5. SETTING FOR DEVELOPMENT OF THE BANG SAPHAN AREA

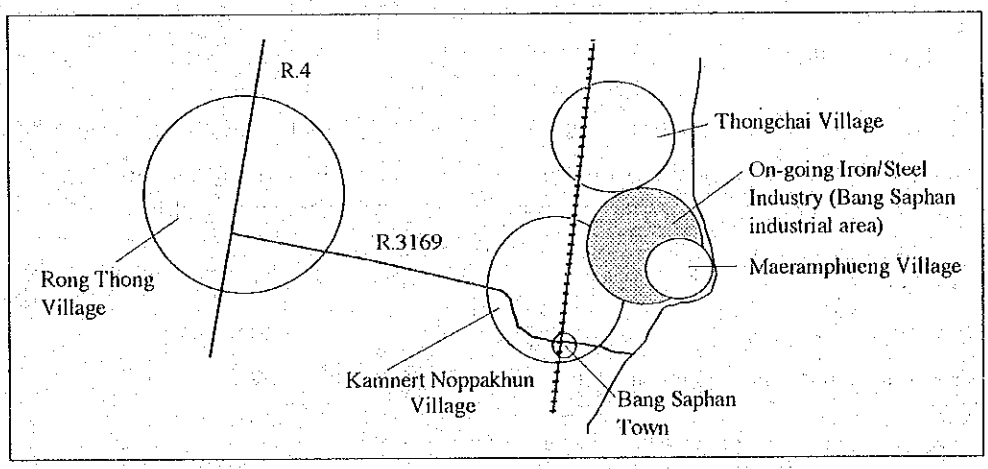
5.1 Development Concept of the Bang Saphan Area

The proposed Bang Saphan Industrial Estate is located in Bang Saphan District of Prachuap Khiri Khan Province. The general socio-economic situation in Bang Saphan District and the project area, as well as prospective development of the Bang Saphan industrial area, has been reviewed to set up a framework for development of the industrial estate.

1) Socio-economic Situation and On-going Projects

Labor Force

The population of the Bang Saphan District increased from 61,640 in 1987 to 65,500 in 1995 (0.7%) as explained in detail in Chapter 8. Ron Thong Village located at the junction of Route 4 and Route 3169, the main access to the Bang Saphan industrial area, is the most populated area with 14,230 residents and 3,034 households, showing a 4.3% annual increase in population between 1987 and 1995. Population growth for the other villages, on the other hand, is stagnant. In fact, the populations of Thongchai and Kamnert Noppakhun villages have been decreasing since 1992 due to the influence of the development of iron and steel factories.



Social Indicators of Bang Saphan District (1995)

Population	65,503
	(3,864 increase during 1987 and 1995)
Number of Households	13,476
Average Household Size	4.9

Source : Prachuap Khiri Khan Provincial Office

Industrial Location

Several manufacturing industries are located in the Bang Saphan industrial area. Major industries are iron and steel factories of the Sahaviriya group as shown below.

Iron/Steel Industries by Sahaviriya Group

Name	Products	No. of Employees
Sahaviriya Steel Industries Co., Ltd. (SSI)	Hot coil	app. 330
Thai Coated Steel Sheets Co., Ltd. (TCSS)	Electric galvanize coil	230
Thai Cold Rolled Steel Sheet Co., Ltd.(TCRSS)	Cold coil	under construction
Bang Saphan Bar Mill Co., Ltd. (BSBM)	Iron bar	under construction

Source: Industrial Statistics of Prachuap Khiri Khan and Sahaviriya information

2) Present Land Use and Development Constraints of Bang Saphan

General Land Use

The terrain of Bang Saphan District is endowed with vast farmland as shown below. The residential area is very limited, occupying only 1.7 % of the total district area.

	km^2	%
Housing Land	15	1.7
Farmland	531	60.6
Others (mountain, forest, public use, etc.)	330	37.7
Total	876	100.0

Source: Prachuap Khiri Khan Provincial Office

The farmland in Bang Saphan District is characterized by large coconut plantations. Of the total farmland area of 531 km^2 in the District, about 63% (335 km^2) is covered by fruit trees and crops (mostly coconut). The remaining farmland is cultivated with field crops, paddies and vegetables.

Distribution of Residential Area and Forest Reserve

According to the existing land use map provided by DTCP and reproduced in Figure 6.1 by the Study Team, the commercial and densely populated area is concentrated along Route 4 and Route 3169 and villagers reside along local roads where the population density is low. The Bang Saphan industrial estate will be developed in a remote area, far from the commercial and dense by populated area

Mountains and swamp land scattered in the Bang Saphan area are designated as the national reserve forest by the Royal Forest Department. Development of this forest land is prohibited, in principle, by the National Forest Reserves Act enacted in 1964. The forest land is categorized into two types: Strict reserve forest and common reserve forest. The strict reserve forest cannot be developed, the common reserve forest however may be developed by the ministerial permission. Forest growing alongside the Khlong Mae Ramphueng running in the iron and steel complex area is designated as common reserve forest. Major national reserve forests in the Bang Saphan District are cited below.

National Forest	Total Area		Strict Reserve		Common Reserve	
	(ha)	(Rai)	(ha)	(Rai)	(ha)	(Rai)
Khlong Ao Forest	190	1,200	190	1,200	0	0
Khlong Mae Ramphueng Forest (Swamp)	730	4,550	220	1,375	510	3,175
Srisurk Forest	38	237	38	237	0	0
Chaiyarai Forest and Khlong Krud Forest	10,600	66,212	2,600	16,475	8,000	49,737

Source: Investment Plan of Prachuap Khiri Khan Province
Note: as of 1993

Development Constraints

Figure 5.1 shows that the distribution of reserve forest with topographic conditions and the major built up areas scattered along Route 3169 and in the center of the District near the Bang Saphan station constraints the land development of Bang Saphan District. The land owned by the Sahaviriya group presented in the figure will be predominantly utilized by the iron/steel industry except for the western part of the railroad.

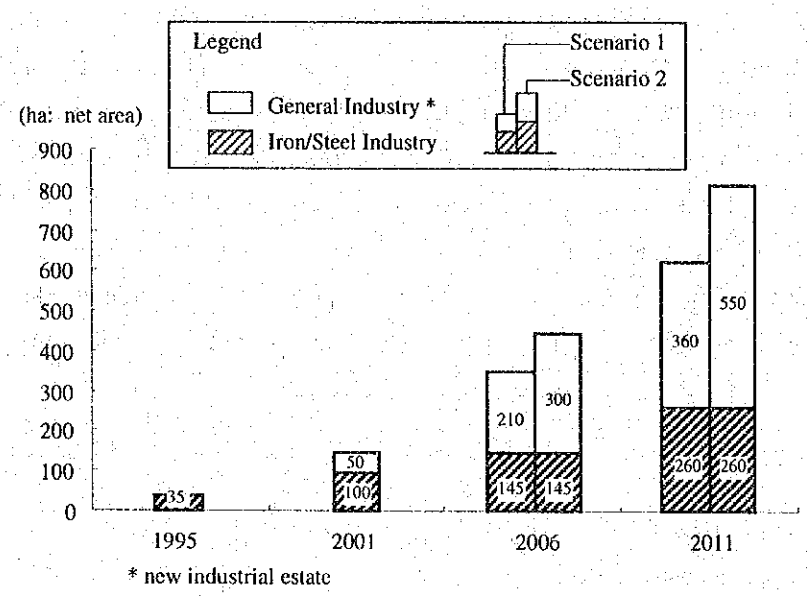
In addition, the coastal area within a distance of 500 m from the shoreline is prohibited from industrial development by the City and Town Planning Act enacted in 1975.

It can be said that available land for the development of the general industrial estate is rather limited.

3) Setup of Development Framework

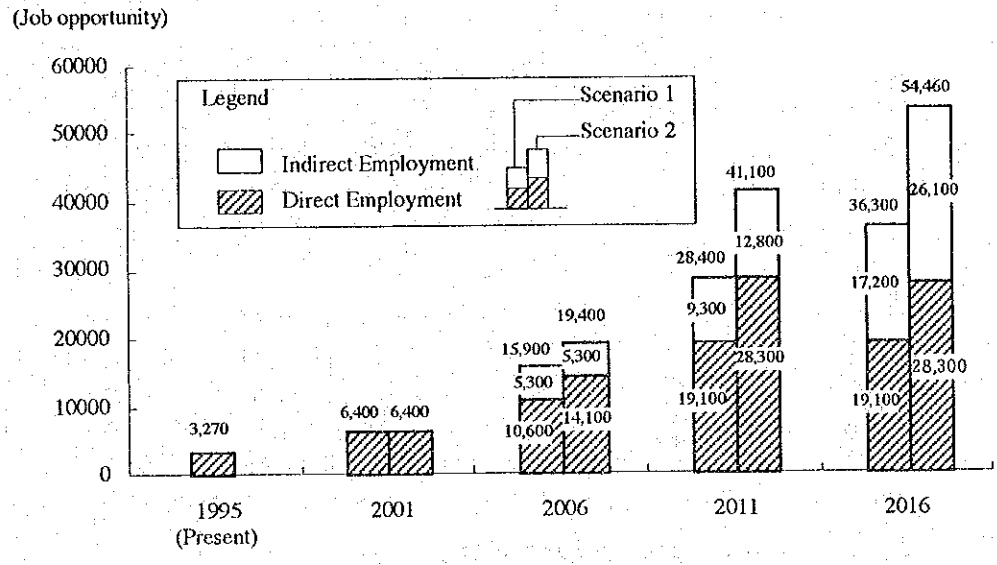
Demand for Industrial Area

As discussed in 4.3, demand for industrial area in Bang Saphan is assumed to be 150 ha and 620 ha (scenario-1) or 810 ha (scenario-2) in the years 2001 and 2011 respectively, as shown in Table 5.1 and summarized in the figure below.

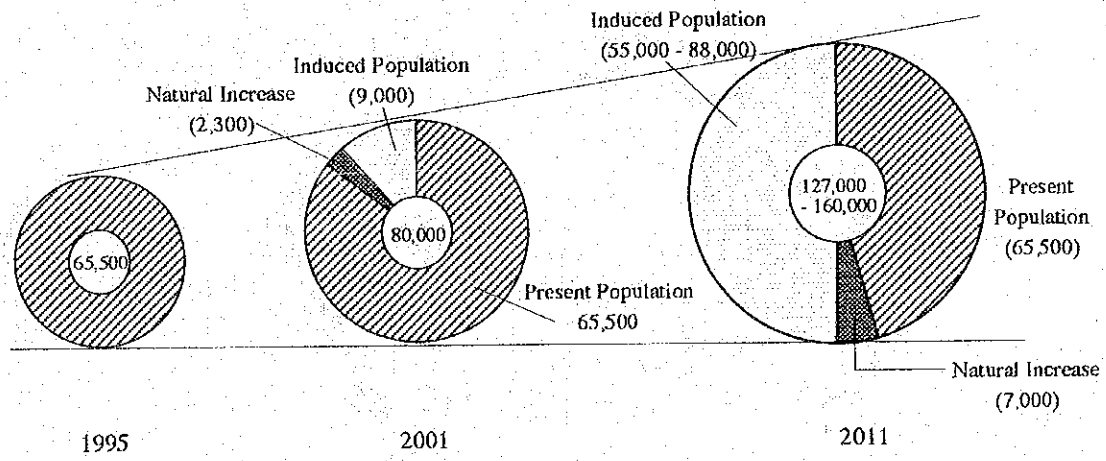


Setup of Population and Number of Employees

Direct and indirect employment opportunities will be induced by the Bang Saphan industrial area and relevant port and power plant development. 36,000 (scenario-1) or 54,000 (scenario-2) job opportunities that are equivalent to 11 or 16 times the present number of employees of the industrial sector in Bang Saphan District will be expected after 2010. Direct employment is estimated to amount to 19,000 ~ 28,000 workers in 2011 and indirect employment induced by the third sector will be 9,000 ~ 13,000 in 2011 and 17,000 ~ 26,000 workers in around 2016. A time lag of indirect employment inducement will occur behind the development of direct employment, so the number of employees will increase gradually until around 2016 as illustrated below (refer to Appendix C for details on employment projection).



The population increase induced by the Bang Saphan industrial area and relevant project development is estimated based on the projected number of employees as described above. 55,000 or 88,000 people will come and reside in Bang Saphan District and the total residential population is estimated at 127,000 ~ 160,000 including current residents and natural growth population of Bang Saphan District in 2011 as illustrated below. It means that the population of Bang Saphan District will be more than double after the implementation of the Bang Saphan industrial complex.



Estimate of Population Increase in Bang Saphan District

Demand for Infrastructure

Water and electricity demand and cargo volume generated by the development of the Bang Saphan industrial area are estimated as shown below (detailed demand of infrastructure is shown in Table 5.1).

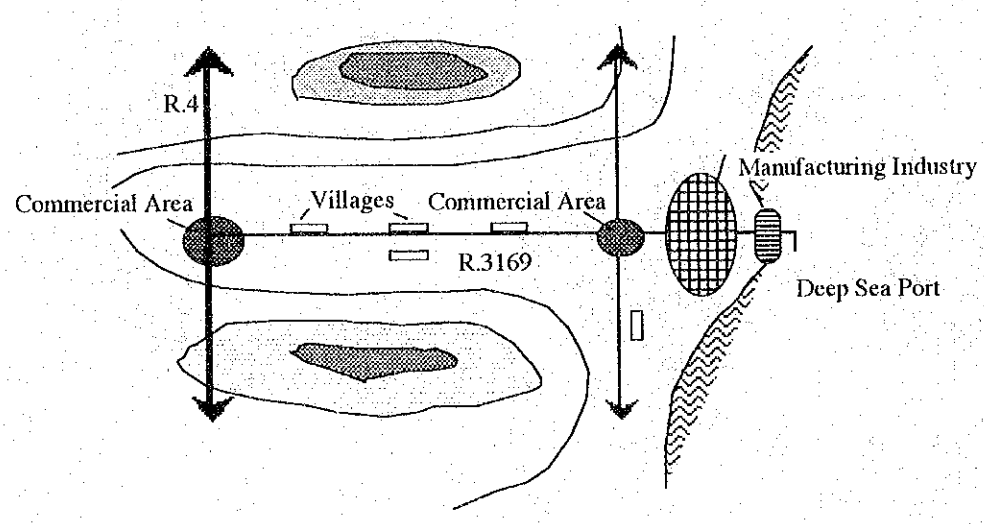
	1995	2001	2006	2011
Water Demand (million m^3/year)				
Industrial use	2	12.9	45.5~52.6	59.2~72.2
Iron/steel industry	1.8	11.7	36.0	36.0
General industry	-	1.0	8.7~15.7	22.3~35.4
Others	0.2	0.2	0.8	0.8
Domestic use	0.6	1.0	1.6~1.8	2.8~4.0
Total	2.6	13.9	47.1~54.4	62.0~76.2
Electricity Demand (MW)	94	400	1,800	1,900
Cargo (million tons/year)	1.9	7.0	14.8~20.2	30.0~31.0

4) Land Use Concept of the Bang Saphan Area

Land Use Alternative

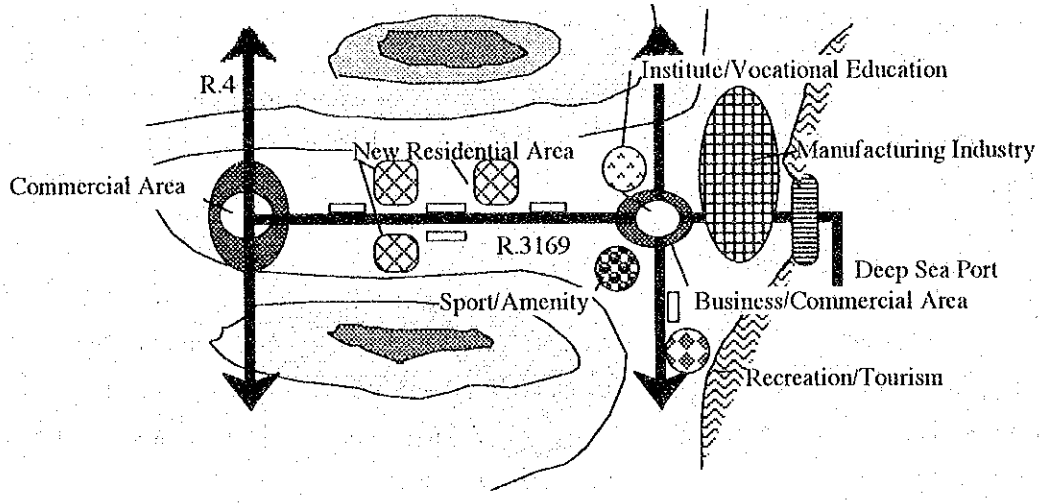
Current land use of Bang Saphan District can be determined as schematically figured out below. Although large scale iron and steel industry has been established in the east coastal area, small villages scattered along Route 3169 and local commercial zone in Bang Saphan town and urban amenities are too poor to support the gigantic industrial development.

Present Land Use of the Bang Saphan Area



Available land in Bang Saphan District is rather limited due to the mountainous area and green reserve designated by the Royal Forest Department. The supporting amenities and new residential area will be distributed in the neighboring area of Bang Saphan town and the corridor along Route 3169 as shown below.

Future Land Use of the Bang Saphan Area



Conceptual plans for the development of the Bang Saphan industrial city by alternative development scenario 1 and scenario 2 in 2011 have been formulated and presented in Figure 5.2 and 5.3. The midway plan for 2001 is also drawn in Figure 5.4 and land use configuration is tabulated in Table 5.2.

Evaluation of Development Alternatives

Development alternatives, scenario 1 and scenario 2, of the Bang Saphan industrial area are evaluated on the basis of the following criteria.

Overall Evaluation of Scenario 1 and Scenario 2

	Scenario 1	Scenario 2
1. Contribution to the enhancement of Thai industry	△	○
2. Adequacy of land use	○	△
3. Development potential of infrastructure		
· Water resources	○	△
· Port	○	○
· Road	○	○
· Power	○	○
4. Environmental impact	less impact	–
5. Development cost	○	○
Overall	◎	○

As shown above, the medium size development of scenario 1 is more promising than the large size development scenario 2. It means that a medium size industrial estate will be more suitable for the Bang Saphan area where the development potential of infrastructure is

limited at some extent and environmental problems, especially the impact on social environment, are smaller.

Scenario 1, therefore, is proposed for the development of the Bang Saphan industrial area, paying due attention to the reservation of a sufficient industrial area for future expansion.

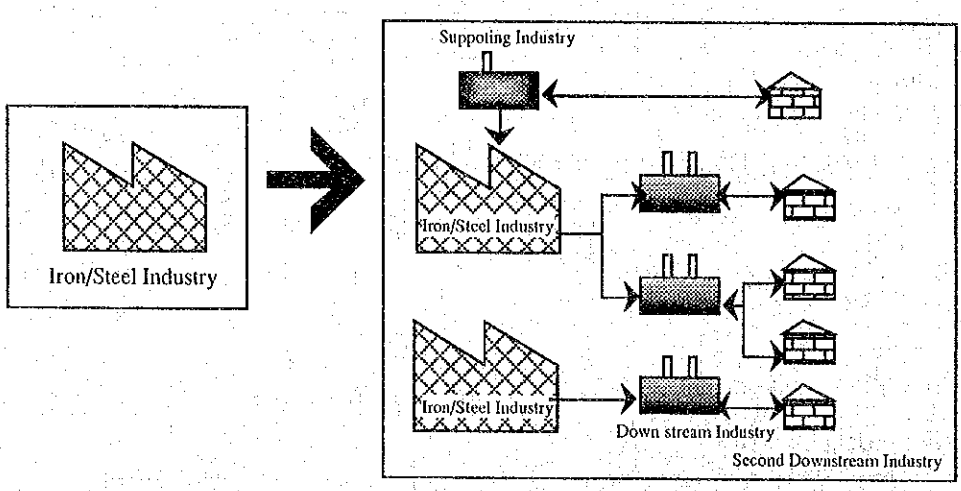
5) Prospective Development of the Bang Saphan Area

The development of the Bang Saphan area in which a gigantic iron and steel industry is being developed by the private sector, shall aim to accomplish the comprehensive targets proposed below in order to successfully attract investment and bring about long term prosperity to the industry and the citizens of Bang Saphan.

Development of the Iron and Steel Industrial Complex

Bang Saphan was conceived as the first project for iron and steel material industry development. A hot strip mill and an electric galvanizing line are currently operating and a bar mill and a cold strip mill will be constructed in 1996 and 1997. Iron making by arc furnace and other relevant steel production such as a wire rod and section mill are scheduled to be developed between 2000 and 2010.

Utilizing this iron and steel industry, an industrial complex in which downstream steel industries such as metal and machinery industries and supporting and relevant industries are established, should be developed in the Bang Saphan area.



Present Industrial Structure (Mono-Industry)

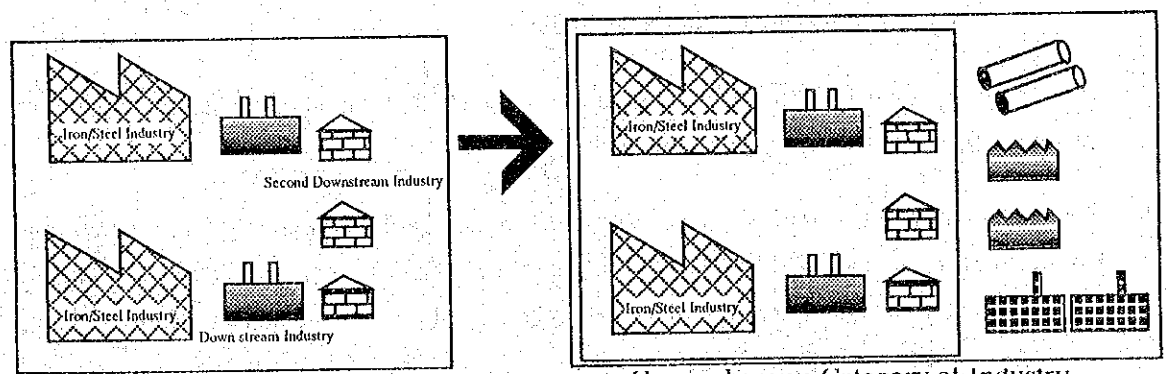
Future Industry in Bang Saphan (Comprehensive Industry)

In the case the iron and steel industrial complex realized, the following effects can be expected:

- accumulation of downstream, supporting and relevant industries in the vicinity;
- improvement and enhancement of productivity by less transportation and cost of materials and products and easy access to a better and more efficient labor market;
- enhancement of competitiveness in the international and domestic markets;
- expansion of production and export;
- effective consumption of resources such as water, land, human resources, etc.;
- more contribution to regional development.

Development of Comprehensive Category of Industry

The development of a comprehensive category of industry including petrochemical industry, food industry and construction materials industry, etc., is desirable for sustainable prosperity of the Bang Saphan area. Experiences in Japan and other industrialized countries show that an industrial area which is developed by a single industry, even if it is the iron and steel industry, is too weak to endure economic stagnation or to respond to changes in demand. Once the monopolistic iron and steel industry is faced with a drop in steel demand, the regional economy and employment market will be damaged. In order to avoid such a case, a comprehensive category of industry is recommended for the Bang Saphan industrial development.



Monopolized Category of Industry　　Comprehensive Category of Industry

Industrial Development Centered on a Deep Sea Port

The most advantageous characteristic of the Bang Saphan area is the existence of a deep sea port. The port's future maximum water depth of 20 m, which could not be

developed in other places in the Gulf of Thailand, is suitable for large vessels for the transportation of iron ore and coal. So the port shall play an important role in the development of the Bang Saphan industrial area, particularly in attracting investors. The prospective investors' interest in the deep sea port was revealed in the investment demand survey. They expressed desire to utilize the deep sea port for export of products to overseas and domestic markets and for import of materials and semi-finished products. Especially, the automobile manufacturing companies have shown an interest in exporting their products and semi-finished products to the ASEAN countries and Western Asia namely, India.

The existing Prachuap Port in Bang Saphan has only three berths with a water depth of 15 m and handles mostly import iron slabs and export hot coils. Additional berths should be developed to handle general cargoes in parallel with the establishment of the downstream industry and supporting industry. A cargo handling yard with enough area, a new deep quay capable of accommodating 200,000-ton bulk cargo vessels, and a new highway connecting the port and industrial area to the national road Route 4 will be required to realize a real deep sea port to attract prospective investors and to develop the Bang Saphan industrial area.

Development of Industrial City

The crucial points for the industrial development in areas remote from Bangkok are;

- establishment and improvement of the living conditions for workers;
- training and nurture of engineers and managers.

Foreign investors who are unfamiliar with the local situation of Thailand are cautious and desire the improvement of these problems.

Bang Saphan is approximately 400 km from Bangkok and existing living conditions and supporting social facilities are insufficient for the workers of factories. Highly educated managers and engineers living in Bangkok would hesitate to settle in Bang Saphan.

In order to make up for the weak points of Bang Saphan, the creation of a self-contained industrial city with the following facilities is required:

(1) Residential facilities/land with efficient area and quality

(2) Business and commercial facilities/area

(3) Sports and recreation facilities

(4) Institute and college for the nurture of managers and engineers

(5) Efficient infrastructure such as water supply, electricity supply, and telecommunications

Educational institutes and a college with a high level educational program are required for the nurture of managers and engineers through training of locally recruited medium educated workers and semi-skilled laborers. This is most urgent in Thailand where managers and engineers are in shortage due to the recent sharp increase in demand.

Introduction of a Free Trade Area (FTA)

Considering the disadvantageous location of Bang Saphan, which is located 400 km from Bangkok metropolis where major economic activities are concentrated, remarkable investment incentives should be given to the Bang Saphan area.

Bang Saphan will receive BOI incentives as a 3rd zone, though application of more attractive and motive incentives is recommendable for the promotion of foreign and local investments.

In this context, a Free Trade Area where manufacturing and cargo transactions are managed with exemption of tax and procedures, would be the best solution to attract investors to the Bang Saphan area.

The Bang Saphan area located in the center of Western Seaboard, which is a frontier to Myanmar and Southwest Asian countries through the Andaman Sea, could play the role of an international trade center. FTA is one of the effective measures for that purpose.

5.2 Prospective Development Plan of the Bang Saphan Industrial City

1) Background

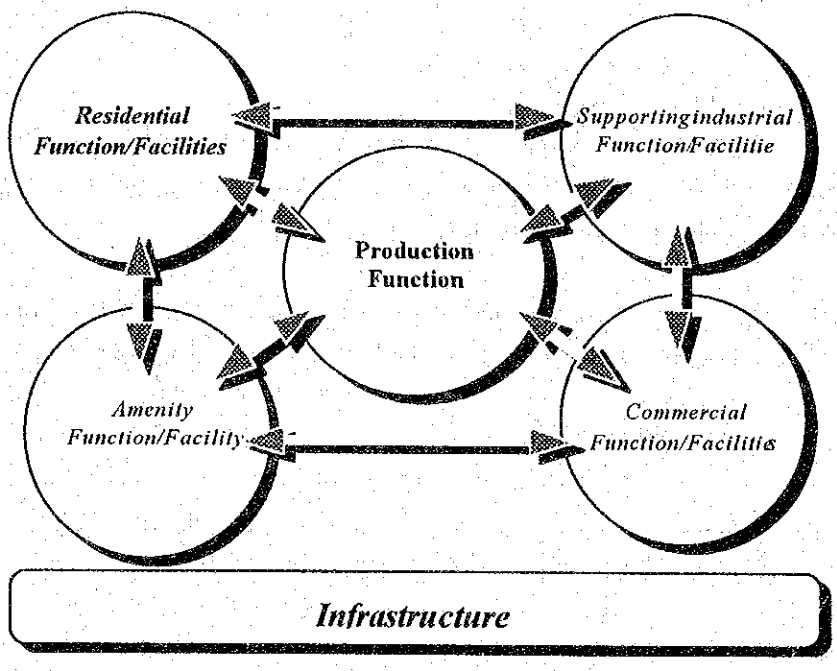
For the success of the Bang Saphan industrial estate development, urban facilities as well as production facilities are indispensable. There have been several iron and steel factories, but existing urban facilities do not allow high living standards for the workers.

According to the questionnaire survey, the potential investors required the supporting facilities for production activities as well as the basic urban facilities.

2) Concept of the New Industrial City and Industrial New Town

The realization of a New Industrial City is important as well as other infrastructure develoment such as water, electricity, road, etc. for the success of the industrial estate. The City shall be highly integrated and well planned and will consist of five major functions: i) Production, ii) Industrial Support, iii) Habitation, iv) Business & Commerce, and v)

Amenity. From the land use point of view, the New Industrial City will be divided into port area, iron & steel complex area, industrial estate, institutions & education area, industrial new town area, and amenity area. The basic concept of the City is shown in the following figure.



Concept of New Industrial City

The Production Function is the prime motor of the New Industrial City which will absorb all manufacturing industries including the iron & steel industry.

The Industrial Support Function mainly consists of five facilities: Port, warehousing, R & D, testing and measurement, education and human resource development.

Habitation is a main function of the Industrial New Town. There will be three types of residences: Bungalow, town house, and condominium.

The Business & Commercial Function consists of office, retail sales, wholesales, banking, accommodation facilities, etc. Basically the consumer-oriented facilities such as retail sales will be located in the Industrial New Town.

The Amenity Function mainly consists of sport and amusement facilities such as tennis court, athletic field, stadium, gymnasium, golf course, park etc.

The Study Team proposes that the Industrial New Town should have three functions: Habitation, Business & Commercial, and Amenity Functions.

3) Industrial Support Function

Research and Development (R&D), Testing & Measurement, and Human Resource Development (HRD) are discussed as Industrial Support Functions in this section.

In case of HRD, aiming at the nurture of employees, different facilities shall be set up in accordance with the target trainees such as engineers, skilled workers, etc. As for the education facility, which is included as one of the HRD facilities, a Technical College will be constructed to nurture the technical level of workers in the Bang Saphan area. But education of high grade engineers is impractical in Bang Saphan and, therefore, should be done in colleges established outside. In other words, engineers will be supplied from other regions such as BMA with special preparation for the intended purpose of working in the industrial estate.

To nurture skilled and unskilled workers, an ordinary vocational school should be established. The demand for skilled and unskilled workers is expected to increase soon, therefore the Study Team proposes that the vocational school will start by using the facilities in the planned technical college and when the demand is revealed, an independent school will be considered.

As for R&D and Testing and Measurement, the Study Team proposes to establish a Material Research Center. The outline of the Center is described below.

Material Research Center

The Bang Saphan industrial estate will be developed to accommodate not only steel-related industries but also other material-based industries such as non ferrous metals, ceramics, rubber, petrochemicals and so on. Most of the technical standards will be transferred from the industrially developed partners but Thai companies must obtain their own technical capabilities to modify such manufacturing standards to match the local requirements such as customer requirements, different raw material sources, and different manufacturing alignments and their operational skill. To conduct those technical development works, there must be a material research laboratory in a nearby location. This material research laboratory should better start with the iron and steel field and have the following, the functions:

1) Product research:
   * decide manufacturing standards to meet customer requirements.
   * identify root causes of quality fluctuation and develop countermeasures.

2) Process research:
   * identify operational causes of process data fluctuation and develop countermeasures.

3) Training of operation staffs and key operators:
   * give the basic understanding of overall process and products.
   * clear understanding of control indexes and their relations to process stability and product quality.

4) Assistance in qualification procedures for authorized standards:

4) Frame of the Industrial New Town

The Study Team estimates the population of the Industrial New Town as shown in the following table.

Estimated Population of the Industrial New Town (2001, 2006, and 2011)

Year (Estimation)	2001	2006	2011
Planned population	4,400 (5.5%)	15,700 (16%) ~22,000 (22%)	36,000 (25%) ~69,000 (43%)
Amphoe Bang Saphan (DTCP estimates)	-	-	137,000
(Study Team estimates)	88,000 (100%)	94,000~100,000 (100%)	127,000~160,000 (100%)

Based on the above estimated population, the Study Team estimates the required land area by each function. As a result, the residential area will be 350 ha (planned population will be 36,000) and the Commercial & Business Area 60 ha in 2011.

DTCP proposed four sites for residential area in "City Planning of Bang Saphan Community".

- Area around the junction of Routes 4 and 3169
- Area between the above junction and the Municipality Area along the Route 3169
- Area near the Tourism Area
- Area to the south of the proposed Industrial Area

The Study Team selects the area to the south of the Industrial Area as the first development site.

The land use plan of the Industrial New Town is planned as shown in the following table.

Land Use Plan in 2011

Development Sector	Land Use	Specification & Contents	Area (m^2)
Public	☐Road Area	☐ Road w= 6.0m～16.0m	700,000
		☐ Green Belt w= 4.0m～14.0m	
	☐Public Space (Regional Space of Community Area)	☐ Public Facilities(Medical Facilities/Post Office/Education Facilities/etc.)	123,000
		☐ Garden/Pond/Refresh Area/etc.	205,000
	☐Public Garden	☐ Car Park/Bus Terminal/etc.	25,000
	☐Traffic Facilities		
Private	☐Residential Area	☐ Bungalow/Town House/Collective Building/etc.	2,665,000
	☐Commercial Area	☐ SSC/Plaza/Restaurant/Book Store/Bank /Flower Shop/Barber/etc.(200 people/ha)	382,000
Total		Industrial New Town Area	4,100,000

There are various types of management for this Industrial New Town. A joint venture enterprise is expected to be established, grouping several private developers and public sectors.

The Study Team proposes the establishment of the "Bang Saphan New Town & Amenity Co., Ltd." to play following roles as explained detailedly in Chapter 8:

Main Roles of the Bang Saphan New Town & Amenity Co., Ltd.

- planning, construction, management and maintenance of the Industrial New Town
- planning, construction, and management of the related business area
- leasing and selling of land, facilities, and floors
- Cordination with other development & management bodies

5.3 Free Trade Area

1) Background

a. World Trade Organization (WTO) and AFTA

WTO has been established in accordance with the decisions of the GATT Uruguay Round. The basic principle of WTO is to promote free trade around the world.

The establishment of AFTA was agreed by the ASEAN countries. To achieve AFTA successfully the Common Effective Preferential Tariff (CEPT) system was adopted. According this system, each country has to reduce the tariff rate to 0 to 5 % till the target year. Along with the changes in the trade situation, the implementation of CEPT has been advanced to 2003. As a result tariff rate of all manufactured products will be reduced to 0 - 5% in 2003.

b. Current Situation of Export Processing Zones (EPZ) in Thailand

In Thailand more than 10 EPZ have been developed by IEAT. Major objectives of EPZ are considered as follows:

- Promotion of foreign direct investment especially in the manufacturing sector
- Creation or expansion of job opportunities
- Accumulation of foreign currency

The available works in EPZ are in general limited compared to the Free Trade Zones (FTZ), however some of them are liberalized in recent years; for example the deregulation of sales to the domestic market and bonded cargo transportation between EPZs. Some companies located in EPZ also request to start sales to domestic market because of the rapid economic growth in Thailand. In response to this request, the Thai government liberalized 20% of total products to domestic market. However it is very much complicated to access the domestic market because the companies located in EPZ were provided incentives under condition for export of their products.

The occupancy rate of EPZ has slightly decreased in Thailand. AFTA, mentioned above, is already on schedule and the proposed exception list in Thailand is one of the most liberal, namely less-tax-protected, among the countries. Under these conditions, effectiveness of EPZ becomes smaller than before. Another issue of EPZ is related to the economic or industrial linkage. For example technology transfer to local companies or usage of parts and intermediate goods produced locally is difficult.

c. Experience in Other Countries

There are more than 600 FTZ in the world. Because of the conditions of the development stages or of the purpose of the development, the characters of FTZ are different. Furthermore the name of 'FTZ' is also different (refer to Appendix C.2 for details).

Foreign Trade Zone in the USA

There are more than 400 FTZ approved in the USA. The purposes of FTZ in USA are to promote international trade, to expand exports, to strengthen competitiveness of the domestic industries, and to create job opportunities. FTZ in USA is divided into two types; one is called General Purpose Zone and the other Special Purpose Zone or Subzone. There are around 220 FTZ of the latter type, in which individual factories are allowed. The major tenants in the remaining 180 FTZ of the former type are trade and/or distribution companies and their special feature is exhibition. In the contrary of the purpose products or goods from zone are mainly to the domestic market (These are imports).

FTZ in Europe

The major purpose of the FTZ in Europe is expansion of trade. Most of them are located behind or in the vicinity of airports and sea ports. They play the role of the gateway to the EU Market.

Foreign Access Zone (FAZ) in Japan

Under the situation of huge trade surplus, import promotion zones called FAZ have been planned by the Government. The incentives for FAZ are divided into two categories; one is the incentive provided to the tenant companies and the other is the support provided to the development and management bodies.

2) Bang Saphan FTA

Based on the aforementioned background, the Study Team proposes the new concept of FTA. The objectives of FTA are summarized below.

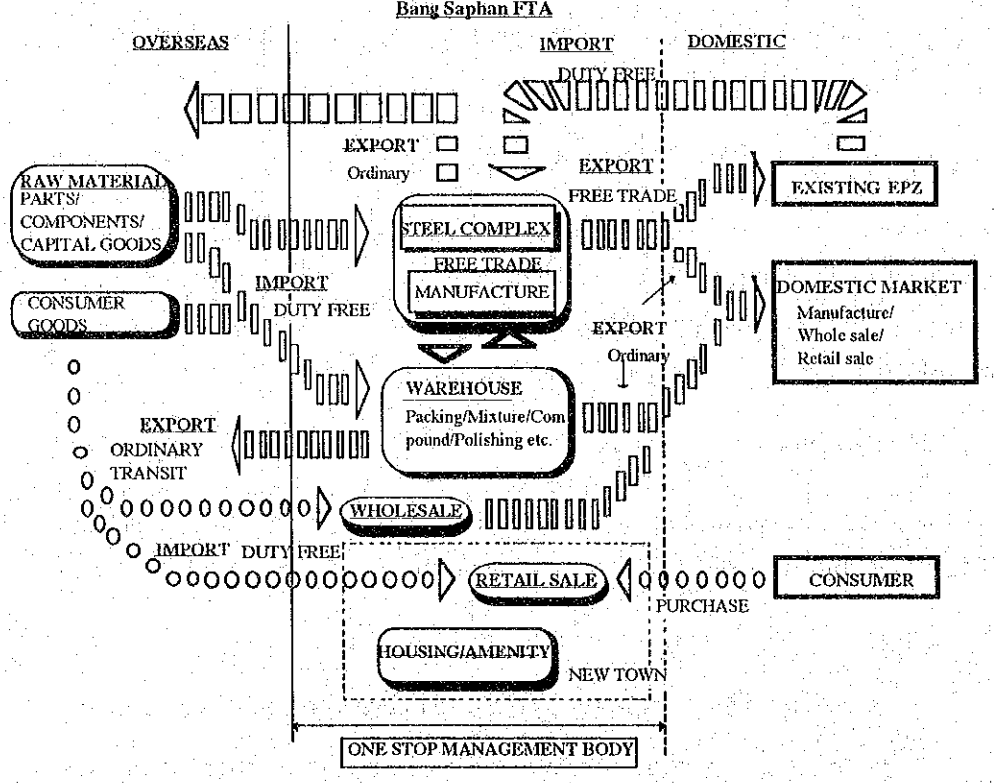
- To prepare for AFTA and WTO.
- To attract not only manufacturers but also traders for both export and import.
- To strengthen competitiveness of domestic market-oriented manufactures.
- To contribute to decentralization of businesses from the Bangkok Metropolitan Area.

- To encourage trades in exporting and importing.

In order to achieve the objectives, the basic concept of FTA in the Bang Saphan area is proposed as follows.

- Import duties must be exempted for the importers locating in FTA.
- The companies shall be allowed to 'export' to domestic market in ordinary 'import' procedure. In other words, the '20% sales constraint to domestic market' rule applied to the existing EPZ must be lift.
- Besides manufacturing, other activities such as packaging, labeling, compounding, polishing, testing, measurement, warehousing, and wholesale must be allowed for both re-export and 'export' to the domestic market.
- The whole area in FTA is under the customs domain.
- One organization must govern FTA, from construction to operation and management.

The concept of FTA in Bang Saphan is illustrated in following figure.



3) Legal Aspect of FTA

The proposed FTZ is a new concept, therefore there is no existing law for FTA. It is preferable to enact the new law for FTA. But some aspects of FTZ should be covered by the existing law.

If there is no law on the 'import processing' activities, new law should be enacted.

- It might be possible to cover the above activities by changing a part of the New IEAT Law and Customs Law like in the case of Gemopolis.

4) Area of FTA

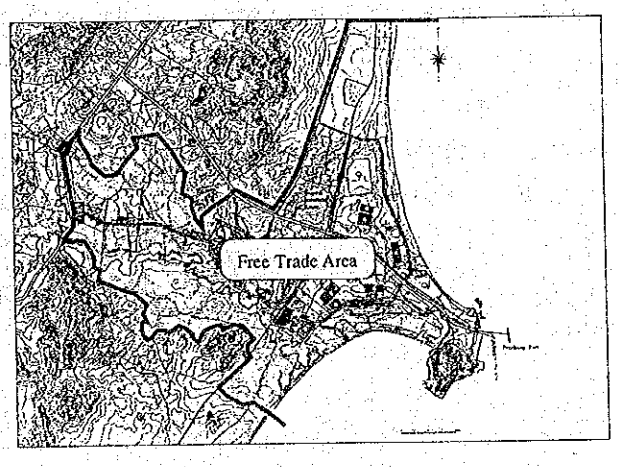
The Study Team proposes the 'area-designation-method' for the FTA area. This method is similar to the BOI zoning but the area is limited enough to be managed. In this sense there are two alternative areas for FTA; one is the area including the proposed Industrial City and the other is the area of Amphoe Bang Saphan except the mountainous or hilly area.

Alternative 1: The whole area of Bang Saphan except for hilly area will be designated as FTA.
Amphoe Bang Saphan will be demarcated as FTA and players in FTA will be "licensed" by the Board of Development & Management of FTA and enjoy incentives in accordance with the guideline of development or activities in FTA set by the Board.

Advantage: Same administration boundary as local government.
Easy cooperation with governmental activities.
Vast land for future expansion.
Easy participation by new developers for the facilities.

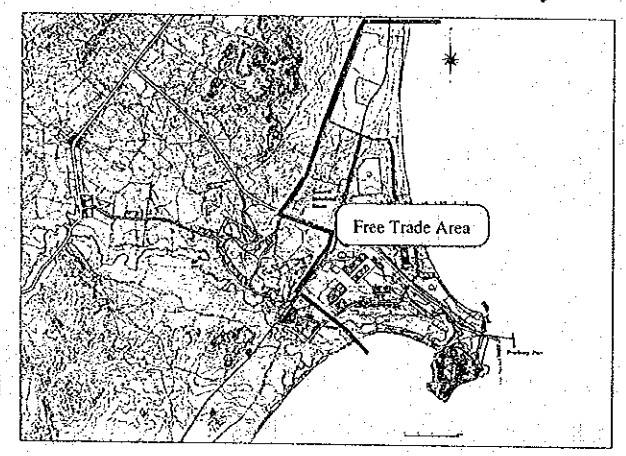
Alternative 2: Similar area of the Industrial New City. In this case the area-designation-method also is adopted. There is limitation for expansion of the new facilities such as the warehousing development area.

Advantage: Easy operation and management of the whole area.



Alternative 3: Bang Saphan industrial estate, iron/steel industry and port area are designated as the FTA.

Advantage: Area designation will be easy and quickly made on the basis of the IEAT law and FTZ law newly enacted.



The Study Team recommends the Alternative 1 in consideration of easy participation of new developers in the FTA for the long term perspective, and the Alternative 3 for the realistic designation in the short term development.

5) Advantages of FTA

It is necessary to identify the differences among FTA, FTZ, and EPZ. The most significant difference is that goods manufactured in FTA are allowed to be 'exported' to the domestic market. The companies in FTA will be allowed to sell goods and services to the domestic market in the same way as to export. FTZ proposed by the Ministry of Industry (MOI) will be allowed to function in a more flexible manner than EPZ: trading, exhibition, etc. The purposes of FTZ, however, should be to encourage exports. The basic idea of FTZ is considered only to follow the conventional export-oriented policy.

Under the borderless transaction, to keep or encourage international competitiveness is one of the critical issues for all countries and businesses. In this situation, it must be hard to protect the domestic industries by erecting the tariff barriers as well as non-tariff barriers. While companies strengthen their technological capabilities, materials and/or parts and components should be available with ease and at reasonable prices. The Thai Government has made efforts to do so, but the economic and trade situations should be much more severe than before. The introduction of FTA would be one of the solutions to overcome such difficulties.

6. DEVELOPMENT PLAN OF THE BANG SAPHAN INDUSTRIAL ESTATE

6.1 Land Use Plan and Land Grading Design

1) Location and Area of the Site

The Bang Saphan industrial estate is proposed to be located the west of the Sahabiriya iron/steel industrial site as shown in Figure 6.1 in consideration of road access to the Prachuap port and Route 4 and land availability as analyzed in Chapter 5. The total site area is approximately 600 ha (3,750 rai) covering plantations on hilly areas and ricefields in lower swampy areas (refer to Appendix D for details).

2) Land Use Plan

The land use plan of the Bang Saphan industrial estate is elaborated on the basis of the following planning principles.

a. Land use of the Bang Saphan industrial estate should be in harmony with the present land use of the surrounding area. Socially important facilities such as religious and educational facilities will be preserved with their surrounding environments.

b. A lot of green areas such as park and buffer green will be designated.

c. The configuration of a factory lot area is designed to be 60 % ~ 75% in order to receive the BOI privilege.

d. Land use will be planned with consideration of future expansion.

The total area of the Bang Saphan industrial estate is 600 ha (3,750 rai) and the land use plan is summarized below. The detailed land use plan is presented in Table 6.1 and Figure 6.2.

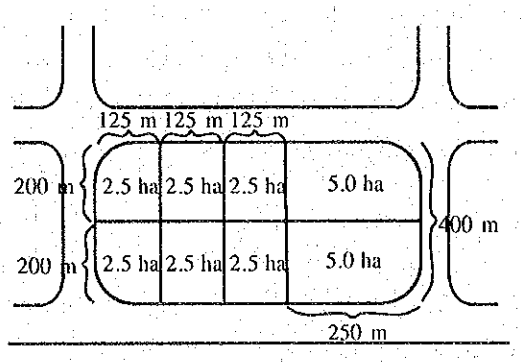
	Area		(%)
	(ha)	(rai)	
Factory lot *	414.5	2,590	69.1
Road & utility	101.9	640	17.0
Green area	81.8	510	13.6
Others	1.8	10	0.3
Total	600.0	3,750	100.0

* Future expansion area of factory lots of 54.5 ha is inclusive.

3) Design of Lot Shape

Seven sizes of typical factory lots are proposed as shown in the table below. The 5 ha and 2.5 ha lots, which are dominant in the Bang Saphan industrial estate, have been designed as shown in the figure below.

	Size (ha)	No. of Lot	Shape
1	0.5	3	50 m x 100 m
2	1.0	11	100 m x 100 m
3	2.5	13	125 m x 200 m
4	5.0	26	200 m x 250 m
5	10.0	7	250 m x 400 m
6	20.0	4	400 m x 500 m
7	35.0	1	300 m x 1,000 m
	Total	65	



4) Plan of Phased Development

The Bang Saphan industrial estate is proposed to be developed in three phases as summarized below. The detailed development schedule is explained in Chapter 8.

	Total Area		Factory Lot Area	
	(ha)	(rai)	(ha)	(rai)
Phase 1	108	680	52	330
Phase 2	202	1,260	149	930
Phase 3	290	1,810	159 *	990
Total	600	3,750	360	2,250

Note: * Reserve area of 54.5 ha is not inclusive.

5) Land Grading

Earthworks

Topographically, the land of the Bang Saphan industrial estate site is rather undulated as shown in Figure 6.3. The highest part of the site has an elevation of more than 20 m above mean sea level (MSL) and the lowest part with an elevation of 1.2 m is found in the

swamp area inundated in the rainy season. Thus the site shall be graded by cut and fill. Considering of the higher cost of earth borrowed from quarries located outside the area, it is recommendable that the cut volume and filling volume inside the site shall be balanced.

The following criteria are applied in the design of land grading. A land formation plan of the Bang Saphan industrial estate is presented in Figure 6.4.

a. Elevation of the land after grading is designed to be higher than 4 m above MSL to avoid inundation.

b. Gradient of the factory land is designed to be more than 0.5 % to drain the rain water effectively.

The earthworks volume is estimated at 4.0 million m^3 for the total development area. Cut and filling balance is designed to be kept in each development phase as shown below.

(Unit: million m^3)

	Phase 1	Phase 2	Phase 3	Total
Cut Volume:	1.28	1.38	1.40	4.06
Filling Volume:	1.35	1.27	1.04	3.66

Note: Some soil shall be brought from outside for phase 1.

Geological Consideration

Judging from the geological data acquired by the core boring test conducted in the area adjacent to the Bang Saphan industrial estate site, N value of more than 10 appears at 5 ~ 6 meters below the surface and stiff sand with N value of more than 40 follows after 8 ~ 10 meters from the surface. It means that the surface soil is rather weak, however, stiff soil appears at a shallow depth and short pile foundation will be sufficient to support the buildings and structures.

Estimate of Settlement

Two soft soil layers observed in the swampy area at the Bang Saphan industrial estate site are deemed to be compressible and composed of Clay (CH) and Sandy Clay (CL) with a thickness of 2 m and 4 m respectively as tabulated below.

	Thickness (m)	Depth (m)
Clay (CH)	2	0 - 2
Sandy Clay (CL-CH)	4	2 - 6

On the basis of the geological conditions shown above, a maximum consolidation settlement of 25 cm is expected to occur in the lowest part of the industrial estate site after land filling. Therefore, to cope with such land settlement, extra land filling is required in the expected settlement area.

Residual Settlement

The period of 90 % consolidation settlement in the lowest part of the industrial estate site is estimated to be 15 months as summarized below. The consolidation settlement will continue for a long time though the settlement amount will not be large. Thus, it is recommended that supplemental earth filling be carried out after a sufficient settlement period before the construction of infrastructure facilities.

% of Settlement	Settlement Time
10	0.1
20	0.5
30	1.2
40	2.2
50	3.4
60	5.0
70	7.0
80	9.8
90	14.7

6.2 Preliminary Design of Internal Infrastructure

1) Roads

Projection of Traffic Volume in the Bang Saphan Industrial Estate

The following three traffics to and from the Bang Saphan industrial estate are considered:

- Cargo traffic : Import raw materials and export products will be transported by heavy trucks.
- Business traffic : Passenger cars will be dominant in the business traffic.
- Commuter traffic : Public buses, private buses and passenger cars will be utilized for commuting of workers.

Traffic generated by the Bang Saphan industrial estate is estimated at 5,500 PCU (passenger car unit) in the year 2001 and 29,000 PCU in the year 2011 as shown below.

Item	2001	2006	2011
1. Traffic Volume (vehicles/day)			
1) Truck	1,900	4,300	10,000
2) Bus	100	300	600
3) Passenger car	400	1,000	2,000
Total	2,400	5,600	12,600
2. PCT Converted			
1) Truck (x 2.5)	4,800	10,800	25,000
2) Bus (x 3.0)	300	900	1,800
3) Passenger car	400	1,000	2,000
Total	5,500	12,700	28,800

Thus the main roads in the Bang Saphan industrial estate should handle a design traffic volume of approximately 29,000 PCU per day and four (4) lanes will be required in 2011 assuming that the traffic capacity of one lane is approximately 10,000 PCU per day. Two lanes will be enough to cope with 5,500 PCU in 2001 and 13,000 PCU in 2006.

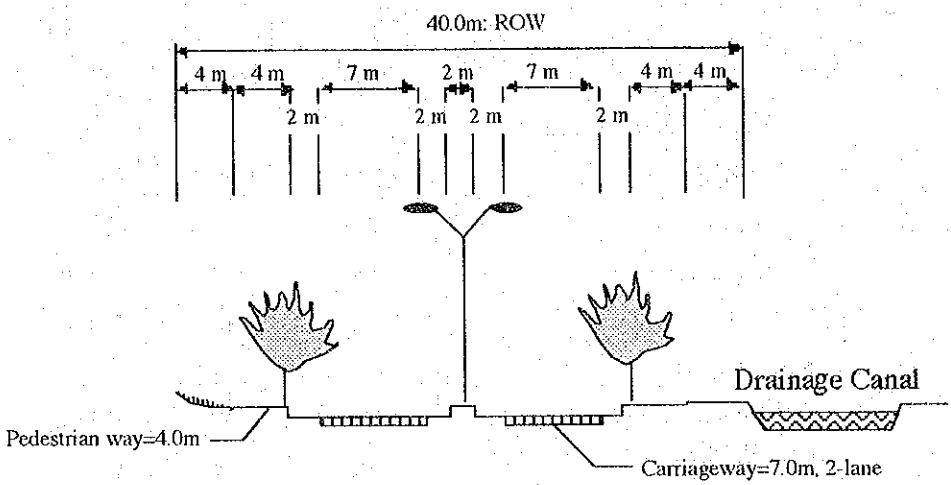
The railway which is projected to have a capacity of approximately 1.1 million tons (0.6 million tons from the Bang Saphan industrial estate and 0.5 million tons from iron/steel industry) will not play an important role but will support cargo carriers in the future.

Road Design

Three (3) types of roads have been planned as follows:

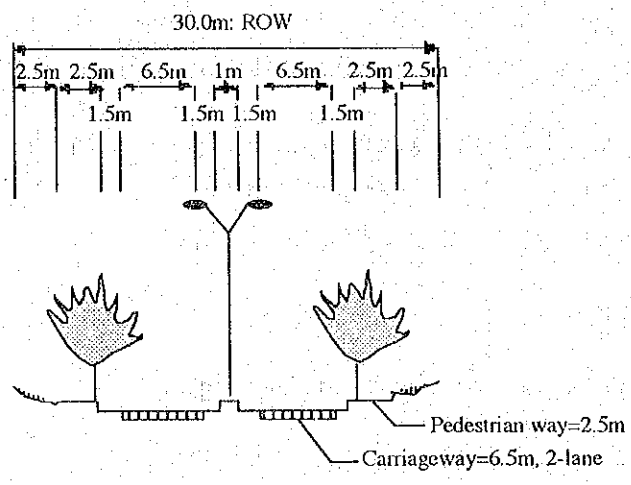
(1) Main road : The main road which passes through the center of the industrial estate will be 40 m wide (4 lanes), with a large pedestrian deck on each side. This is the main service road to factory lots, particularly to large size lots.

Main Road : 4 lanes with a median
Right of way : 40 meters



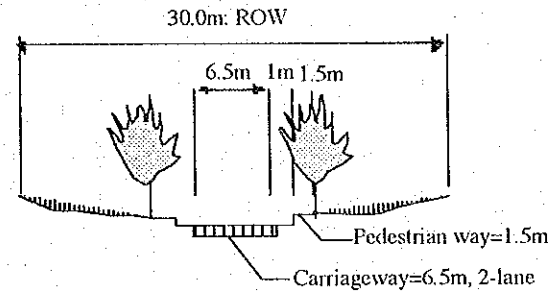
(2) Sub-main road : The sub-main road is the access road to medium size factory lots. The road width is 30 m (4 lanes) with a pedestrian deck on each side.

Sub-Main Road : 4 lanes with a median
Right of way : 30.0 meters



(3) Collector road : The collector road is the access road to small size factory lots and some sections are utilized as the boundary of the industrial estate.

Collector Road : 2 lanes with a median
Right of way : 30.0 meters



The distribution of roads is shown in Figure 6.5.

The design standards to be applied for the main road and sub-main road are as follows:

- Design speed : 40 km/hour
- Minimum radius : 60 m

The pavement of the carriage way of main road is designed as shown below in consideration of the dominance of heavy trucks and buses in the industrial estate.

Traffic of truck and bus : App. 5,000 vehicles/day/one direction
Design CBR : 10
Design thickness : 50 cm

2) Water Supply

Preliminary design and cost estimate for water supply facilities of the Bang Saphan industrial estate were carried out on the basis of the land use plan and water demand by lot. Design criteria and standards for water supply systems in Thailand are applied in this Study.

The industrial water demand for the Bang Saphan industrial estate is estimated as summarized below.

Water Demand Projection of Bang Saphan Industrial Estate in 2011

Type of Industry Group	Number of Lots	Total Lot Area (ha)	Water Demand (m^3/d)	Water Demand (m^3/d/ha)
1. Food	11	49.0	10,560	215
2. Textile	3	12.0	6,050	504
3. Wooden and furniture	4	11.0	390	35
4. Paper and pulp	2	2.0	70	35
5. Chemicals	10	66.0	25,950	393
6. Ceramics	5	65.0	7,400	114
7. Steel processing	14	76.0	7,580	100
8. Machinery	15	78.5	6,320	79
9. Ship building	1	0.5	10	20
10. Reserve lot	2	54.5	5,450	100
Total	67	414.5	69,780	168

The water distribution network plan and conceptual layout of the water purification plant in the Bang Saphan industrial estate are designed as shown in Figure 6.6. The pipes will be laid underground along the roads. The method of preliminary design is explained below.

(a) Water demand of Bang Saphan industrial estate = 70,000 m^3/d

(b) Water Consumption
Daily Maximum Water Consumption (DMWC) =77,000 m^3/d (Unaccounted water: 10%)
Hourly Maximum Water Consumption (HMWC) = 3,200 m^3/h

(c) Service reservoir
- Design Capacity: HMWC = 3,200 m^3

(d) Distribution Network
Design discharge: HMWC = 3,200 m^3/h (=900 l/s)
Design velocity: V < 2.6 m/s
Pipe material and diameter: - Steel : 150 to 700 mm

3) Sewerage

Design criteria and standards for the waste water treatment system decided by IEAT are applied in this Study. The layout of the waste water collection system and conceptual layout of sewer treatment plant are designed as shown in Figure 6.7. Effluent from the

waste water treatment plant will be discharged to the Khlong Podaeng river, a tributary of the Mae Ramphung river. The method of preliminary design is summarized below.

(a) Daily max. waste water (DMWW) = 68,000 m^3/d
(80% of Daily max. water consumption plus 10% as underground water = 77,000 m^3/d x 0.8 x 1.1)

(b) Sewer collection : Separate sewer system with gravity flow
- Pipe materials : Hume/concrete
- Roughness coefficient : 0.015
- Allowable flow velocity : 0.6 - 2.6 m/s
- Minimum size of pipe : 200 mm

(c) Waste water treatment plant :
Activated sludge process (Oxidation Ditch Process or equivalent)

Pre-treatment shall be made by the factories from which the effluent may not satisfy the effluent standard in Thailand.

(d) Distance between manholes
- Diameter of pipe < 300 mm : Less than 40 m
- 300 - 600 : 70 m
- > 600 : 100 m

4) Storm Water Drainage

Storm water in the Bang Saphan industrial estate will be discharged to the Khlong Podaeng river, a tributary of the Mae Ramphung river, through the retention pond designed to retard the flood discharge.

The drainage system is designed as presented in Figure 6.8.

The design method of drainage facilities is described below.

(a) Drainage facility : Storm water drainage, road side ditch and retention pond

(b) Design rainfall : 10-year probable rainfall

(c) Design discharge : by Rational formula
- Runoff coefficient, $C = 0.7$
- Rainfall intensity, $I_{10} = 4051/(t^{0.9}+19.13)$

(d) Storm drain ditch

Material	:	Concrete or stone masonry
Allowable flow velocity:		0.8 ~ 3.0 m/s calculated by Manning Formula

(e) Retention pond

Storage volume	=	170,000 m3
Area	=	16 ha (3 % of gross area, 600 ha)
Depth	=	3 m

5) Electricity

The power demand for the industrial estate is estimated on the basis of each development stage as shown below:

(MW)

	2001	2006	2011
1. Factory lot	16	61	125
2. Others*	3	3	3
Total	19	64	128

Note: * Industrial estate center, water purification plant, sewage treatment plant, street lighting

A 22 kV distribution system should be constructed to feed power from the new 115/22 kV substation to factory lots, industrial estate center, water purification and sewage treatment plants in the industrial estate. Either underground or overhead distribution line will be applied for the project, but the underground distribution system using buried armored cables is recommendable from an aesthetic viewpoint. The cables shall be buried at a depth of not less than 1.2m under the carriage way, and 0.6m under the pedestrian way. The distribution system is designed to be of open loop type to secure stable power supply. 22 kV switchgear units are also recommended to be installed in factory lots to tap electricity. The proposed 22 kV power distribution system is shown in Figure 6.9.

In addition to the power supply system, the street lighting system shall also be designed along the main and sub-main roads. Street lights of high-pressure sodium lamps with double arm steel poles will be constructed on the medium strip of roads at intervals of 35 meters.

6) Telecommunications

The telephone demand in the industrial estate is estimated at 280 subscriber lines in 2001, 870 lines in 2006 and 1730 lines in 2011 as summarized below.

(lines)

	2001	2006	2011
1. Factory lot	210	800	1660
2. Industrial estate center	60	60	60
3. Others*	10	10	10
Total	280	870	1,730

Note: * Water purification plant, sewage treatment plant, electric substation

Metallic cable telephone lines will be installed between the switching station planned in the Industrial Estate Center and each distribution pull box installed in the factory lots, so that subscribers can be connected to the network easily from the pull box. Cables sealed in PVC pipes will be buried in the ground. The PVC pipes shall be buried at a depth of not less than 1.2 m under the carriage way, and 0.6 m under the pedestrian way. A trunk line will be designed and constructed in the development phase 1, considering the telephone demand in phase 2 and phase 3. To cope with the increase in telephone demand and high speed telecommunication requirement by optical fiber cable in future, some spare plastic pipes shall be installed beforehand.

The telecommunication network of the industrial estate is shown in Figure 6.10.

6.3 Development Cost

The development cost of the Bang Saphan industrial estate is estimated at Baht 2,770 million or US$ 111 million for the total area of 600 ha as shown below. The cost breakdown is given in Appendix H.

Development Cost of the Bang Saphan Industrial Estate (Internal Cost for 600 ha)

	million Baht	$ million equivalent	Unit Cost /1 1,000 Baht/rai	Unit Cost /1 $/m^2
1. Construction Cost	2,250	90	870	22
2. Engineering Cost	270	11	100	3
3. Physical Contingency	250	10	100	2
4. Total	2,770	111	1,070	27

Note: /1 Per net factory area (total area is 414.5 ha including reserve factory area)
/2 Land acquisition cost for industrial estate site and price contingency are excluded.

The cost by the development phase is also estimated as shown below.

Cost by Development Phase of Bang Saphan Industrial Estate

	million Baht	$ million equivalent
Phase 1	610	24
Phase 2	890	36
Phase 3	1,270	51
Total	2,770	111

Note: 1/ Land acquisition cost for the industrial estate and price contingency are excluded.

In addition to the internal cost of the Bang Saphan industrial estate, the following estimated external infrastructure cost will be required. Baht 11.6 billion or US$ 463 million for overall external infrastructure, including Baht 3.3 billion or US$ 132 million (approximately 30 % of the total cost) for the Bang Saphan industrial estate, and the remainder for the iron/steel industry, urban area, and port development project.

Development Cost of External Infrastructure

		Overall Cost		Cost for BSIE	
		(Baht million)	(US$ million)	(Baht million)	(US$ million)
I	Water supply facilities	3,260	130.4	1,440	58
II	Road	1,170	46.8	890	36
III	Port	6,100	243.8	610	24
IV	Electric facilities	290	11.6	290	12
V	Telecommunication facilities	20	0.8	20	1
VI	Hazardous waste treatment	750	30.0	20	1
	Total	11,590	463.4	3,270	132

Note: Water supply facility: Pipeline between the Tha Sae dam to BS, etc.
Road: Access road, interchange, etc.
Port: General cargo berth, bulk cargo berth of the Prachuap port
Electric facility: Transmission line, etc.
Telecommunication facility: Trunk line cable, etc.

7. DEVELOPMENT PLAN OF EXTERNAL INFRASTRUCTURE

7.1 Water Supply

1) Water Demand

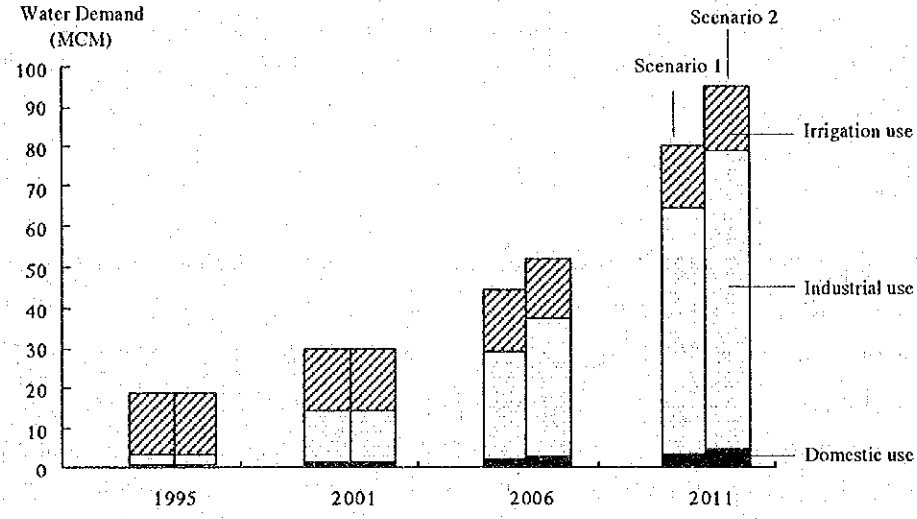
Water demand in the Bang Saphan area is composed of domestic water demand, industrial water demand and irrigation water demand.

The domestic water demand is projected to be 3 ~ 4 million m3 (MCM) per year, on the basis of the projected increase of the local population and growth induced by industrial development. A per capita water consumption of 100 liters per person is assumed for the projection. The industrial water demand, which would increase rapidly, is estimated according to the unit consumption rate by industrial category of prospective industries. The estimated industrial water demand is 60 ~ 70 MCM per year. The irrigation water demand is estimated at 15 MCM per year on the basis of the monthly consumption by crop.

Total water demand of the Bang Saphan area is summarized in the table and figure below. 77 MCM and 92 MCM of water will be required annually for development scenarios 1 and 2 planned in Chapter 5.

Water Demand Projection in MCM/year

	1995	2001	2006	2011
Scenario 1	17.98	29.30	62.53	77.33
Domestic Water	0.62	1.04	1.61	2.77
Industrial Water	1.96	12.86	45.52	59.16
Iron/steel industry	1.83	11.68	36.03	36.03
General Industry	0	1.00	8.65	22.29
Others	0.13	0.18	0.84	0.84
Irrigation Water	15.40	15.40	15.40	15.40
Scenario 2	17.98	29.30	69.84	91.59
Domestic Water	0.62	1.04	1.84	3.97
Industrial Water	1.96	12.86	52.60	72.22
Iron/steel industry	1.83	11.68	36.03	36.03
General Industry	0	1.00	15.73	35.35
Others	0.13	0.18	0.84	0.84
Irrigation Water	15.40	15.40	15.40	15.40



2) Development Concept

(1) Water Resources

Present Condition

RID proposed the development of the Tha Sae dam project, which will supply 30 million m^3 of industrial water per annum to the Bang Saphan industrial estate. The project is waiting for approval of the Cabinet. If the Tha Sae dam project is approved in 1997 or 1998, it will be commenced immediately and completed around the year 2003 or 2004.

The Bang Saphan river will also constitute a main water resource because of the its proximity to the Bang Saphan industrial city. The minimum and average annual runoff recorded by RID during 1980 ~ 1989 near the weir were 59.5 million m^3 (MCM) per year (1.88 m^3/sec as average flow) in 1980 and 147 MCM per year (4.68 m^3/sec) in 1989.

Water Resource Potential

Assuming that 85 % of the runoff of the Bang Saphan river can be practically exploited, the balance between demand and supply water resources mentioned above can be calculated as shown in the table below.

(unit: MCM)

	1995	2001	2006		2011	
			Scenario 1	Scenario 2	Scenario 1	Scenario 2
I Resources						
1 Bang Saphan River						
1) average (1980-1989)	125.0 /1	125.0	125.0	125.0	125.0	125.0
2) drought in 1980 (actual data recorded by RID)/2	50.4 /1	50.4	50.4	50.4	50.4	50.4
3) most droughty during 50 years (estimation)	36.7 /1	36.7	36.7	36.7	36.7	36.7
2 Tha Sae River	0.0	0.0	30.0	30.0	30.0	30.0
3 Total						
1) average (1980-1989)	125.0	125.0	155.0	155.0	155.0	155.0
2) drought in 1980 (actual data recorded by RID)/2	50.4	50.4	80.4	80.4	80.4	80.4
3) most droughty during 50 years (estimation)	36.7	36.7	66.7	66.7	66.7	66.7
II Demand (Domestic, Industry and Irrigation use)	18.0	29.3	62.5	69.8	77.3	91.6
III Balance						
1) average (1980-1989)	107.0	95.7	92.5	85.2	77.7	63.4
2) drought in 1980 (actual data recorded by RID)/2	32.4	21.1	17.9	10.6	3.1	-11.2
3) most droughty during 50 years (estimation)	18.7	7.4	4.2	-3.1	-10.6	-24.9

Note: /1 Exploitable volume: 85 % of runoff
/2 The minimum flow during 10 years of 1980-1989 recorded by RID
/3 Most droughty year during 50 years of 1939 - 1988 (estimated by Sahaviriya group)

As shown in the above table, water shortage will be happen in the industrial development scenarios 1 and 2 in 2011 and scenario 2 in 2006 in the case of runoff of the most droughty year (1947). Further, based on the average drought year of 1980, a shortage of 11 MCM is expected in 2011 for scenario 2.

In other words, if the water resources in Bang Saphan river basin are adequately developed and water a conveyance pipeline from the Tha Sae dam is constructed, water will be sufficiently available for the development of the Bang Saphan industrial city in the average drought year as recorded in 1980 except for demand of scenario 2 in 2011.

If the Tha Sae dam project is not completed, a water shortage in the range of 15 ~ 20 MCM and 30 ~ 40 MCM is projected to occur in 2006 and 2011 respectively.

(2) Development Plan of the Water Supply System

Strategy of Water Resource Development

A development strategy of water supply system for the Bang Saphan industrial city is preliminarily proposed for the purpose of securing sufficient water in average drought years.

Step - (1) Upgrade and expand the existing water intake system located in the Bang Saphan river to meet the water demand in 2001

Step - (2) Develop the Tha Sae dam and conveyance pipeline

Step - (3) Study the development possibilities of other reservoirs in the Bang Saphan river basin and develop the economically viable reservoirs

In 2001, expansion of the existing pumping system on the Bang Saphan river with a capacity of 18 MCM per year will be necessary because the Tha Sae dam has not yet been implemented. For the scenario 1 in 2006, the pipeline from the Tha Sae dam with a capacity of 30 MCM will be sufficient to meet the demand of 47 MCM. For the scenario 1 in 2011 and scenario 2 in 2006, in addition to the expansion of the pumping system on the Bang Saphan river with a capacity of 18 MCM and the Tha Sae dam water of 30 MCM, construction of new reservoirs in the upper stream of the Bang Saphan river will be required. For the scenario 2 in 2011, additional water resource development in other river basins outside the Bang Saphan river will be necessary.

An integrated water supply system to meet the water demand of the scenario 1 for the Bang Saphan industrial city is illustrated in Figure 7.1.

Intake by Pump at the Weir on the Bang Saphan River

The Sahaviriya group has installed a pumping system at the irrigation weir on the Bang Saphan river, which has a capacity of 0.4 m^3/sec taking approximately 8.3 MCM. Approximately 18 MCM can be extracted after the intake of irrigation water of 15.4 MCM and river maintenance flow of 2.4 MCM (0.1 m^3/sec), if the pumping station is expanded up to a capacity of 1 m^3/sec.

Water Conveyance from the Tha Sae Dam

According to RID plans the Tha Sae dam will supply 30 MCM of industrial water to the Bang Saphan industrial city. A conveyance pipeline from the Tha Sae dam to Bang Saphan over a distance of 72 km is required to send 30 MCM per year (1.0 m^3 /sec). Two pipelines have been preliminarily designed to be constructed in consideration of the convenience of maintenance work. Two sets of 750 mm diameter steel pipe, which will be buried under-ground in the right-of-way of Route 4, and a pump station are designed. Figure 7.2 presents an alignment plan of the pipeline. The development cost of pipeline is estimated at approximately 1,700 million Baht.

Development of Reservoirs in the Bang Saphan River Basin

Development of new reservoirs in the Bang Saphan river basin will be necessary by 2011. Some ideas concerning new reservoirs were already proposed by the RID as shown below.

Potential Water Resources of the Bang Saphan River

Name of Dam	Storage Capacity (MCM)	Original Purpose
Bang Sai Tong	7.8	Irrigation 4,000 rai
Khlong Loi	6.3	Irrigation 7,000 rai
Khlong Tong	9.2	Irrigation 5,000 rai

Source: RID

The above small dams will be the prospective alternative water resources on the Bang Saphan river and it is recommended that a detailed study be conducted to examine environmental impacts and economic viability of development of these dams.

7.2 Port

1) Existing Prachuap Port

The Prachuap Port is located in the cove of the Laem Mae Ramphung. The water depth in the cove is rather deep. A seabed contour of -15 m below MSL lies as close as 900 m off the coastline. This natural water depth has a good potential for development of a deep seaport.

To run the steel factory of Sahaviriya, the Prachuap port was developed by the Sahaviriya group in 1994. Steel materials (steel slabs) are imported mostly from Japan and steel products are shipped out from the port. The port consists of two berths, a main berth and a secondary berth. The main berth has a total quay length of 450 m and the secondary berth 245 m. The water depth along the quayside is 15.0 m below MSL in the main berth and 10.0 m below MSL in the secondary berth. As MSL is 1.7 m above the chart datum, the water depth at the quayside is equal to -13.3 m below the Chart Datum (CD) and -8.3 m CD respectively, which means that the main berth can accommodate vessels of up to 45,000 DWT class and the secondary berth up to 7,000 DWT class, in full loaded condition.

According to the latest port statistics, the cargo shipment and vessel calls are summarized below.

Cargo Shipment and Ship Calls in Prachuap Port

		1994	1995	1995/1994
Import	(ton)	550,101	1,606,126	292%
	No	48	134	279%
Export	(ton)	425,278	819,630	193%
	No	55	232	422%
Total		975,379	2,427,756	249%
		103	366	355%

As shown above, the Prachuap Port has, since its inauguration in 1994, been experiencing a very high growth of cargo throughputs. The annual growth rate between 1994 and 1995 was 249% in terms of cargo traffic and 355% in terms of ship calls. According to the Prachuap Port, the cargoes other than those for the Sahaviriya steel factory also seem to be rather high in volume. Affected by the booming construction works such as buildings and roads/bridges in the region, various construction materials like cement and steel have been unloaded through the Prachuap Port. It is expected that this tendency of cargo shipment growth will continue in the future.

2) Cargo Traffic Demand in Future

On the basis of the cargo demand forecast related to Bang Saphan industrial development, the seaborne cargoes in the Prachuap Port are projected as follows:

Prachuap Port Cargo Demand

(Unit: 1,000 ton)

	1995	2001	2006 /1	2011
Steel Related General Cargo	1,800	4,980	3,150	4,080
Industrial Estate General Cargo	--	470	1,020	2,640
Locally Based General Cargo	500	805	1,030	1,310
General Cargo Total	2,300	6,255	5,200	8,030
Bulk Cargo Total	--	--	7,500	14,780
Grand Total	2,300	6,255	12,700	22,810

Note: /1 Steel related general cargo will decrease in 2006 because iron making will start and import of slabs will be stopped.

3) Berth Demand in Future

In 1995, 2.3 million tons of cargoes were handled by the Prachuap Port, while the berth length available totaled 695 m, which means that the berth productivity was 3,300 tons/m/year. Simply applying the current berth productivity to future cargo demand, the

berth length requirement for the shipment of general cargoes in the years 2001, 2006 and 2011 could be estimated as follows:

Berth Requirement for General Cargo Shipment

		2001	2006	2011
(1)	Steel Cargo and General Cargo (1,000 tons)	6,255	5,200	8,030
(2)	Required Berth Length (m)	1,895	1,940	2,430
(3)	Required Berth Expansion** (m)	1,200	1,245	1,735

** (3) = (2) - 695 m

As calculated above, in the year 2011, the berth length requirement would be 2,430 m, which means that an additional 1,735 m berth should be newly developed.

4) Port Expansion Plan

(1) General Cargo Berth Zone

Alternative Plan A

To meet the above berth demands, several port development plans have been worked out. A possible port expansion "Plan A" has been prepared, in which the offshore berth will be expanded by 210 m immediately south of the existing main berth, and the existing shoreline inside the port will be reclaimed, providing a port area with a marginal wharf in front, about 1,000 m long x 200 m wide. To the south of this marginal wharf, small-size cargo berths will also be constructed.

To protect the expanded port basin, the existing breakwater will be further expanded southward, and an additional eastern breakwater will be constructed to the south of the small-size cargo berths.

The total berth length would be 2,265 m which is not long enough to meet the berth demand up to 2011, when a total berth length of approximately 2,430 m would be required.

Alternative Plan B

If the Prachuap Port singlely continues to play the role of a major port in the Western Seaboard zone, and its port demand expands steadily as projected, the proposed "Plan A" would not be appropriate. As such, other port expansion plans, namely Plan B and Plan C could be considered. In Alternative "Plan B", the existing main breakwater will project southeastward, instead of southward, and the nearshore land reclamation will be expanded southward around the small point. To protect the turning basin for the southward

expansion zone, a detached breakwater will be provided about 350 m - 400 m off the berth line. This port configuration will easily allow continuous southward expansion in the future.

Alternative Plan C

This lastly recommended port "Plan C" will have the following port configuration (See Figure 7.3):

* The existing breakwater will be expanded southward with a slight skew to the sea side.

* Along the existing N-S shoreline, about 200 m wide land reclamation will be executed and its southern waterfront will serve as a general cargo berths zone.

* The land reclamation around the point will project out to the sea in the ESE direction.

* Along the northern waterfront of the ESE reclamation, general cargo berths will be developed.

* In the south of the ESE reclamation, a commercial dock could be developed.

* A Ro/Ro ferry terminal, which does not require deep berth depth, could be provided along the northern part of the N-S reclamation (The rocky seabed appears at a rather shallow elevation)

Optimum Plan

As discussed above, three alternative plans for future port expansion have been prepared. Each alternative plan has merits and demerits in terms of port planning. On that basis, the "most economical", "with less physical constraint for future expansion" and "easy to get quick returns in capital investment" plan should be implemented. Although all the above questionable points still remain unsettled, this Study proposes that alternative "Plan C" would be a most realistic solution, and further implementation study has been made on the basis of Alternative "Plan C".

(2) Mineral Bulk Berth Zone

In addition to the general cargo berth, bulk berths should also be developed to unload 8,580,000 tons of bulk cargoes in 2006 and 14,780,000 tons in 2011. Unlike general cargoes, mineral bulks will be transported by large bulk carriers, most likely in the size of

60,000 - 140,000 DWT. The former one is called "Panamax-Size" and the latter "Cape-Size". In the case Cape-Size bulk carriers (140,000 DWT) call in the Prachuap Port and the average shipment size would be 100,000 tons/ship, the number of ship calls would be 86 in the year 2006 and 148 in the year 2011.

If two sets of 2,000 tons/hour unloader are installed, one berth could be enough to handle the target throughputs up to the year 2006, but one more berth will be required in 2011.

Assuming that one Cape-Size berth is constructed off the existing Prachuap Port, an about 1.2 km long trestle would be required to link the mineral cargo berth with a water depth of -19 m draught to the shore conveyor system as shown in Figure 7.4.

5) Implementation Programs of Phasewise Port Development

As the investment cost of port development is so large and the port demand in Prachuap, particularly the industrial estate-related general cargo, will have some uncertainty, a phasewise development of the Prachuap Port is proposed. The cargo demand by development phase in the Prachuap Port could be summarized as follows:

Phasewise Port Demand

	Phase I (2001)	Phase II (2011)
Cargo Demand (x 1000 tons)	6,300	8,000
General Cargo Berth Demand (m)	1,200	1,740

6) Port Development Cost

(1) General Cargo Berth Zone

On the basis of the proposed port development plan (Alternative Plan C), a preliminary cost estimate is made in this section. The cost of port development will comprise the following:

Construction Cost of General Cargo Berth Zone

(Baht million)

Phase 1	2,016	Break water, berth, dredging, etc.
Phase 2	1,044	- ditto -
Total	3,420	(US$ 137 million)

(2) Mineral Cargo Berth Zone

The unloading of mineral bulk cargo will require a 140,000 DWT bulk berth along with two (2) sets of 2,000 tons/hour unloader as well as a 1.2 km conveyor system mounted on a pile-supported trestle structure.

The cost for these port facilities could be estimated as follows:

Construction Cost of Bulk Cargo Port

		(Baht million)
Phase 1	1,445	Offshore berth, unloader, etc.
Phase 2	1,230	- ditto -
Total	2,675	(US$ 107 million)

7) Implementation Program of Port Development

The Prachuap Port is being operated by Prachuap Port Co., Ltd., which is a private enterprise specialized in port management and operation. The company has a head office in Bangkok and a site operation office in Prachuap.

The Sahaviriya Group developed the existing port and wishes to undertake further port development by itself. Historical background could well explain this stand, although there will be a possibility that further investment for the port expansion might be shared by other investor groups, including the government body.

The development of the Prachuap Port was primarily aimed at the shipment of seaborne cargoes relevant to the operation of the Sahaviriya Industrial Complex. Nevertheless, a substantial amount of non-Sahaviriya cargoes has, since its inauguration, been shipped in and out through the Port, and in the future the throughputs of this commercial cargo is likely to grow up.

As widely expected, the role of the Port will gradually be diversified making full use of its geographical advantage. In view of the domestic sea traffic network in Thailand, the functional role of the Port could become much more important.

In this sense, the potential role of the Prachuap Port should be more intensively reviewed, referring to the future investment program. The possible scenarios of further development of the Prachuap Port would include the following:

(1) Prachuap Port Co., Ltd., under the financial support of the Sahaviriya group, will invest in all the port development expected in the coming stage, and singlely operate the port as it is.

(2) IEAT or another government body will participate in the future port development, particularly in the development of common-use port zone. In return, they will receive adequate investment returns in proportion to their participation. IEAT-financed port facilities may be leased to the Prachuap Port, who will virtually take care of terminal operation on behalf of the government body.

(3) The extent of IEAT's involvement would have some latitude, either part of the future development or all of the future development. If the IEAT's participation is limited, high priority would be given to the common port area such as breakwater expansion and dredging works for the future navigation zone, all of them requiring huge amount of investment. This kind of IEAT's involvement will ease the financial burden on Prachuap Port Co., Ltd., and allow financially sound port operation for Prachuap Port Company.

Aside from the port development itself, it is proposed that the port operation should be maintained by one operator, most recommendably by Prachuap Port Co., Ltd. as a sole operator who knows the locality very well and surely will ensure efficient port operation.

7.3 Roads

1) Highway Network Linked to the Western Seaboard Zone

The existing road networks in the South of Thailand, most of which were developed to serve 2-lane traffic, are now being upgraded to 4-lane traffic roads to cope with the growing traffic demand from Bangkok zone to Western and Southern Thailand. The main highway running from north to south is Route No. 4, which starts from Pak Tho through Petchaburi and Prachuap Khiri Khan up to Chumphon.

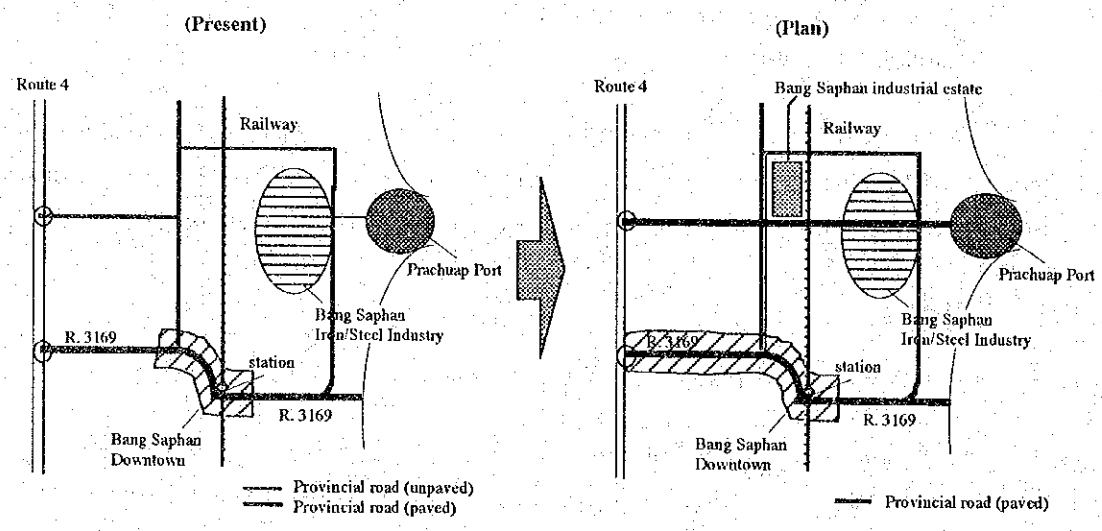
Of the total stretch of 1,201 km of the north to south highways, the section of 203 km closer to Bangkok zone up to Cha Am has already been upgraded to 4-lanes, another section of 450 km beyond Cha Am is being improved to 4-lanes, and the remaining section of 548 km is in the designing stage. According to the information of DOH, all the improvement works are expected to be completed by the year 1999.

2) Road Networks in the Vicinity of the Project Area

Access to the Prachuap Port and Bang Saphan industrial estate site is made via Route 3169 from the national highway Route No. 4. Route 3169 with two 2-lane roads is running toward the project area, both of them pass through the local community zone of Bang Saphan city. Route 3169 crosses the national railway near the coastal zone where the Bang Saphan river flows into the cove of Laem Mae Ramphung.

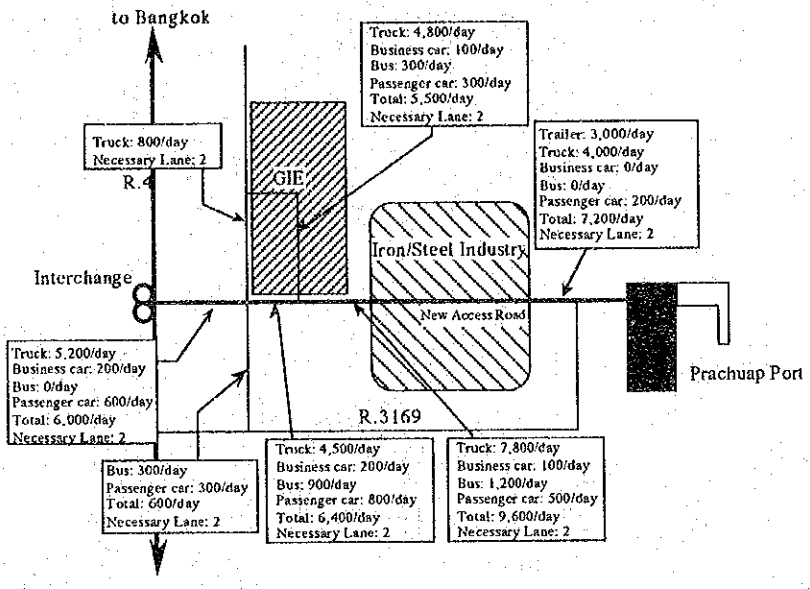
Now the port and iron and steel industrial areas are directly connected by a two-lane provincial road to Route 3169.

The existing provincial road running parallel to the national highway Route 3169 is planned to be upgraded to a well-paved road formation. This provincial road will not run through the Bang Saphan downtown, so this new road will play a key role in port access as well as to the Bang Saphan industrial area in the near future.

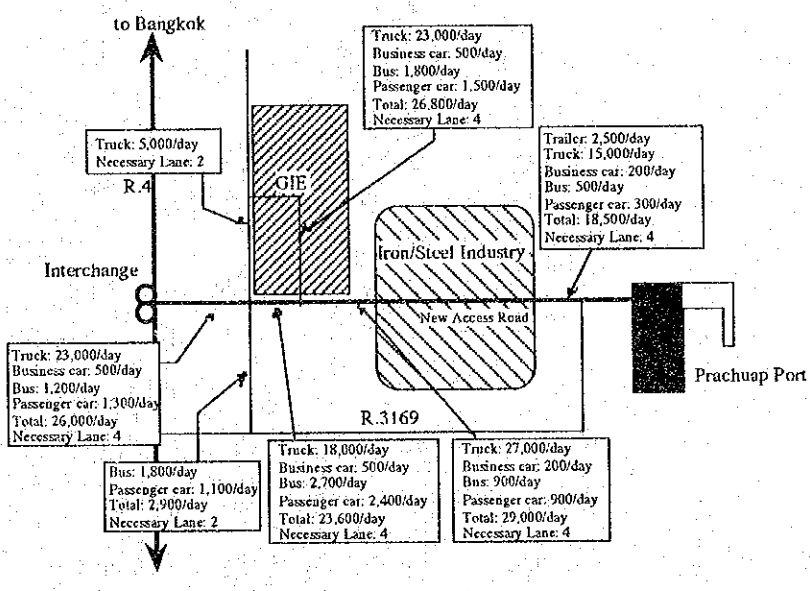


3) Access Road

A new access road connecting Route 4 with the Bang Saphan industrial estate, the iron/steel industry and Prachuap port is the urgent project to be developed considering that the heavy traffic to/from the industrial area and port has drastically increased and damaged the local community road in Amphoe Bang Saphan. Traffic on the new access road is estimated at approximately 10,000 PCU and 30,000 PCU per day in 2001 and 2011 respectively as illustrated below.



Road Traffic Projection (PCU, 200

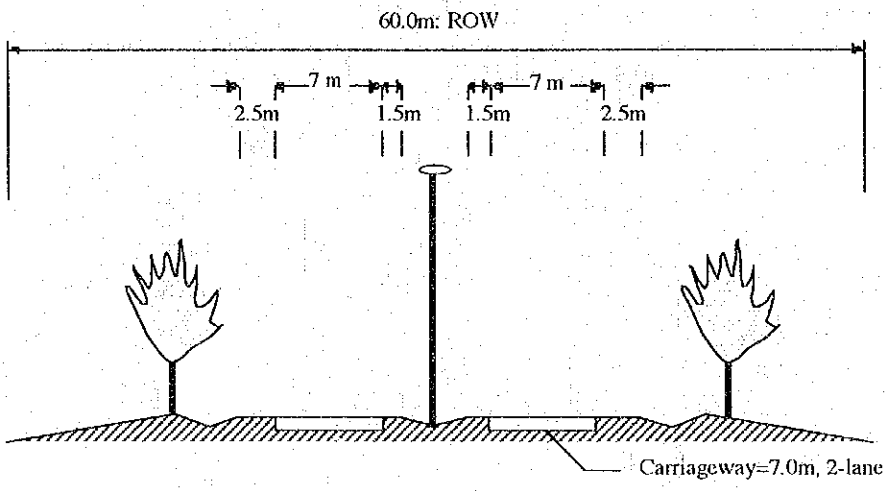


Road Traffic Projection (PCU, 2011)

Traffic Demand and Necessary Lane for Access Road

The section of the access road is designed to have 4 lanes in 2011 with approximately 16 km in length as shown below, paying due attention to the pavement design to deal with the heavy vehicle traffic generated from the port and iron/steel factories located in Bang Saphan. In the preliminary development phase, a 2-lane carriageway will be sufficient.

Access Road between R.4 to Port : 4 lanes
Right of way : 60.0 meters (in 2011)



7.4 Power Supply

The total power demand in the Bang Saphan area is estimated as summarized below.

(MW)

	1995	2001	2006	2011
1. Iron/Steel Group	84	359	1,746	1,746
2. General Industry	-	19	64	128
3. Port	-	3	6	9
4. Existing Residence	10	15	16	20
5. New Residence	-	1	3	7
Total	94	397	1,835	1,910

Up to the end of 2001, electric power for the Bang Saphan area will be fed from the existing Bang Saphan substation of EGAT, which is located 22 km northwest of the estate and connected with the 230 kV national grid. According to EGAT, the maximum power supply capacity of the Bang Saphan substation is limited to around 250 MW in total. By the end of 2001, a new 500 kV substation connected with the new 500 kV national power grid will be constructed near the Bang Saphan substation. In addition, by 2003, a new IPP power plant with a 500 kV substation is expected to be constructed in the Bang Saphan area, therefore from the year 2003, sufficient power could be supplied to the Bang Saphan industrial city. It is noted, however, that steel industry in the Bang Saphan area shall be developed in line with the power development plan of EGAT.

For the first and second phase development of the Bang Saphan industrial estate, a new 115/22 kV on-site substation (2×50 MVA) and a primary 115 kV transmission line

connected with the Bang Saphan substation will have to be constructed. Another 115/22 kV on-site substation (2×50 MVA) and 115 kV transmission line connected with the IPP power plant and substation should also be constructed.

The schematic diagram of power supply system is shown in Figure 7.5.

The two 115 kV transmission lines and two on-site substations of the Bang Saphan industrial estate will be constructed by PEA at its own cost in accordance with PEA's standards, under the condition that necessary land for construction of the substation in the estate should be supplied free of charge to PEA.

7.5 Telecommunications

There exists a Bang Saphan Remote Switching Station of TOT which is located 9 km southwest of the project site. It is controlled by the Master Switching(MS) Station located at Prachuap Khiri Khan city, connected by a 34 Mb/s optical fiber cable link.

The present switching capacity of the Bang Saphan Remote Switching Station is 600 lines, and TOT plans to expand it to 1,000 lines by October 1998.

TOT also plans to construct a Synchronous Digital Hierarchy (SDH) network which is composed of 156 Mb/s optical fiber cable (120 fibers) and microwave.

The TOT's new network will be completed in 1998, and the 120-fiber optical cable will be laid between the Prachuap Khiri Khan Master Switching Station and the Bang Saphan Remote Switching Station. Consequently, there will be no shortage in telecommunication facilities after 1999.

The total telecommunication demand in the Bang Saphan industrial city is estimated as summarized below.

(lines)

	2001	2006	2011
1. Iron/Steel Group	220	540	540
2. General Industry	280	870	1,730
3. Power Plant	-	20	20
4. Port	20	30	50
5. Existing Residence	7,460	8,060	9,720
6. New Residence	440	1,570	3,610
Total	8,420	11,090	15,670

It is proposed that by 2001 a new Remote Switching (RS) Station be installed in the estate for exclusive use of the Bang Saphan industrial estate in view of a rather bigger telecommunication demand in the industrial estate. In order to link the RS Station to the MS Station in Prachuap Khiri Khan through the SDH network, an optical fiber cable should be laid between the RS Station in the industrial estate and the existing Bang Saphan RS Station. The new RS Station in the Bang Saphan industrial estate and the optical fiber cable will be constructed by TOT at its own cost.

The schematic diagram of telecommunications system is shown in Figure 7.6. Appendix E presents the details of external infrastructure plan.

8. IMPLEMENTING METHOD OF THE BANG SAPHAN INDUSTRIAL ESTATE

8.1 Setting of Implementation Method

1) Integrated Development Organization for the Bang Saphan Area

The Board of Development & Management of Bang Saphan FREE TRADE AREA (FTA) is recommended to be established to administer the economic development of the designated Bang Saphan area. The Board will be managed in accordance with the policy set out by the Committee of Western Seaboard (WSB) Development under NESDB.

The Board should consist of representatives not only from governmental authorities such as BOI, IEAT, Customs Department, etc., but also from Private Sectors such as industrial developers, financial institutions, manufacturing firms, etc. Under the Board, an executing organization, so-called the "Bang Saphan FTA Company" (the Company) shall be set up to administer and manage the activities undertaken by several companies in cooperation with and with assistance from the Customs Office. The Company, a main player of developing the FTA, shall be run under the initiative of the Private Sectors.

The Integrated Development Organization is schematically presented in Figure 8.1.

2) Industrial Estate

A "Joint Venture" ("JV") of a private company and IEAT is proposed to be established in order to implement the development of the "Bang Saphan Industrial Estate". The equity proportion and the form of equity contribution of each party will be determined between the parties concerned. But it should be noted that the private company will play the main role in the project in terms of not only financing but also operation & management. The project formation is schematically presented in Figure 8.2.

The development of the industrial estate by establishing a JV in which IEAT takes an equity participation, but a minor participation, will be the first case for IEAT.

In the light of the IEAT regulations, the responsibilities of each party are advised to be defined as follows :

Responsibilities of IEAT:

1. To supervise, direct and advise on the design and construction of public facilities and utilities within the industrial estate;

2. To recognize it as an industrial estate;

3. To help the JV administer and operate in accordance with IEAT Act.

Responsibilities of the Private Developer:

1. To find suitable land and location;

2. To develop public facilities and utilities within the industrial estate;

3. To sell the land in the project area;

4. To operate and maintain the various facilities and utilities of an industrial estate with support and in cooperation with IEAT.

The positive involvement of the public sector in this project will be really conforming to the envisaged strategy of IEAT towards the coming 21st century. According to that strategy, IEAT will no longer act simply as regulator of the industrial estate development in which IEAT plays a role in the promotion and partial operation, but IEAT's functions might include those of an organizer, coordinator, assistant, and partner. To succeed, IEAT will need to change its orientation and acquire new skills. In this sense, the Bang Saphan I/E will be a challenging project for IEAT. Furthermore, this is a good opportunity to keep a leading edge in the industrial development in Thailand.

3) Water Supply Facilities

In the initial stage of the Bang Saphan Industrial Estate development, IEAT is advised to play an important and responsible role in supplying water to the project site in consideration of the emergent and integrated development of water supply facilities and the industrial estate. After the project is recognized to progress satisfactorily, the management structure should be shifted from the public sector to the private sector because of the governmental privatization policy. Finally the "West Water" (provisionally named) is recommended to be established for supplying water to the Western Seaboard area. The role which the "West Water " will play in the Western Seaboard Area is principally as same as the " East Water " in the Eastern Seaboard Area.

The equity participation of the Government agencies (IEAT) in the West Water will contribute to a continuous management of water resources and to the proper and efficient development in conformity with the national development policy.

4) Power Supply Facilities

PEA is expected to be fully responsible for installing a distribution line from the nearest PEA's sub-station (Bang Saphan Substation) to a substation in the industrial estate and the substation itself. The distribution line and other facilities in the industrial estate have to be constructed by the JV.

5) Telecommunication Facilities

TOT is expected to be fully responsible for installing a distribution cable up to the exchange station in the industrial estate. The exchange station and the distribution line in the industrial estate have to be constructed by the JV.

6) Sea Port Facilities

The role of the seaport is strategically important in terms of marketing for the development of the Bang Saphan Industrial Estate in due consideration of its location and its characteristics such as deep water, easy access, etc. The Prachuap Port is now operated and managed by PRACHUAP PORT CO., LTD., which is not yet listed on the Stock Exchange of Thailand (SET).

In the light of the future development envisaged in the area, the expansion of the existing port facilities will be inevitable. In this connection, a large fund for the port expansion will be required and at the same time the social responsibility of the port company as an infrastructure utility, will be eventually increased. To meet these requirements, it will be one of solutions for the company to invite public participation and/or be listed on the stock market.

Organization to be envisaged for the development and management of the industrial estate and external infrastructure is summarized in Table 8.1.

8.2 Development Schedule

The Bang Saphan industrial estate is proposed to be developed in three phases in accordance with the investment demand increment.

The construction schedule of the Bang Saphan industrial estate is prepared as shown below in consideration of the period of investment promotion and the schedule of external infrastructure construction. The target years of 2001 and 2011 as discussed in Chapter 4 will coincide with the construction schedule of the industrial estate on the assumption that 1 ~ 3 years are necessary for investment promotion.

- Implementation year of Phase 1 (610 rai or 108 ha): end of 2000
- Implementation year of Phase 2 (1,260 rai or 202 ha): end of 2003
- Implementation year of Phase 3 (1,810 rai or 290 ha): end of 2007

A detailed implementing schedule of the Bang Saphan industrial estate and external infrastructure is summarized in Figure 8.3.

The development schedule of major external infrastructure is critical for the development of the Bang Saphan industrial estate. Necessary development of the external infrastructure is summarized below by development phase.

Industrial Estate	External Infrastructure
Phase 1 (by end of 2000)	- Expansion of the existing pump and development of **a pipeline from the Bang Saphan river** to the site reservoir - Construction of **an access road (2 lanes)** from Prachuap Port to Route 4 via the industrial estate - Partial development of the **general cargo berth** in Prachuap Port - Construction of a S/S in the industrial estate and **a 115 kV transmission line from Bang Saphan S/S to the industrial estate** - Construction of a new switching station in the industrial estate & optical fiber cable from the Bang Saphan Switching Station to the industrial estate (For Iron/Steel Industry) - Construction of **a bulk berth** in Prachuap Port for the Iron complex (by 2001) - Construction of **a new 500 kV S/S** near the existing S/S and **a 230 kV transmission line** from the new S/S to Iron complex (by 2001)
Phase 2 (by end of 2003)	- Development of **the Tha Sae Dam and pipeline** from the dam to the industrial estate - Continuous development of the bulk cargo berth (for the iron complex) in Prachuap Port - **IPP power plant** with 500 kV S/S and **a 230 kV transmission line** from IPP to Iron complex
Phase 3 (by end of 2007)	- **Expansion of the access road (4 lane)** and **interchange** at the junction of Route 4 and the access road - Development of **new reservoirs in the Bang Saphan river basin** (by 2009) - Continuous development of the general cargo berth in Prachuap Port - **115 kV transmission line from IPP power plant** to the industrial estate

8.3 Method of Investment Promotion

The result of interview survey showed that the potential investors requested not only industrial infrastructure such as electricity, water supply, industrial estate, transportation facilities, etc. but also the facilities for the quality of life, education facility (i.e. international school), etc. In the investment promotion point of view, these facilities should be stressed as well as the infrastructure and provision of incentives.

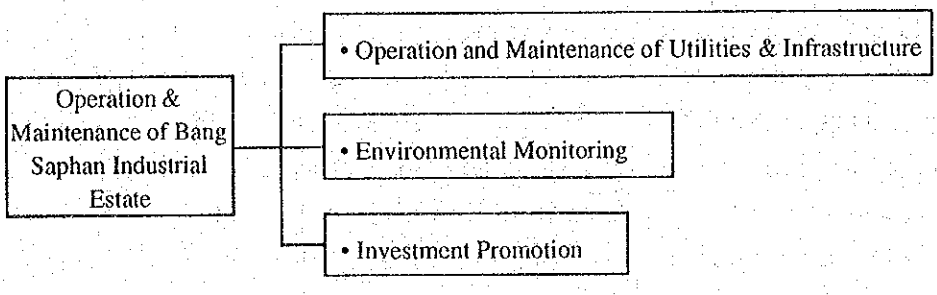
In general, the promotion begins with the preparation of the materials. These are classified as printed materials, audio visual materials, and others. The typical printed material is a pamphlet of the industrial estate. The pamphlet of the Bang Saphan IE shall be prepared in several languages such as English, Japanese, Chinese, Hangul, etc. The pamphlet should include an explanation of above life-related facilities. As for the Audio Visual materials (AV materials), along with the improvement of electrical equipment, the media has been changing; for example changing from a stillness medium (i.e. slide, transparency) to motion medium (i.e. video) and from video tapes to compact disc. Both printed materials and AV materials are the unilateral media. The method of bilateral media is important in recent years. The typical bilateral media for the promotion will be the computer-aided method such as using the home page in the Internet. There are a few cases of using Internet to promote the industries but it is expected to use the Internet home page. In using it, daily responses from the potential investors will be received and to replies to their requirement will be made. The materials for a promotion should be a combination of the above media.

After the preparation of the materials, concrete activities are requested. One of the most efficient methods of promoting investment is to open a representative office in the target countries. This has been already adopted by IEAT. The most important thing to open the promotion office is to establish the route to access the related organizations which have the information about the potential investors. In the case of Japan, for example, the related organizations are considered as JETRO, JILC, the Chamber of Commerce & Industry, Governmental Financial Organizations such as Small Business Financial Corporation, Banks, etc. Dispatching the promotion missions and inviting foreign delegation of potential investors are also effective. The point in both cases is to identify the potential investors. In this case, the representative office shall be very much useful to identify the potential investors. Seminars and/or symposiums combined with the missions are also effective. In case of Bang Saphan, most of the potential investors interviewed in Thailand did not know the name of Bang Saphan and its development plan (at the interview survey the Study Team had to begin with the location of Bang Saphan and even sent them the pamphlet and questionnaire forms). The most urgent requirement

in the promotion activities should be to inform the outline of the BSIE. It is useful to use the home page in the Internet for information dissemination on the BSIE.

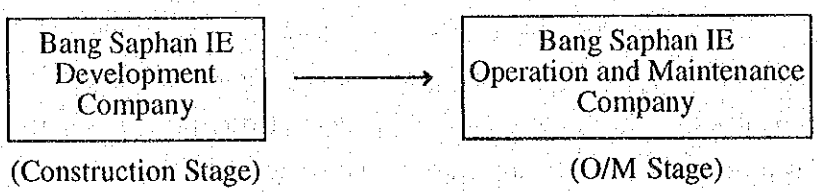
8.4 Operation and Maintenance System

Following works will be required for the operation and maintenance of the Bang Saphan industrial estate.

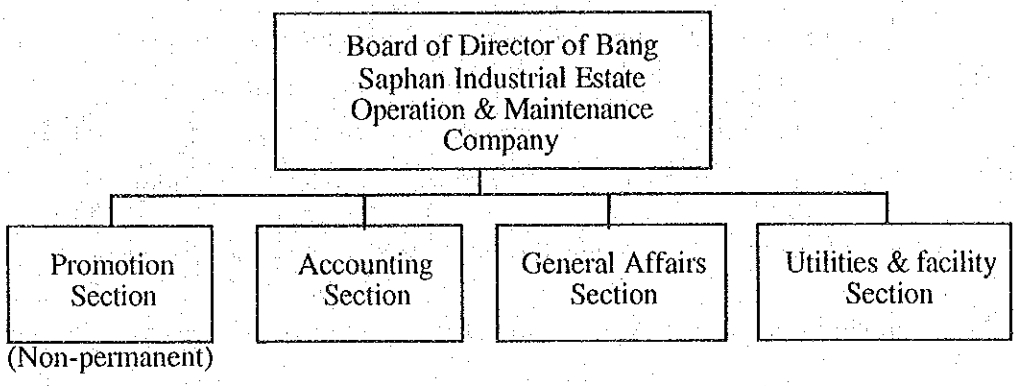


Operation and maintenance of utilities and infrastructure of the Bang Saphan industrial estate is discussed in this section, while the environmental monitoring method and investment promotion work are explained in Chapter 9 and Chapter 8, Section 3.

A private enterprise will be established succeeding the organization of the Industrial Estate Development Company and will operate and maintain the Bang Saphan industrial estate with the technical cooperation of IEAT.

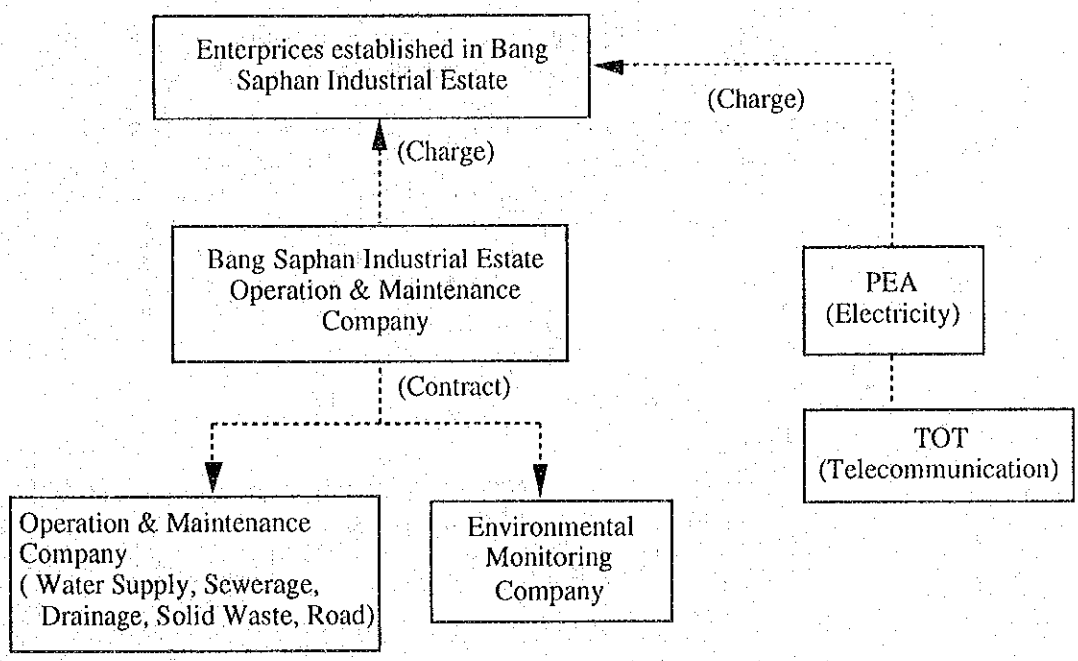


The organization of the operation and maintenance company is proposed as illustrated below.



The Utilities and Facilities Section will handle the operation and maintenance work. Actual operation and maintenance work including environmental monitoring will be carried out by the specific engineering company on a contract basis under the supervision of the Operation and Maintenance Section as illustrated below.

Utilities and facilities of water supply, sewerage, drainage, solid waste disposal systems and roads will be operated and maintained by the specific engineering company, while facilities of electric supply and telecommunication systems will be maintained by PEA and TOT.



The operation and maintenance system entrusted to the specific engineering company was adopted in existing industrial estates of IEAT such as the Laem Chabang industrial estate and Map Tha Phut industrial estate.*/

The number of staffs and operation and maintenance cost of the Bang Saphan Industrial Estate Operation & Maintenance Company are estimated as shown below, in the case the operation and maintenance by specific engineering company on a contract basis is adopted (detailed cost of operation and maintenance is shown in Appendix G).

Bang Saphan Industrial Estate Operation and Maintenance Company

Number of Staffs: Approx. 30 (inclusive of staffs for investment promotion)

Cost of O/M : 62 million Baht at maximum (or 1,200 million Baht for 30 years)

- Remuneration cost (inclusive of training cost), promotion expense and operation and repair cost of utilities.

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*/ Note 1/ IEAT decided to entrust the O/M work to a private engineering company in line with the privatization policy of the Government, and seven industrial estates, scheduled to be expanded to 18 estates, have started to be operated and maintained by Berli Jucker Co., Ltd. and Thames Water Plc. (BJT Company) from October 1994. IEAT entrusted to BJT Company the operation, maintenance, and repair of the water supply, sewerage, drainage and solid waste disposal facilities. BJT Company dispatched 16 and 27 staffs to the Laem Chabang industrial estate and Map Tha Phut industrial estate respectively.
BJT Company employs locally educated managers and engineers so as to contribute to the improvement of employment situation in the local area.

2/ Profitable utilities such as water supply and sewage treatment would be directly operated by the Bang Saphan Industrial Estate Operation & Maintenance Company instead of being entrusted to any specific engineering company. In such a case, more staffs, and engineers will be required in the Bang Saphan Industrial Estate Operation and Maintenance Company.

9. PRELIMINARY ENVIRONMENTAL IMPACT STUDY

9.1 Present Conditions

1) Natural Environment in Bang Saphan area

The Bang Saphan area is located in the southern part of Prachuap Khiri Khan Province, and faces the Gulf of Thailand on the east. The land of Prachuap Khiri Khan Province is covered by forest (20.8%), farmlands (35.2%) and unclassified land (44%). The Royal Forest Department designated 45.8% of the provincial land as protected land, including the Sam Roi Yod National Park and Wa-Kar Science Park. Land use in the Bang Saphan area is characterizedby large coconut plantations.

Topography of the Bang Saphan area is rather flat except for scattered mountainous areas and slight undulation is observed at places where natural streams and rivers are running. The area is mainly occupied by coconut plantations, paddy fields and coppices at present except for the town center and the iron and steel factories. According to the existing land use map provided by DTCP, mountainous areas scattered in Bang Saphan are designated as national reserve forests by the Royal Forest Department. According to the National Forest Reserve Act enacted in 1964, it is prohibited to develop these forests, in principle, and ministerial permission is required for their development.

(1) Climatology and Air Quality

The proposed Bang Saphan industrial estate site is under the influence of two major monsoons, i.e. the northeast and southwest monsoons.

The ambient air quality in the vicinity of the site was monitored by several governmental authorities and/or institutions as shown in Appendix F. The three significant air pollutants, i.e. TSP, SO_2 and NO_2 were observed. The results indicate that the concentrations of pollutants of interest are generally very low and well below the National Ambient Air Quality Standards of Thailand.

(2) Water Quality

Information on surface and groundwater in the area is limited. Significant water pollution indices measured in the Klong Maerampung in the Bang Saphan area are shown in Appendix F. Groundwater in the area is moderately hard water. Color, chloride and iron contents are generally higher than the drinking water standards.

With regard to the coastal water, a regional survey of water quality was undertaken by several institutions. The survey results revealed that the coastal water quality of Bang Saphan District is in good.

(3) Others

Agriculture

The main occupation of the people in Bang Saphan District is mainly agriculture. Main economic crops of the District are pineapple and coconut.

Transportation

The primary highway passing through Bang Saphan District is National Highway No. 4 or Phetchkasem Road which is an artery road connecting the southern part of Thailand to the central region.

Archaeology and Historical Values

It is found that there are no ancient places nor ancient objects which have been registered with the Department of Art.

Tourism and Aesthetic Values

The proposed site is a plain adjacent to the sea, with a steep seashore. Coconut plantations line the shore. The beach is narrow and is a tourist spot for local tourists.

2) Social Environment

Considering the project implementation, the current conditions of the basic characteristics of social environment in the Bang Saphan Area are studied and elaborated.

Population

As of 1995, Amphoe Bang Saphan had a total population of 65,503 and covered a total area of 876 km^2, which accounts for 14.6% of the total population and 13.8% of the total area of Changwat Prachuap Khiri Khan. The population of the amphoe has not grown significantly in the past, showing only a fairly low annual average growth rate of 0.68%. In fact, the total population of the amphoe has increased only by 3,864 from 1987 to 1995.

Labor Force

3,268 workers were engaged in the industrial sector and 1,280 workers in the service sector as of 1995, accounting for 4.9% of the total population of Amphoe Bang Saphan. The number of workers in both sectors has increased at a fairly high annual average growth rate of 9.4% in the industrial sector and 11.8% in the service sector over the last three years from 1993 to 1995.

Land Ownership

According to interviews of local people, most farmers in Amphoe Bang Saphan have their own lands and are mostly engaged in the coconut plantation. Since their lands are divided into small parcels, it is rather difficult to identify land ownership clearly and accurately.

General Education

In terms of the quality and quantity of labor force available for future development in Amphoe Bang Saphan, the amphoe has not been well developed yet. At present, the number of secondary school graduates in the amphoe is estimated to be around 690 annually, and the number of graduates employed in the industry sector is then anticipated to be at around only 130. The Rajabhat Institute in Petchaburi, a public semi-higher educational institution, is offering bachelor's degree in a relatively large variety of subjects for students in the Changwats of Petchaburi and Prachuap Khiri Khan.

VocationalEducation

The first vocational school in Amphoe Bang Saphan was established in May 1996 by the Department of Vocational Education of the Ministry of Education. The vocational school, called Bang Saphan Industrial and Commercial College, provides 240 engineers and 200 technicians per year for the industrial developmentin Bang Saphan.

Public Health

According to information obtained from the Bang Saphan Community Hospital under the Ministry of Public Health, there is only one hospital for the local community.

In Amphoe Bang Saphan, water sources locally available are mainly taken from shallow wells, deep wells and rivers. A water supply system taking water from both deep wells and rivers, distributes drinking water by pipe only to sanitary districts in the amphoe. In the other areas of the amphoe, drinking water is mainly provided in bottles for individual consumers and by water tank trucks for large consumers, both by local private water venders. Under these circumstances, water-born diseases are generally not observed in the amphoe.

Tourism

In Amphoe Bang Saphan, there is a total of 15 major tourism points. Of these, 5 tourism points are located approximately 5 km from the proposed site of the industrial estate, but impacts on the environment such as landscape, tourism resources are unforeseeable.

9.2 Environmental Impact Assessment

The objectives of this study is to assess the potential impact on the environment of the Bang Saphan area during the construction and after the completion of the Project.

In Thailand, environmental impact assessment (EIA) for industrial projects is prescribed by the "Enhancement and Conservation of National Environmental Quality Act" enacted in 1978. Accordingly, the industrial estate which is planned to be newly constructed, shall also be subject to an EIA before its implementation

It takes more than one year to carry out full-scale EIA. Therefore, in this study, the potential environmental impact in the Bang Saphan area was studied preliminary utilizing readily available data and information. In the Bang Saphan area, in addition to the environmental impact caused by the activity of the industrial estate, those of the iron/steel industry and the thermal power plant cannot be disregarded. Hence, the environmental impacts assessed in this study cover also those of the iron/steel industry and the thermal plant. A full-scale EIA will be undertaken, as required, by the Government of Thailand after the completion of this study.

1) Impact of Project Implementation

If the Bang Saphan industrial estate is not implemented in the proposed area, it is likely that the area will remain roughly as it is now. The implementation of the

industrial estate will have both direct and indirect impacts on the surrounding areas. The largest environmental impact of the project implementation is likely to occur during construction activities such as excavation, landfilling, construction of buildings and infrastructure. After the completion of the project, pollutants from factories such as air emissions, water effluent and disposal of solid and liquid wastes have potentially damaging environmental impacts. Furthermore, the new industrial estate will increase traffic, and it will enhance demand for housing and services in the area. Implementation of the industrial estate will also increase other activities and business in the area, and thus increase the number of workplaces in the service sector. The landscape will change totally from the existing coconut plantations to the factory buildings. Therefore, from the environmental conservation standpoint, it is necessary to pay careful attention to prevent pollution and changes during the construction and operation, and it is also necessary to consider how the landscape of the project will blend into the surrounding area.

During the construction phase, fugitive dust, sediments and erosion from construction activities will be the major pollutants which affect local air and water quality. And during the operation phase, stack emission gases and effluent waters from factories will have the most important influence on the environment in and around the Bang Saphan area. Therefore, proper measures should be taken to mitigate and control these pollutants, such as proper construction techniques, flue gas desulfurization process, wastewater treatment facilities, etc. Tables shown in Appendix F summarize the environmental impact, mitigative measures and monitoring plan involving the main items such as physical resource, biological resource, etc. in the Bang Saphan area during the construction phase and operation phase.

2) Environmental Impact Forecast

A variety of industrial groups, such as food manufacturing, chemical industry, ceramics industry, steel processing industry, and so on will be introduced in the Bang Saphan industrial estate. And it is assumed that various types of pollutants and wastes generated by the planned factories will be discharged into the environment. These pollutants and wastes might possibly have a serious impact on the environment of the Bang Saphan area unless proper measures to reduce the quantity of the pollutants and wastes are taken.

An industrial plant should ideally be located in an area which will tend to minimize its environmental effects. The proper location of a plant will not eliminate the need for final treatment for environmental protection, but it may lessen the degree of

treatment needed. In controlling pollution, the industrial estates have the advantage that a large number of relatively modern and homogenous firms are clustered together.

The influence of industrial activities on the environment of the Bang Saphan area was studied in connection with air, water qualities, solid waste and social environment. The impact on the air and water quality by pollution sources can be evaluated by the use of environmental models; the future environmental quality impact can be determined by this modeling. The following are forecasts of environmental impacts in the Bang Saphan area when the project is into operation.

(1) Air pollution

In order to know the impact of effluent gas from stacks, it is necessary to calculate the ambient ground level concentration in the objective area. The ambient ground level concentration of effluent gas from stacks can be calculated and predicted by using the smoke plume-puff formulae. In this study the ambient concentration of stationary sources in the Bang Saphan area including the iron industry and the thermal power plant was forecasted by a computer program based on such significant air pollution indices as SO_2, NO_2 and TSP.

The coal-fired thermal power plant of IPP to be built in the Bang Saphan area with a capacity of 1,400 MW will be the largest contributor to air pollution. Equal-concentration contours shown in Appendix F, are obtained from these calculations and the following table indicates maximum ground level concentrations.

Maximum Ground level Concentration in the Bang Saphan Area

	Maximum Ground Level Concentration	Ambient Concentration (Reference)*	Air Quality Standards		
			1-hr average value	24-hr average value	1-yr average value
SO_2 (mg/m ^{3})	0.034	0.003	-	0.30	0.10
NO_2 (mg/m ^{3})	0.012	0.017	0.32	-	-
TSP (mg/m ^{3})	0.008	0.096	-	0.33	0.10

Note: * Data measured during March 12 to 15, 1995, in the Bang Saphan area

The result of calculation shows that the concentrations of SO_2, NO_x and TSP are all within the ambient air quality standard of Thailand as of the year 2011 when the

factories in the Bang Saphan area, which are factories in the industrial estate, the iron/steel making mills and thermal power plant, are into operation. It is expected that the concentrations of NO_x and TSP will not change remarkably as compared with the present concentrations. However, the concentration of SO_2 is forecast to become relatively higher in areas near the industrial zone.

(2) Water pollution

Wastewater generated by the industrial estate is to be treated by a central wastewater treatment facility to be installed in industrial estate. The central wastewater treatment facility receives wastewater from factories in the industrial estate. Each factory should pre-treat the wastewater before discharging it to the central facility. This pre-treated wastewater in each factory, which is discharged to the central treatment facility, should conform with IEAT's standard. Treated wastewater in the central treatment facility should meet the industrial effluent standards provided by the Ministry of Industry. Wastewater generated by iron/steel making industry, the wastewater is also treated by the treatment facility installed in the site.

Wastewater is discharged to a receiving water body after being treated by the central wastewater treatment facility. In rivers, dilution and advection of pollutants proceed with the linear flow of water downstream. In this study, it is assumed that the treated wastewater is discharged to the Mae Ramphung river and mixed completely. Hence, concentrations of pollutants are determined by flow rate of river water, and can be simply expressed by the following equation:

$$\text{Pollutant Concentration } C_2 = (C_0q_0 + C_1q_1 + C_2q_2) / (q_0 + q_1 + q_2)$$

where, C_0 : Average concentration of a given pollutant in river water (mg/l), q_0 : Flow rate of river water, C_1 , C_2: Concentration of the pollutant in wastewater flowing into the river (mg/l) 〔BOD = 20 mg/l, SS = 30mg/l〕 , q_1, q_2 : Flow rate of the wastewater (m^3/day).

The flow rate of wastewater and the concentration of pollutants in wastewater which were used for the calculations are summarized in Appendix F. The following table shows the forecast pollutants concentration in the Mae Ramphung river in connection with BOD and SS when treated wastewater from the industrial estate and the iron/steel making industry are discharged into the river.

Forecast Pollutants Concentration in the Mae Ramphung River

	Forecast Concentration	Background Concentration *
BOD_5 (mg/l)	8.2	2 -6
SS (mg/l)	17.5	3 - 22

* : Data at Klong Maerampung, 1994 - 1996

A BOD value of 8 ppm is still allowable considering that toxic waste will be completely removed in the wastewater treatment facility, however, further degradation of the river water should be avoided and higher grade treatment of wastewater shall be considered after 2011.

3) Solid Waste

(1) Load of Solid Waste

Solid wastes generated as a result of human activities are divided into two categories. One is municipal solid waste and the other is industrial solid waste. Furthermore, industrial solid wastes are classified into two types of waste, those that present a hazard to the environment as a result of improper disposal or handling, and those that do not.

Municipal Solid Waste

Municipal wastes generated in the Bang Saphan area are disposed off now by dumping to the ground and burning. IEAT indicates that the waste generation rate in residential and commercial zones is 0.8 kg per person per day. When the Bang Saphan industrial estate is implemented in the proposed area, the total residential population in the year 2011 is estimated at 127,000 - 160,000 including current residents and natural growth of the population of Bang Saphan District. This means that the municipal waste generated from residential and commercial zones in the Bang Saphan area in 2011 increases three or four times in quantity compared with the waste generated at present and this also demand the establishment of an appropriate waste collection system and disposal method such as sanitary landfill and incineration. The volume of municipal waste to be generated in Bang Saphan area in 2011 is estimated at 37,000 to 47,000 tonnes per year.

Industrial Solid Waste

As mentioned before, industrial wastes are generally divided into two categories, general wastes and hazardous wastes. General wastes do not present a hazard to the environment. Hazardous wastes have physical, chemical, or biological characteristics which require special handling and disposal procedures to avoid risks to health and/or adverse environmental effects. The Department of Industrial Works (DIW) gave a definition of industrial hazardous wastes in the Notification No. 25 in 1988.

Both general and hazardous wastes generated in the Bang Saphan industrial estate include coal ash from the thermal power plant, refractories from the steel industry, organic sludge, wastewater treatment sludge, sludge and slurries containing chemicals, and off-specification products. Some of these wastes may contain heavy metals, chlorinated hydrocarbons and other chemicals and therefore, require special care in disposal. IEAT has presented the design criteria for solid wastes disposal. According to the IEAT's criteria, the solid waste generation rate in industrial estate is 18 kg per rai per day and the quantitative ratio of hazardous waste to total wastes generated is 10 to 15 %. The following table shows the summary estimate of general wastes and hazardous wastes to be generated in the Bang Saphan industrial estate. In this table, the ratio of hazardous wastes generated from general manufacture is assumed to be 15 %.

Estimate of Industrial Solid Wastes Generated in Bang Saphan Area

(Unit : ton/yr.)

Type of Industry	General Waste	Hazardous Waste	Total
Food	1,377	243	1,620
Textile	387	68	456
Wooden and furniture	316	56	371
Paper and pulp	57	10	68
Chemicals	1,836	324	2,160
Ceramics	1,865	329	2,194
Steel processing	2,235	394	2,629
Machinery	2,080	367	2,447
Shipbuilding	29	5	34
Industrial estate total	10,181	1,797	11,978
Iron/Steel Industry	90,000		150,000
	* 60,000		
Thermal power plant	480,000 (Ash)		480,000

* Although the sludge generated from the pickling and plating process will contain Ferrite, Aluminum, Zinc, etc., heavy metal will not be contained. Therefore, the sludge will be recycled efficiently.

(2) Treatment and Disposal of Solid Wastes

General Waste

For the treatment and disposal of general wastes, there are two methods. One is by landfill and the other is by incineration. IEAT also recommends to use incinerator or sanitary landfill for the treatment and disposal of general wastes. The above table indicates that the amount of general waste to be treated in the industrial estate by these two methods is about 10,000 tonnes per year, and 150,000 tonnes and 480,000 tonnes per year in the iron/steel industry and the thermal power plant respectively. Ash produced by IPP coal-fired power plant is proposed to be processed for manufacturing of ash blocks/modules. It is further proposed that ash blocks/modules be utilized as artificial reefs for the promotion of environmental rehabilitation of coastal fisheries in the central and lower Western Seaboard.

Hazardous Waste

A hazardous waste treatment facility should be constructed adjacent to the industrial estate area for the treatment and disposal of hazardous wastes generated by the Bang Saphan industrial estate. The above table shows that the total amount of hazardous wastes to be treated is about 1,800 tonnes per year. MOI has the responsibility for treatment and disposal of hazardous wastes and has the guideline on the implementation of industrial waste treatment centers. MOI has already established a new company, the General Environmental Conservation (GENCO), by joint investment with G.C.N. Holding Co., Ltd for constructing treatment centers. Judging from these precedent examples, the facilities for treatment and disposal of hazardous wastes generated by the Bang Saphan industrial estate will be constructed and managed by a joint venture between the government and the private sector. Treatment and disposal of hazardous wastes, after being sorted by each factory, are entrusted to a private firm. This private firm is responsible for all waste collection, treatment and disposal activities, but its operations (including service fees and treatment specifications) are regulated by the DIW. In the case of the Samae Dam hazardous waste treatment center, which is the first hazardous treatment center in Thailand, the DIW issued the tender documents to select the private company to operate the center and provide services to all factories. The bidder who quoted the lowest price to undertake the waste disposal would be considered to operate the center.

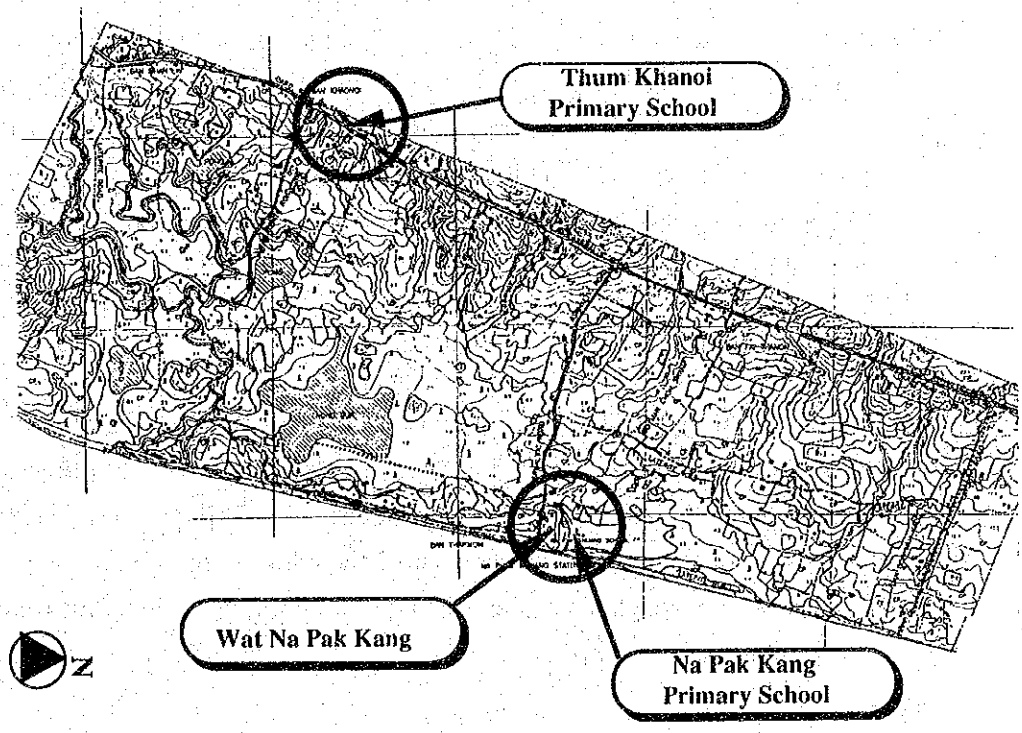
4) Social Environment Impacts in the Bang Saphan Area

The following are the major social environment impacts eventually cause by the project in the Bang Saphan Area:

Relocation of Social Facilities

Social facilities such as two primary schools and one temple are identified in the proposed site of the industrial estate, as shown in the figure below. The Wat Na Pak Kang Primary School and Thum Khaonoi Primary School had reportedly 122 and 106 students respectively in 1995. The temple is called Wat Na Pak Kang. The Wat Na Pak Kang Primary School is sited in the grounds of Wat Na Pak Kang, in the middle of the east part of the site while the Thum Khaonoi Primary School is located along the road near the southwestern corner of the site.

Existing Social Facilities in the Proposed Site



A preliminary relocation plan of each social facility is examined and suggested in the study, although the final relocation plan should be further examined and then prepared in detail, prior to the project implementation.

(1) Since a temple is to be respected as a religious asset of the local people and community, Wat Na Pak Kang is suggested to be preserved as it is at present.

(2) Maximizing utilization of the site, the existing two primary schools are considered to be relocated in the outside area as follows.

a) The Thum Khaonoi Primary School is located in the site of Phase I development, and a certain number of students living outside the site is expected to remain at the same place. It is advised that this school be preserved until the construction of a new school building is completed at a relocation site. The school shall then be relocated as soon as possible before construction of Phase I starts. The relocation site should be near the project site for easy commuting of the students still remaining in the area.

b) The Na Pak Kang Primary School is located in the site of Phase II development, and a certain number of students living outside the site is expected to remain at the same place. However, as the commuting route to the school will be cut by the industrial estate and also the expansion area of Sahaviria's factories, the school is presumed to be closed down after the construction of Phase II and Sahaviria's upstream factories starts. It is suggested that this school be preserved for the time being and most likely closed down later on.

Relocation of Local Residents

Approximately 170 establishments were identified in the site, as of 1995. However, since some establishments are identified as not being in use at present, it is estimated that approximately 120 establishments or 70% are occupied by local residents. Since the local residents currently living in the site are planned to be relocated in the outside area, the following are possible optional measures for compensation and livelihood support to be carried out prior to the project implementation.