in the coastline, and the sea in front of the site is very shallow. Therefore, this site is not good for utilizing the seawater as cooling water.

The site is far from the trunk road, so a long access road needs to be constructed. In addition, there is an old temporary and rotten bridge on the trunk road from Sihanoukville, which requires to be replaced or rehabilitated for transporting materials and equipment from the port to the site.

OP-2 : OP-2 site is located on the hill near Sokimex Oil Terminal. This location is preferable for transportation of fuel oil, but not preferable to obtaining cooling water due to the long distance from the sea.

The site has good accessibility because the trunk road runs on the site area.

OP-4 : OP-4 site lies just on the south of Sokimex Oil Terminal. This location is preferable for transportation of fuel oil. Furthermore, the site is close to the sea and the sea in front of the site is relatively deep. This condition is the best for utilizing the seawater as cooling water among the sites.

On the other hand, a relatively high and steep mountain is located in the northeast and the east ends of the site area. This situation may have some restriction on future expansion of power plant larger than 270 MW. The site has good accessibility and transportation condition because the trunk road and the railroad run beside the site.

OP-5 : OP-5 site is located just on the east of Sokimex Oil Terminal. This location is suitable to transportation of oil fuel. The sea in front of the site is relatively deep (but not so deep as OP-4), so the seawater can be used as cooling water.

The serious disadvantage of this site is its topographic feature. The site is hilly and bisected by a valley, and the river runs in the middle of it. This landform causes a large-scale civil works, such as rerouting of the river, large amount of soil excavation and/or reclamation.

After comparing each site in the aspects of environmental impact, land acquisition cost and construction/operation cost, OP-4 was selected as the most preferable site for the Sihanoukville power plant.

***Table 4.2-1 Investigation Results of Candidate Sites***

Index of Evaluation Items:

1. Topographic Condition
2. Soil and Rock Condition
3. Oceanographic Condition
4. Fuel Supply and Transportation
5. Availability of Cooling Water
6. Availability of Fresh Water
7. Access and Transportation from main Road
8. Environmental and Social Aspects

**Table 4.2-1 Investigation Results of Candidate Sites (1/5)**

No	Item	Candidate Sites			
		Option-1	Option-2	Option-4	Option-5
1.	Topographic Condition	About 0 m - 10 m above sea level, with coastal flat area and slightly hilly mountain behind the area.	About 10 m - 20 m above sea level, with slightly hilly land extending.	About 2 m - 5 m above sea level, with slightly hilly land extending to the foot of northward mountain with about 100 m height. A pond is located just southern part of the site area.	About 4 - 40 m above sea level hilly area extending with gradually higher land to south-westwards. East side falls to lower valley of a stream and swamps near the river mouth area.
2.	Soil and Rock Condition	Flat area with partly swamp land extended. Almost fluvial coastal terrace spreads around the site area. Sedimentary rocks (sandstone, siltstone) are presumed to extend underneath the surface soil layer.	Slightly hilly slopes extend around the area, with rock outcrops scattered. Rock layer is presumed near the ground surface soil layer of about 0.5 m - 1.5 m. Sandstone, siltstone are presumed to spread widely.	Bed rock of sand stone mainly spreads out widely under site area, and gradually it becomes deep in southern part of the area. Mainly sand silty sand overburden covers the land surface.	Sedimentary rocks of sandstones is presumed to extend widely under relatively thick surface soil layer of about 2 - 4 m over.
3.	Oceanographic Condition	In front of the site, shallow sea water spreads. Accordingly, relatively small wave presumed to occur. Silty sediments from the Thma Rung River are presumed to spread out near the shore line.	In front of the site, shallow sea water spreads. Accordingly, relatively small wave presumed to occur. Sandy-silt sediments are presumed to spread out near the shore line. No large river exits near the area.	In front of the site, relatively steep sea bed spreads and the sea shore faces westwards. Accordingly, high waves are expected in the rainy season due to west - southwest monsoon. Beach width is narrow about 2 m to 5 m with silty-sand.	In front of the site, shallow sea water spreads out widely northwards. Sea coast consists of sandy beach with a width of about 600 m. Partly scattered rock outcrops.
4.	Fuel Supply and Transportation	Fuel supply and transportation from Sokimex Oil Terminal to each site by railway, truck carry, pipeline and ship were examined for oil pipe. In case of truck, required number of trucks per day exceeds 80 which is not realistic. There is no difference of natural gas pipe length for all options.			
		1. Railway Sokimex Oil Terminal has branch line from main route. From main route to site, new branch line must be constructed. new branch line : approx. 4 km	1. Railway ditto new branch line : approx. 1.5 km	1. Railway ditto new branch line : approx. 0.5 km	1. Railway ditto new branch line : approx. 0.5 km
		2. Pipeline Required pipeline along railway is approx. 15 km. Pipeline must be harmonized with the plan of industrial zone. Length is approx. 15 km	2. Pipeline ditto	2. Pipeline ditto	2. Pipeline ditto
		3. Ship For 5,000 ton tanker, 7.5 m or deeper sea is required. For 1,000 ton ferry, 2 m depth is required. Pipe length for 5,000 ton : approx. 8.2 km for 1,000 ton : approx. 1.5 km	3. Ship ditto Length is approx. 3 km	3. Ship ditto Length is approx. 3 km	3. Ship ditto Length is approx. 0.8 km
		4. Economical status The longest facilities and the highest construction and operation cost are required among four candidates. Approx. 24,000 m <sup>3</sup> /h for 3 units of 90 MW (270 MW)	4. Economical status For pipeline, this site is relatively advantageous. For other method there is no advantage. tagc.	4. Economical status For all methods the shortest facilities, the cheapest construction and operation cost can be achieved.	4. Economical status All methods have no disadvantage. (Pipeline is a little longer than OP-5 but cost difference is negligible)
5.	Availability of Cooling Water	1. River Water This site is close to the Prek Thma Bong River, but river bed is shallow and moving sand and mud is assumed. This river is not suitable for condenser cooling water.	1. River Water There is no river.	1. River Water No river water is available from surrounding area. Fresh water is available during rainy season.	1. River Water No river water is available from surrounding area.

**Table 4.2-1 Investigation Results of Candidate Sites (2/5)**

		Candidate Sites			
No	Item	Option-1	Option-2	Option-4	Option-5
5.	Availability of Cooling Water	<p>2. Sea Water Front sea is very shallow (4 m of depth at about 2 km away). Surrounding area is good fishery and also mangrove is growing.</p> <p>3. Availability of Cooling Water River and sea water are considered as "not good".</p>	<p>2. Sea Water High altitude of 10 ~ 20 m and about 2 km to coast line is not suitable for the use of sea water.</p> <p>3. Availability of Cooling Water Cooling water is practically "not available".</p>	<p>2. Sea Water This site is close to coastline, but pipeline must cross railway and trunk road. Sea bed declination is steep. No difficulty is observed for water taking.</p> <p>3. Availability of Cooling Water Cooling water is considered as "available".</p>	<p>2. Sea Water This place is adjacent to coast line and sea bed is declined up to 3 m depth, this is good condition for taking cooling water.</p> <p>3. Availability of Cooling Water Cooling water is considered as "available".</p>
6.	Availability of Fresh Water	<p>Roluos Thom River located about 2 km away. A way Hun Sen Spillway Dam reservoir located about 3.5 km from the river mouth could be used for the fresh water supply. This reservoir is about 3 km far from the Site.</p>	<p>No near-by river is located, neither well located around the site. Therefore, Prey Treng Pond is expected as the water supply source, which is 3 km apart from the Site.</p>	<p>A pond just south of the site could be used for fresh water, although the water is being used for the Sokimex Oil Terminal and residents around the area. The catchment area of the pond is relatively limited along the coast area. Therefore, storage water tank will be necessary in case of water shortage.</p>	<p>No near-by river from which fresh water can be withdrawn in the dry season is located around the site. Therefore, Prey Treng Pond is expected as a fresh water supply source, that is located about 3 km from the site.</p>
7.	Access and Transportation from Main Road	<p>1. Existing Facilities Unpaved wide road to Stung Hav Village is suitable for the transportation, except that at the entrance of village a very weak temporary bridge crossing over the Roluos Thom River precludes from transportation of any equipment heavier than 15 ton including vehicle.</p> <p>2. Access from the Main Road From Stung Hav Village no access road is available. A new road of about 3 km is required. In case of de-tour of the above-mentioned bridge, a new road of about 7 km must be constructed.</p> <p>3. Access from the Sea Surrounding sea is very shallow and is not suitable.</p>	<p>1. Existing Facilities Site is sited along the main road.</p>	<p>1. Existing Facilities The site is sited along rail road.</p>	<p>1. Existing Facilities Site is sited along a branch road.</p>
8.	Environmental and Social Aspects	<p>4. Accessibility and Transportability The longest access road construction among 4 candidates and reinforcement of the bridge on a large scale are required. These increase construction cost.</p> <p>1. Risk of off-site spoil disposal No risk.</p> <p>2. Length of new access road 3 km</p> <p>3. Distance to transport construction materials 18 km</p>	<p>4. Accessibility and Transportability The cheapest construction cost is expected among 4 candidates.</p> <p>1. Risk of off-site spoil disposal No risk.</p> <p>2. Length of new access road 0.05 km</p> <p>3. Distance to transport construction materials 10 km</p>	<p>4. Accessibility and Transportability A new road of about 200 m is required.</p> <p>1. Risk of off-site spoil disposal No risk.</p> <p>2. Length of new access road 0.2 km</p> <p>3. Distance to transport construction materials 6 km</p>	<p>4. Accessibility and Transportability Easy access of 50 m is achievable.</p> <p>1. Risk of off-site spoil disposal Earth moving to achieve plant grade that is low enough for economical pumping of cooling water will require offsite spoil disposal of 4.5 million m<sup>3</sup>.</p> <p>2. Length of new access road 0.05 km</p> <p>3. Distance to transport construction materials 9 km</p>



**Table 4.2-1 Investigation Results of Candidate Sites (3/5)**

No	Item	Candidate Sites				
		Option-1	Option-2	Option-4	Option-5	
8.	Environmental and Social Aspects	<p>4. Fuel transport distance 1.5 km</p> <p>5. Possibility of valuable habitats on site High quality habitats were not observed. The area is deforested, sandy, stony and boulder-strewn. The dominant vegetation is grass. Except for Stung Hav village there are few trees.</p> <p>6. Protected species on site Protected birds observed near Hun Sen Reservoir and Prey Treng Pond during baseline surveys.</p> <p>7. Possibility of aesthetic effects on landscape There are no notable aesthetic features other than the view of the sea. Low hills behind the site help to make the plant less conspicuous from many viewing directions.</p> <p>8. Physical infrastructure on site None observed. A dirt road enters the west side of the original OP-1 area but becomes an unimproved track before reaching the proposed site.</p> <p>9. Villages / houses on site One house and family observed near the site, within the original OP-1 area.</p> <p>10. Irrigated land on site None observed.</p> <p>11. Other agriculture on site One home garden, duck pen and fish pond were observed at a house near the site and within the boundaries of the original OP-1 site area.</p> <p>12. Cultural property on site None observed.</p> <p>13. Provincial or district boundaries on site Provincial boundary would be crossed by cooling water pipeline. However, with air-cooled condenser, entire project is in Stung Hav District.</p> <p>14. Distance to nearest national park About 17 km to the boundary of Ream National Park.</p>	<p>4. Fuel transport distance 3 km</p> <p>5. Possibility of valuable habitats on site Similar to Site OP-1.</p> <p>6. Protected species on site ditto</p> <p>7. Possibility of aesthetic effects on landscape There are no notable aesthetic features on site. The elevation of the site is higher than the elevations of the other sites. This makes it more conspicuous to surrounding areas in several directions.</p> <p>8. Physical infrastructure on site Infrastructure observed on the site includes only a 10 m wide dirt road that traverses the northern edge of the site; and some scattered fence posts.</p> <p>9. Villages / houses on site No houses were observed on site. One shelter observed just north of the site.</p> <p>10. Irrigated land on site None observed.</p> <p>11. Other agriculture on site None observed.</p> <p>12. Cultural property on site None observed.</p> <p>13. Provincial or district boundaries on site No provincial or district boundaries cross the site.</p> <p>14. Distance to nearest national park About 17 km to the boundary of Ream National Park.</p>	<p>4. Fuel transport distance 3 km</p> <p>5. Possibility of valuable habitats on site The site is adjacent to Prey Treng Pond that supplies fresh water to Sokimex oil terminal. Otherwise it is not remarkable and does not appear to include valuable habitats.</p> <p>6. Protected species on site ditto</p> <p>7. Possibility of aesthetic effects on landscape The site has a view of the sea, but is along the railroad, and otherwise not aesthetically remarkable. Low hills behind the site will help to make it inconspicuous from a number of directions.</p> <p>8. Physical infrastructure on site Infrastructure observed on the edge of the site includes a shallow impoundment that provides the fresh water supply for Sokimex oil terminal.</p> <p>9. Villages / houses on site In late 2001 there are 4 houses on the site, as then defined.</p> <p>10. Irrigated land on site None observed.</p> <p>11. Other agriculture on site None observed.</p> <p>12. Cultural property on site None observed.</p> <p>13. Provincial or district boundaries on site No provincial or district boundaries cross the site.</p> <p>14. Distance to nearest national park About 17 km to the boundary of Ream National Park.</p>	<p>4. Fuel transport distance 0.8 km</p> <p>5. Possibility of valuable habitats on site This site area is bisected by a forested ravine. Areas around the ravine where construction would be most likely are covered by grass (mostly to the west) and shrubs (mostly to the east) and appear unlikely to include valuable habitats.</p> <p>6. Protected species on site Protected species on site ditto</p> <p>7. Possibility of aesthetic effects on landscape The site has a view of the sea, but is adjacent to the railroad, adjacent to a cleared area and warehouse (to the east) and near to the Sokimex tank farm (to the east). Low hills behind the site help to make it inconspicuous.</p> <p>8. Physical infrastructure on site Property maps indicate that several unimproved roads exist on site. A road on the west side of the ravine was passable with 4 WD vehicle only on relative flat areas above the ravine.</p> <p>9. Villages / houses on site One structure was observed on the western part of the site.</p> <p>10. Irrigated land on site None observed.</p> <p>11. Other agriculture on site None observed.</p> <p>12. Cultural property on site None observed.</p> <p>13. Provincial or district boundaries on site No provincial or district boundaries cross the site.</p> <p>14. Distance to nearest national park About 18 km to the boundary of Ream National Park.</p>	

**Table 4.2-1 Investigation Results of Candidate Sites (4/5)**

		Candidate Sites			
No	Item	Option-1	Option-2	Option-4	Option-5
8.	Environmental and Social Aspects	<p>15. Impacts of obtaining fresh water Water from Hun Sen Spillway Dam, 3 km from the site, seems to be available. This reservoir supplies washing water to Stung Hav Village, which obtains most of its drinking water from wells.</p> <p>16. Topographic constraints to atmospheric dispersion Site is near sea level. Topography is undulating and generally suitable for atmospheric dispersion. The highest point within 5 km of the site is El. 134 m, about 5 km SW. El. 218 m occurs 10 km SE of the site.</p> <p>17. Possibilities of construction effects on nearby villages Stung Hav Village appears to contain a large fraction of the 11,000 persons in the district. Plans for resettlement of families from Sihanoukville Port Area have been changed. Stung Hav will not receive these resettlers.</p> <p>18. Nearby air pollution sources There are no major sources in the region. A fish meal plant in Stung Hav and scattered brush burning are minor sources of smoke. Roads are minor sources of dust.</p> <p>19. Compatibility with land use Since Stung Hav will not be receiving resettlers from the Sihanoukville Port Area, the conflict between resettlers and the project (noted in Progress Report 1) has disappeared.</p> <p>20. Population distribution within 30 km radius Population within a 30 km radius is fairly low and about the same for each site. Most of the 150,000+ population of Sihanoukville Municipal Province are within the radius.</p> <p>21. Possibility of construction effects on coastal habitats The site is near the mouth of the Thmarong River and therefore in an estuary. There are mangroves nearby. The sea in front of the site is very shallow. However, these items will not be affected by an air-cooled condenser.</p>	<p>15. Impacts of obtaining fresh water The site is 3 km from the Prey Treng Pond and at a higher elevation. Water flow of Prey Treng Pond is already committed to Sokimex.</p> <p>16. Topographic constraints to atmospheric dispersion Site is 10s of meters above sea level. Topography is hilly but favorable for atmospheric dispersion. Highest point within 5 km is El. 134 m and 4 km S. The highest point within 10 km is El. 156 m, 6 km SSW.</p> <p>17. Possibilities of construction effects on nearby villages There are no villages in the immediate vicinity of this site.</p> <p>18. Nearby air pollution sources There are no major sources in the region. Scattered brush burning is a minor source of smoke. Roads are minor sources of dust.</p> <p>19. Compatibility with land use No conflict. The site is within the boundaries of a planned industrial park.</p> <p>20. Population distribution within 30 km radius Similar to OP-1.</p> <p>21. Possibility of construction effects on coastal habitats The shoreline in front of the site is rocky and appears not to have especially valuable habitats. However, there will be no impacts with air-cooled condensers.</p>	<p>15. Impacts of obtaining fresh water Prey Treng Pond is at the edge of the site but flow is already committed to Sokimex.</p> <p>16. Topographic constraints to atmospheric dispersion Site is near sea level. Topography is undulating. Hills within 5 km east and south have peaks of EL. 127 m, 134 m, 156 m and 143 m. These hills are the highest areas within the 10 km radius. There are lower hills to the north.</p> <p>17. Possibilities of construction effects on nearby villages Houses extend along the road from Sihanoukville to just south of the site.</p> <p>18. Nearby air pollution sources There are no major sources in the region. Scattered brush burning and charcoal production are minor sources of smoke. Roads are minor sources of dust.</p> <p>19. Compatibility with land use The site was previously within the long-term expansion plan for Sihanoukville Port, but is now reserved for industrial development. Proposals for residential developments are reported to have already been denied.</p> <p>20. Population distribution within 30 km radius Similar to OP-1.</p> <p>21. Possibility of construction effects on coastal habitats Construction will extend into the sea from a narrow white sand beach where there appear to be no especially valuable habitat. Sea depth is 5 m within 1 km, 7.5 m within 1.8 km and 13 m within 3 km. near the site.</p>	<p>15. Impacts of obtaining fresh water This site area is 3 km from the Prey Treng Pond. Also, a small stream bisects the site, but its catchment area is small and its dry season discharge cannot be observed until next year.</p> <p>16. Topographic constraints to atmospheric dispersion Site is near sea level, but higher than OP-1 and OP-4. Topography is undulating. A hill of El. 61 m is about 1 km SE of the site. Hills of El. 127, 130 and 134 m are SSE within 5 km. Hills of El. 156 and 143 m are S within 10 km.</p> <p>17. Possibilities of construction effects on nearby villages There are no villages near this site.</p> <p>18. Nearby air pollution sources There are no major sources in the region. This site is near the Sokimex terminal, but there was no evidence of air pollution from the terminal during the site visits.</p> <p>19. Compatibility with land use No conflict. The site area is already surrounded by industrial uses and activity.</p> <p>20. Population distribution within 30 km radius Similar to OP-1.</p> <p>21. Possibility of construction effects on coastal habitats Construction will extend into a shallow sea from a muddy sand beach with scattered rocky areas, toward an island located 2 km offshore.</p>

**Table 4.2-1 Investigation Results of Candidate Sites (5/5)**

		Candidate Sites			
No	Item	Option-1	Option-2	Option-4	Option-5
8.	Environmental and Social Aspects	<p>22. Possibility of aesthetic effects on seascape None with air-cooled condenser and general absence of scenic vistas, beaches and clear water. Low hills behind site are deforested. Sedimentation to estuary is apparently increasing.</p> <p>23. Cooling system impacts on marine life and fisheries With an air-cooled condenser the cooling system will not affect the marine environment or fishing industry and there will be no need for marine studies or monitoring for the life of the project.</p>	<p>22. Possibility of aesthetic effects on seascape There appear to be no remarkable landscapes, scenic vistas, clear water, etc. associated with this site. Sokimex oil terminal and jetty and a sawmill and jetty are visible from the coastline near this site. The shoreline is rocky.</p> <p>23. Cooling system impacts on marine life and fisheries Similar to OP-1.</p>	<p>22. Possibility of aesthetic effects on seascape Cooling water canals would be visible from land and sea. The white sand beach is an attraction, but its narrow width (&lt; 10 in many places) and its proximity to the adjacent road and railroad lower its aesthetic appeal and utility.</p> <p>23. Cooling system impacts on marine life and fisheries Chlorination and heating of 188 million m<sup>3</sup>/yr of sea water could produce adverse impacts on marine life and fisheries, depending on details of fish spawning and the cooling system design. Deep water will favor mitigation.</p>	<p>22. Possibility of aesthetic effects on seascape Cooling water canals would be visible from land and sea, but the area is surrounded by similar visual intrusions. As a result it is not aesthetically notable or valuable.</p> <p>23. Cooling system impacts on marine life and fisheries Similar to OP-4 but water depth is less favorable for reducing the seriousness of impacts of the cooling system. A nearby island raises the possibility of more serious impacts.</p>

#### **4.3. Possibility of Land Acquisition and Price of Land**

According to the investigation done by MIME/EDC, there is no objection to the possibility of land acquisition for all sites except OP-3. The site OP-4 area is owned by about thirteen (13) private owners, however, MIME/EDC explained that the area around here including OP-4 site has already reserved by the government for the industrialization purpose and can be acquired easily for the power plant.

The price of land of each site informed by the Sihanoukville Municipality is as follows:

- OP-1 : approx. 2.0 \$/m<sup>2</sup>
- OP-2 : approx. 3.0 \$/ m<sup>2</sup>
- OP-4 : approx. 2.3 \$/ m<sup>2</sup>
- OP-5 : approx. 3.0 \$/ m<sup>2</sup>

The required area for the power plant is approx. 320,000 m<sup>2</sup>, therefore, the difference of land acquisition cost among the sites is only 0.32 Million US\$ at the most.

#### **4.4. Evaluation of Environmental Impact**

Few houses or no houses were observed in all sites. Therefore, no major relocation issue exists for any sites.

Except for protected birds that were observed in the vicinity of Hun Sen Dam and Prey Treng Pond during the environmental baseline survey for Site OP-4, valuable habitats, other protected species, cultural heritage, etc. were not observed in any areas or sites. All sites are far from the nearest protected area or National Park.

OP-4 and OP-5 have a hot water dispersion problem because the seawater is used as cooling water in these sites. However this problem can be mitigated by means of appropriately design cooling water intake and discharge in compliance with the guideline of the World Bank.

OP-5 also has a problem of large mass of soil disposal. Earth moving to achieve a

plant grade that is low enough for economical pumping of cooling water will require offsite spoil disposal of 4.5 million m<sup>3</sup>.

Until the topographic survey was carried out, there was concern that OP-4 may have a problem of large mass of soil disposal. However, the detailed topographic survey revealed that the elevation of the site was lower than shown on available topographic maps, and that spoil disposal was not an issue.

#### **4.5. Comparison of Construction Cost and Operation Cost**

Based on the characteristics of each site, the difference of construction cost and operation cost for each site were estimated and compared.

The difference of construction costs were calculated on the basis of the following pre-conditions:

- (1) Power plant generation capacity is 180 MW.
- (2) Power plant type is a gas turbine combined cycle, of which condenser cooling system is:
  - OP-1 : Air-cooled condenser
  - OP-2 : Air-cooled condenser
  - OP-4 : Seawater-cooled condenser
  - OP-5 : Seawater-cooled condenser
- (3) Fuel oil is transferred by oil pipeline from Sokimex Oil Terminal to the plant along the railroad.
- (4) For OP-1 fresh water is supplied from Hun Sen Dam. For OP-OP-2, OP-4 and OP-5 fresh water supplied from Prey Treng Pond.
- (5) Substation is located in the power plant area. Transmission line from Takeo will be connected directly to the power plant substation.
- (6) Acquisition prices of land are as mentioned in Section 4.3.

In addition to the construction costs, the difference of operation costs were also calculated because of difference of plant efficiency between the plant with seawater-cooled condenser and the plant with air-cooled condenser. The plant with seawater condenser has a higher power generation efficiency than that with air-cooled condenser due to its lower attainable vacuum in condenser. The length of gas pipeline is considered the same for all sites.

The difference of operation costs are shown as Net Present Value of the difference of cumulative operation cost over the economic plant life of 20 years. The calculation base of operation cost is as follows:

Economic plant life	:	20 years
Natural gas price	:	4.0 \$/MMBTU
Discount rate	:	10 %
Capacity factor	:	54 %
Net heat rate of plant (LHV base)	:	Seawater-cooled condenser 7,419 kJ/kWh
		Air-cooled condenser 7,639 kJ/kWh

Although 220 kV transmission line is not included in the scope of the Project, differences of the construction costs of transmission line were also counted because the length of this transmission line will vary by the location of sites.

Cost comparison results calculated based on the above is shown in Table 4.5-1 and summarized below:

	(Unit : Million US\$)
OP-1	+ 16.5
OP-2	+ 10.6
OP-4	Base
OP-5	+ 28.9

Among the above four sites, OP-4 shows the minimum construction and operation cost.

#### **4.6. Conclusion of Optimum Site Selection**

All sites are considered to be acceptable for environmental requirements as long as appropriate environmental mitigation measures are applied. Therefore, the site OP-4 is most recommendable because of its highest economic superiority mainly depending upon the availability of the seawater as cooling water and the lowest site preparation cost.

Until the topographic survey was carried out, there was concern that OP-4 may have a problem of large mass of soil disposal. However, the detailed topographic survey revealed that the elevation of the site was lower than shown on an available topographic maps, and the soil volumes of excavation and reclamation are balanced at an appropriate site elevation.

**Table 4.5-1 Estimated Cost for Items which are variable by Sites**

\*Natural Gas price: 4 US\$/MBTU

Unit : 1000 US \$

Item	Unit cost 1000 US\$	OP-1		OP-2		OP-4		OP-5	
		Q'ty	Cost	Q'ty	Cost	Q'ty	Cost	Q'ty	Cost
<b>A. Site preparation</b>									
Borrow soil	0.004 /m <sup>3</sup>	187500	750	297000	1,188	95000	380	0	0
Excavation	0.006 /m <sup>3</sup>	187500	1,125	297000	1,782	95000	570	5E+06	27,563
<b>Subtotal</b>			<b>1,875</b>		<b>2,970</b>		<b>950</b>		<b>27,563</b>
<b>B. Fuel supply system</b>									
Cost of pipeline	354 /km	15	<b>5,310</b>	3	<b>1,062</b>	3	<b>1,062</b>	0.8	<b>283</b>
<b>C. Cooling water system</b>									
C-1 Cooling water intake	8580 /km	0	0	0	0	0.3	2,574	0.6	5,148
Cost of intake canal	6110 /km	0	0	0	0	0.2	1,222	0.3	1,833
C-2 Cooling water discharge	700 /km	0	0	0.5	350	0.5	350	0.5	350
Cost of discharge canal									
Replacement of rail road			0		0		4,146		7,331
<b>Subtotal</b>									
<b>D. Steam condensing system</b>									
Cost of air cooled condenser	Lump sum		10,700		10,700		0		0
Cost of cond. plus intake sys.	Lump sum		0		0		5,252		5,252
<b>Subtotal</b>			<b>10,700</b>		<b>10,700</b>		<b>5,252</b>		<b>5,252</b>
<b>E. Difference of operation cost*</b>	Lump sum		<b>7,500</b>		<b>7,500</b>		<b>0</b>		<b>0</b>
<b>F. Fresh water supply system</b>									
Cost of raw water pipeline	47 /km	3	<b>141</b>	3	<b>141</b>	0.1	<b>5</b>	3	<b>141</b>
<b>G. Road condition and access</b>									
G-1 New access road	700 /km	3	2,100	0.05	35	0.2	140	0.05	35
Cost of new access road	24 /m	75	1,800	0	0	0	0	0	0
G-2 New bridge			<b>3,900</b>		<b>35</b>		<b>140</b>		<b>35</b>
Rehabilitation of old bridge									
<b>Subtotal</b>									
<b>H. Power transmission line</b>									
Cost of transmission line	130 /km	(Base)	0	5.9	<b>767</b>	9.9	<b>1,287</b>	7.4	<b>962</b>
<b>I. Land acquisition</b>	(unit price)	(2 \$/m <sup>2</sup> )		(3 \$/m <sup>2</sup> )		(2.3 \$/m <sup>2</sup> )		(3 \$/m <sup>2</sup> )	
Cost of land acquisition	(m <sup>2</sup> )	320,000	<b>640</b>	320,000	<b>960</b>	320,000	<b>736</b>	320,000	<b>960</b>
<b>Total</b>			<b>30,066</b>		<b>24,135</b>		<b>13,578</b>		<b>42,527</b>