



Summary Report

Environmental Impact Assessment Report for Thermal Power Plant Project of Gheco-one Company Limited which is a project that may seriously affect the community with respect to the quality of the environment, natural resources and health

THERMAL POWER PLANT PROJECT

GHECO-ONE CO., LTD.

MAP TA PHUT INDUSTRIAL ESTATE,

MUAENG RAYONG DISTRICT, RAYONG PROVINCE

PREPARED BY



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Summary Report

Environmental Impact Assessment Report for Thermal Power Plant Project of Gheco-one Company Limited (which is a project that may seriously affect the community with respect to the quality of the environment, natural resources and health)

1. Introduction

1.1 Background and Status of the Project

Thermal Power Plant Project of Gheco-One Co., Ltd. is located on a vacated land inside the existing 640-MW power plant facility of Glow SPP3 Co., Ltd. (in operation since 1999) in Map Ta Phut Industrial Estate, Muaeng Rayong District, Rayong Province. This project uses bituminous coal as fuel and has gross power of 700 MW. The environmental impact assessment report of this project was approved by the Office of Natural Resources and Environmental Policy and Planning (ONEP) in May 2008 and its report for modification of the project description was later approved in September 2009. Such modification was about changing location of a run-off pond for wastewater generated from coal stockyard to ensure appropriateness for area condition and consistency with engineering principle. The project's status is now in the process of construction.

Later on, the Ministry of Natural Resources and Environment has regulated a project or activity which may seriously affect the community with respect to the quality of the environment, natural resources and health to prepare an environmental and health impact assessment, to conduct public hearing process for consulting the public as well as interested persons, and to obtain opinions of any independent organizations prior to the operation to ensure consistency with the Constitution of Thailand B.E. 2550. The Ministry of Natural Resources and Environment has therefore announced its Notifications to prescribe criteria, method, and operating procedure for preparation of environmental and health impact assessment for a project or activity which may seriously affect the community with respect to the quality of the environment, natural resources and health on 29 December 2009, and has later announced its Notifications to prescribe type, size, and procedure for a project or activity which may seriously affect the community with respect to the quality of the environment, natural resources and health, on 31 August 2010, that a project owner (government agency, state enterprise, or private company) needs to prepare an environmental impact assessment report.

To ensure that the project has been entirely complied with the Constitution of Thailand B.E. 2550 and operating procedures as prescribed in the above mentioned Notifications, the Company has decided to review the project's environmental and health impact assessment by appointing Air Save Company Limited, which is an ONEP-registered consulting company for preparation of an environmental impact assessment report, to study and revise the environmental impact assessment together with specialists from the Department of Social and Environmental Medicine, Faculty of Tropical Medicine, Mahidol University, in order to conduct additional health impact assessment.

1.2 Justification for the project operation

Electricity is a basic public utility system that is critically important for the country's development. To ensure that there will be adequate electricity supply for increasing demand in the future as a result of social development and economic growth, the government has realized this problem and a significance of development plan for power. The Ministry of Energy, as an agency being responsible for directly supervise the national energy policy, has therefore established Power Development Plan (PDP) with objective to plan an appropriate program for construction of power plants using various fuel types to ensure adequate supply for increasing electricity demand in the next 10-15 years. According to the anticipated electricity demand and installed capacity of Thailand in the Power Development Plan 2010-2030 (or known as PDP 2010), the overall installed capacity at the end of December 2009 was 29,212 MW which could be classified by generation sources into 14,328.1 MW (49%) from EGAT's power plant facility and 14,883.9 MW (51%) from independent power producers (IPP). Of 51% of power purchased from IPPs, about 14,243.9 MW (48.8%) was purchased from domestic IPPs, while 640 MW (2.2%) was from neighboring countries. Nonetheless, the peak electricity demand of the country in 2009 was 22,315.4 MW or about 76.3% of the national overall installed capacity. It is anticipated that in 2011, 2016, and 2021 the national electricity demand will be increased to 24,568 MW, 30,642 MW, and 37,856 MW, respectively.

At present, the government has promoted private sector to participate in the Power Development Program and invest in the supply of the electricity to EGAT under various schemes. GHECO-One Company Limited, which is a joint venture between Glow Energy Public Company Limited and Hemaraj Land and Development Public Company Limited, has realized the significant of this Power Development Program and therefore has planned to develop a thermal power plant project (with gross power of 700 MW) that uses bituminous

coal as fuel. This project has been developed with the objective to produce and supply electricity to EGAT under the Independent Power Producers (IPP) program which GHECO-One Company Limited was selected as a winning bidder by the Ministry of Energy in December 2007. The GHECO-One Project is scheduled for commercial operation in the 4th quarter of 2011.

The project has realized its corresponding environmental impact, in particular the issue of air pollution, this power plant therefore will use coal with very low sulfur content (not exceeding 1% of sulfur) and will install a high efficient air pollution control technology to ensure very low emission rate when comparing to the control standard. In addition, the joint venture has also invested in an improvement program to strengthen efficiency of air pollution control system of the existing plants which belong to its affiliates before proceeding with the project operation to ensure that overall pollutant emission loading in the area will not be increased after the project being in operation period.

1.3 Objective of report preparation

(1) To revise the project descriptions based on data available in the EIA report being approved by ONEP, to study the existing environmental conditions of the project's surrounding in order to identify, to classify, and to assess potential impacts or to predict potential effects on environmental conditions that may occur after the operation of this project, and to propose environmental impact prevention and mitigation measures and environmental quality monitoring measures.

(2) To identify causes, factors, health threats, or other relevant health effects which are associated with the project operation, to assess health impact on the community and workers that is related to the project operation, and to propose health impact prevention and mitigation measures and health impact monitoring measures.

(3) To conduct participation process for the public and stakeholders in the environmental and health impact assessment.

(4) This information is used for project permission for permitted authorization.

1.4 Scope of study area

Initially, the study area for environmental and health impact assessment has been specified to cover area in 5-kilometer radius of the Project's site (as shown in Figure 1.4-1). Nonetheless, an air quality impact assessment has been conducted to cover the area in 12-kilometer radius of the Project's site. Additionally, if the result of the environmental and health impact assessment shows tendency of impact in any aspect occurring beyond the scope of this initially specified study area, the study team will extend its scope to cover such affected area as well. For public hearing process or participation activities for the public and stakeholders, the study team has specified target groups based on social context by covering various communities located in the area beyond 5-kilometer radius which includes the area in Map Ta Phut District Municipality and Ban Chang Sub-district Municipality.

1.5 Study scope and method

This revision of the project's environmental and health impact assessment is mainly based on the data available in the EIA report being approved by ONEP, although the data of existing environmental conditions have been revised and updated. In addition, scope of the study has been extended in accordance with the Notification of Ministry of Natural Resources and Environment prescribing criteria, method, and operating procedure for preparation of environmental and health impact assessment for a project or activity which may seriously affect the community with respect to the quality of the environment, natural resources and health (29 December 2009), in particular the study of health impact and careful consideration of comments and suggestions received from public hearing process. However, the project's environmental impact assessment is conducted at project level. Based on this fact, there are various limitations with respect to a study of overall pollution carrying capacity of the area which requires a strategic (or area-based) environmental assessment (SEA) that needs cooperation of various agencies in conducting such assessment. Consequently, the project's impact assessment has emphasized on anticipation or prediction of the existing environmental conditions that may be changed after the project operation by considering the existing environment conditions or pollution problems in the study area prior to the project operation as well.

Scope of the project's environmental and health impact assessment that was adjusted to be consistent with suggestions of stakeholders received from Public Scoping process is described as follows.

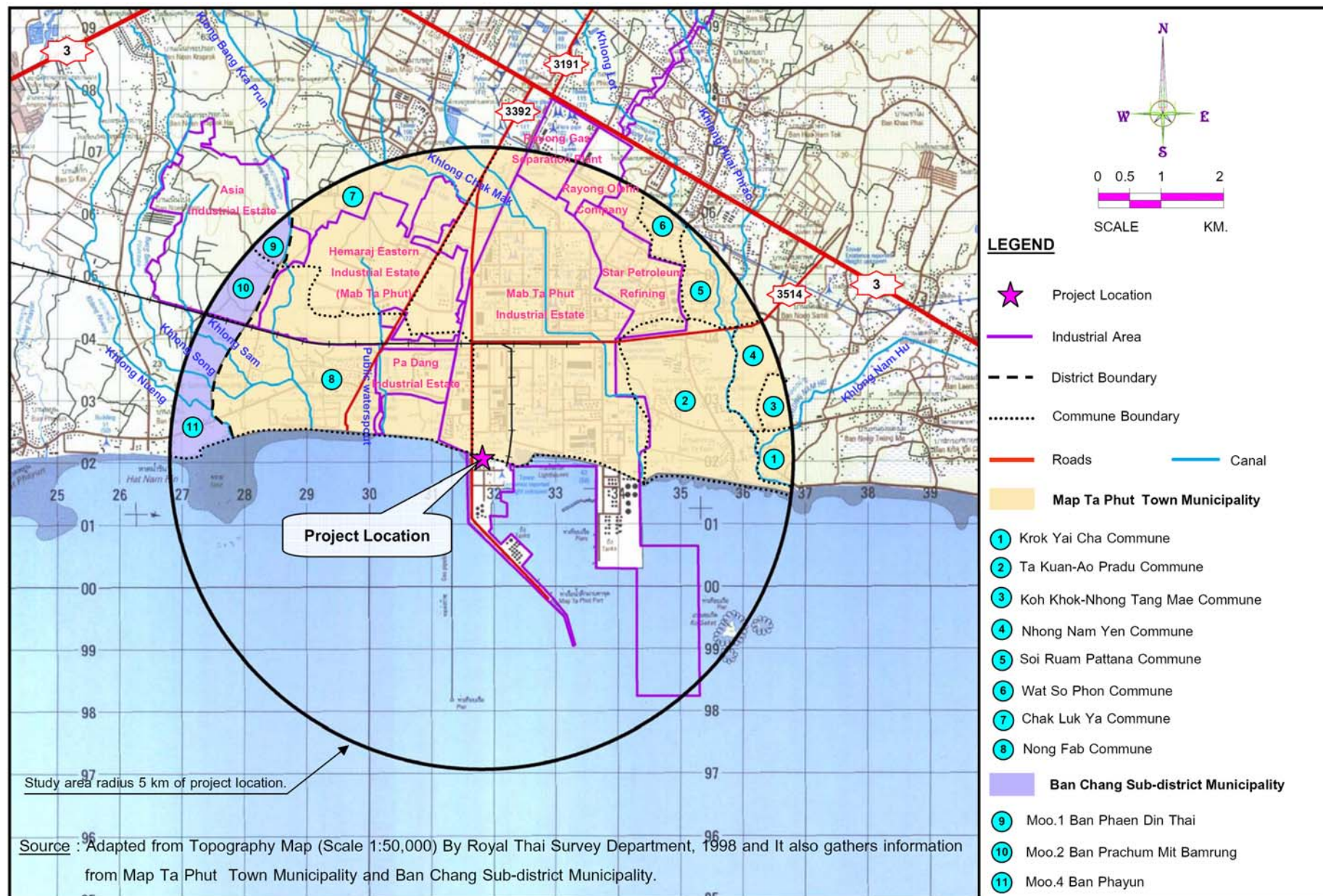


Figure 1.1-1 Study area boundary

1.5.1 Study of project description

Information of the project descriptions will be primarily based on the existing EIA report that was approved by ONEP since the current project descriptions are not quite different from what being prescribed in the such EIA report. The project descriptions being studied cover the following.

(1) Project location and land use project location, land use of project's surroundings, and project's land use layout are presented.

(2) Fuel quantity, components, and transfer of fuel to production process are presented.

(3) Chemicals type, source, consumption rate, transportation method, and chemicals storage including MSDS of these chemicals are presented.

(4) Products production capacity and transmission line to EGAT are presented.

(5) Production process, details of production process, flow diagram and process mass balance are presented.

(6) Auxiliary system and public utility - various systems used to support the project's production such as water supply, cooling system, coal stockyard management, drainage and flood prevention, sodium hypochlorite production system, etc. are presented.

(7) Pollution control system - pollution generating sources, types of pollutant generated from the production and other related activities, including air pollution, noise level, wastewater, solid wastes, characteristics of generated pollutants, pollution control systems, and pollution emission rate are presented.

(8) Employees - number of employees, workers, and administrative organization chart are presented.

(9) Occupational health and safety - occupational health and safety management system for sustaining appropriate working environment, working-related accident prevention system, and emergency responses plan are presented.

(10) Protection strip and green area layout of green area and tree plantation for the purpose of environmental protection and project's landscape improvement is presented.

1.5.2 Study of existing environmental condition of the area

Existing environmental conditions are used as baseline data of the study area for the condition prior to the project operation which can be used as a basis for impact assessment on various aspects as follows.

(1) Physical natural resources and environment

(a) Topography Information on topographical conditions of the study area are studied from a topographic map which was prepared by the Royal Thai Survey Department, together with aerial photograph, soil survey report of Rayong province by the Land Development Department, and a field survey.

(b) Geology and Soil Science - the geological characteristics of the study area are studied from geology map prepared by the Department of Mineral Resources, a topographic map prepared by the Royal Thai Survey Department, and a field survey, while a study on soil science involves data collection of physical characteristics and appropriate land use for the area conditions according to the survey report and soli classification for Rayong Province and map of soil series prepared by the Department of Land Development. Data on criteria for classification of earthquake risky area in Thailand prepared by the Department of Mineral Resources is also collected.

(c) Climate and meteorology - data on climate conditions of the study area such as rain intensity, temperature, wind speed and direction, atmospheric pressure, relative humidity, and other climate conditions are collected from meteorological statistics recorded by the Thai Meteorological Department's weather station being closest to the project area.

(d) Air quality - ambient air quality monitoring data in the study area are collected from reports on performance of environmental impact prevention and mitigation measures and environmental quality monitoring measures of 640-MW cogeneration power plant of Glow SPP3 Co., Ltd. and various industrial estates, air quality monitoring station of the Pollution control Department, and IEAT's Environmental Monitoring & Control Center since these agencies have continually monitored the air quality in the area.

(e) Noise level - noise level monitoring data in the communities nearby the project area in terms of 24-hr equivalent continuous sound level (Leq-24) are collected from reports on performance of environmental impact prevention and mitigation measures and environmental quality monitoring measures of 640-MW cogeneration power plant of Glow SPP3 Co., Ltd., Map Ta Phut Industrial Estate, Hemaraj Eastern Industrial Estate (Map Ta Phut), and Asia Industrial Estate.

(f) Surface water quality - data on characteristics of surface water reservoirs that are fresh water reservoirs and quality and monitoring data of coastal seawater in the study area are collected from reports on performance of environmental impact prevention and mitigation measures and environmental quality monitoring measures of 640-MW cogeneration power plant of Glow SPP3 Co., Ltd. and Map Ta Phut Industrial Estate.

(g) Groundwater quality - data on quality of groundwater and shallow well water within the study area are collected from reports on performance of environmental impact prevention and mitigation measures and environmental quality monitoring measures of Map Ta Phut Industrial Estate and Asia Industrial Estate.

(2) Biological resources and ecosystem - data on biological resources and terrestrial ecosystems such as forest resource and wildlife animals are collected while data on aquatic ecosystems are collected from measurement results of biological resources in seawater presented in reports on performance of environmental impact prevention and mitigation measures and environmental quality monitoring measures of 640-MW cogeneration power plant of Glow SPP3 Co., Ltd. and Map Ta Phut Industrial Estate.

(3) Human use values

(a) Land use - land use pattern of the study area is studied by classifying into various purposes of land use such as industrial area, agricultural area, etc. City plan in the study area and various conditions concerning pollution control zone are also studied.

(b) Transportation - general traffic conditions of existing transportation routes around the project area is studied by conducting a field survey on traffic conditions during rush hours and normal hours and gathering traffic volume statistics of major transportation routes related to the project published by the Safety Bureau, the Department of Highways. In addition, maritime transportation is studied by collecting numbers of industrial ports in Map Ta Phut area from the Office of Map Ta Phut Port.

(c) Water use - sources of water used for public's domestic consumption in the study area and communities' water use problem are studied. Overview of water resource allocation in the study area is also studied by gathering data from related agencies such as Irrigation Office 9, Eastern Water Resources Development and Management Public Company Limited (East Water), etc.

(d) Electricity consumption - data on electricity distribution in the study area and problems related to electricity use of industry and communities in the study area are collected.

(e) Drainage - general drainage conditions of the study area studied including public's problems concerning drainage and flood condition.

(f) Waste management - solid waste management, servicing network and capacity of related agencies such as municipality, and the existing conditions and problem concerning solid waste management in the study area are studied.

(g) Disaster prevention and mitigation - data on disaster prevention and mitigation from related agencies such as fire station or Voluntary Civil Emergency Relief Center, etc. are collected including causes, frequency, and severity of accident and incidents occurring in the study area. In addition, there is also a study on emergency response plan for chemicals and toxic substances for Rayong province at various levels including emergency response plan at level of industrial estates in the area.

(h) Agriculture - agricultural data at provincial and district levels related to the study area are collected from relevant agencies such as Rayong Provincial Agriculture and Cooperative Office and from summary report or 3-year development plan of local authority. These data consist of information on appropriate area for economic crops plantation and yield, including agricultural problems in various aspects.

(i) Fishery and livestock - data on occupation of freshwater fishery, marine fishery and livestock development in the study area are collected from related agencies such as Rayong Provincial Livestock Office and Rayong Provincial Fishery Office, and from summary report or 3-year development plan of Rayong province.

(j) **Industry** - data on industrial development in the study area are collected from related agencies such as the Department of Industrial Works, the Industrial Estate Authority of Thailand, and from 3-year development plan of Rayong province.

(4) Quality of life values

(a) **General socio-economic condition** data on overview of general socio-economic conditions of Rayong province and related local authority in the study area are collected. These data include general area condition, administrative data, population data, occupation, business agencies, servicing facility, religion, educational places, public health service facility, and crime statistics.

(b) **Social survey was conducted in the study area to obtain information regarding social condition, economic condition, environmental condition, and health condition.** The survey is conducted using questionnaires as a tool to obtain opinions of public and stakeholders in the study area. The questionnaire covers various aspects such as general information of interviewee, household structure, birthplace and relocation, economic condition, environmental health data/environmental sanitation data, existing living condition and satisfaction such as environmental problem in community, environmental impact on daily life, and opinions toward the existing environmental conditions and in the future after the project development.

(c) **Public health** - basic public health data, overall population health status, and public health service system of local authorities in the study area are collected. These data include morbidity rate, death rate, medical and public health personnel, and availability of public health resources.

(d) **Aesthetics and tourism** - tourist destinations and important places located in the study area are studied.

1.5.3 Public hearing process for consulting the public and interested persons in the process of environmental and health impact assessment

Public hearing process for consulting the public and interested persons in the process of environmental and health impact assessment is a process that promotes participation of public and stakeholders in exchanging information and expressing

comments/suggestions toward the project development in order to identify appropriate alternatives for the project development. This process also makes the environmental and health impact assessment more thorough. The process is conducted in accordance with the Notification of Ministry of Natural Resources and Environment prescribing criteria, method, and operating procedure for preparation of environmental and health impact assessment for a project or activity which may seriously affect the community with respect to the quality of the environment, natural resources and health (29 December 2009).

Public hearing process will be conducted since the beginning period of the preparation of EIA report, which consists of Public scoping to identify scope of environmental and health impact assessment, public hearing during the assessment and preparation of EHIA report in forms of focus group, individual interview, and workshop, and Public review to consider a draft EHIA report.

1.5.4 Environmental impact assessment

Environmental impact assessment is about prediction of impact posing on natural resources and environmental quality for conditions before and after the project operation. The prediction of environmental impacts is carried out by various appropriate tools such as mathematical model, empirical formula, expert opinion, etc. In addition, an environmental impact assessment is conducted in each aspect covering overview of pollution sources or existing environmental quality (before the project development).

Considering the existing environmental conditions of the study area and the project's activities during Screening and Scoping steps together with suggestions received from the public and stakeholders during Public scoping process, it is found that major aspects that may significantly affect the environment associated with the project operation are impact on air quality in the study area (assessment of impact caused by changing air quality after the project operation is linked with impact on agriculture), impact on noise level in the study area, impact on water quality and biological resources of the project's effluent receiving reservoir, impact on transportation system in the study area, impact on aquatic resources, impact from generated wastes, and impact from major hazards or incidents occurring in the project. Scope and study approach for various aspects of impacts as mentioned above can be summarized as shown in Table 1.5.4-1.

Table 1.5.4-1

**Scope and approach in environmental impact assessment for major
environmental aspects**

Scope of environmental impact assessment	Operating approach in environmental impact assessment
<ul style="list-style-type: none"> - Impact on air quality in the study area 	<ul style="list-style-type: none"> - To study the project's sources or activities that generate air pollutants, to identify major pollutants being generated (significant air pollutants generated from coal combustion in boiler are nitrogen oxide, sulfur dioxide, and total suspended particulates), and to study minor pollutants generated from the project such as heavy metal as well. - To study air quality in the study area before the project operation in terms of nitrogen dioxide, sulfur dioxide, and total suspended particulates. - To assess the impact on air quality according to the criteria of the National Environment Board such that the study area must cover the most affected area that may be beyond the area within 5-kilometer radius of the project site. Moreover, an air quality modeling is used to predict overall concentrations of nitrogen dioxide, sulfur dioxide, and total suspended particulate in the study area that is changed after the project operation and to compare these concentrations with the ambient air quality standard. The study is conducted to cover the overall impact caused by the project's pollutant generating sources and the 401-MW cogeneration and steam plant of Glow Energy Public Company Limited. The impact assessment considers these mentioned generating sources and the existing ambient air quality in the study area (prior to the project operation) which has been affected by the existing pollutant generating sources locating in the study area prior to the project operation. In addition, there is a prediction of heavy metal distribution that may be a constituent of air emission from the project's stack. - To prescribe environmental impact prevention and mitigation measures and environmental impact monitoring measures. <p><u>Remark:</u> the assessment of impact caused by changing air quality after the project operation is linked with impact on agriculture.</p>

Table 1.5.4-1 (continued)

Scope of environmental impact assessment	Operating approach in environmental impact assessment
<ul style="list-style-type: none"> - Impact on noise level in the study area 	<ul style="list-style-type: none"> - To study significant noise generating sources or activities associated with the project operation (steam turbine, power generator, and cooling water pump). - To study typical noise level at the sensitive area that is closest to the project area before the project operation. - To predict typical noise level and disturbing noise level at the sensitive location that may be changed after the project operation in accordance with the Pollution Control Department's procedures by using related mathematical equation/model formula as a prediction tool, and to compare these levels with the noise level standard. The impact assessment is conducted on the community located closest to the project area and covers overall impact posed by the project's noise generating sources and the existing noise level in the study area prior to the project operation. - To prescribe environmental impact prevention and mitigation measures and environmental impact monitoring measures
<ul style="list-style-type: none"> - Impact on water quality and biological resources of the project's effluent receiving reservoir 	<ul style="list-style-type: none"> - To study the project's sources or activities that generate water pollution or wastewater (effluent from the project's cooling system has warm temperature and chlorine compound as constituent), and to study heavy metals that may be contaminated in seawater used in cooling system and in Sea water Flue Gas Desulfurization (SW-FGD). - To study water quality and biological resources of the project's effluent receiving reservoir (prior to the project operation). Studied parameters are temperature, heavy metals, DO, trihalomethanes, etc. In addition, groundwater quality in the study area prior to the project operation is also studied - Mathematical modeling is used as a tool to predict impact on water quality and biological resources of the project's effluent receiving reservoir, specifically impacts associated with water temperature of the effluent receiving reservoir that is changed

Table 1.5.4-1 (continued)

Scope of environmental impact assessment	Operating approach in environmental impact assessment
	<p>after the project operation. In addition, the impact assessment is also conducted on seawater quality and groundwater quality regarding heavy metal contamination associated with use of coal as fuel.</p> <ul style="list-style-type: none"> - To prescribe environmental impact prevention and mitigation measures and environmental impact monitoring measures.
<ul style="list-style-type: none"> - Impact on transportation system in the study area 	<ul style="list-style-type: none"> - To study traffic volume that is increased as a result of the project operation (traffic volume that is generated from transportation of chemicals, solid wastes, and employees). - To study traffic volume and condition within the study area prior to the project operation. - To predict traffic condition that may be changed after the project operation in accordance with the approach or criteria prescribed by relevant agencies. The study will consider traffic volume that is generated from the project's transportation activity together with the existing traffic volume prior to the project operation. Mathematical equation/model formula is used as a tool to assess the existing traffic volume and changing traffic volume associated with the project operation by covering both rush hours and normal hours. - To prescribe environmental impact prevention and mitigation measures and environmental impact monitoring measures.
<ul style="list-style-type: none"> - Impact on aquatic resources 	<ul style="list-style-type: none"> - To study the project's water consumption rate (water consumption in power production). - To study the project's sources of water supply. - To evaluate capacity and adequacy of the project's water sources and to assess the impact by considering the project's water demand and the demand of the existing water users prior to the project operation. - To prescribe environmental impact prevention and mitigation measures.
<ul style="list-style-type: none"> - Impact from generated wastes 	<ul style="list-style-type: none"> - To study characteristics and quantity of waste being generated in the project (ash from coal combustion).

Table 1.5.4-1 (continued)

Scope of environmental impact assessment	Operating approach in environmental impact assessment
	<ul style="list-style-type: none"> - To study current waste management method. - To evaluate appropriateness of the project's waste management including storage and transportation, and carrying capacity for waste management of waste processor. - To prescribe environmental impact prevention and mitigation measures and environmental impact monitoring measures.
<ul style="list-style-type: none"> - Impact from major hazards or incidents occurring in the project 	<ul style="list-style-type: none"> - To classify and identify activities with a risk of initiating major hazards from the project operation. - To evaluate risk associated with boiler and to assess an impact posed by leakage of chemical storage tank (ammonium anhydrous) by considering property and condition of such chemical and using various tools including mathematical modeling to predict affected area and impact level when simulating the leakage of such chemical. - To prescribe environmental impact prevention and mitigation measures and environmental impact monitoring measures.

1.5.5 Health impact assessment

Health impact assessment is about prediction of both positive and negative health impacts that may be posed by various project developments. The process thoroughly considers every aspect in detail to identify relationship between cause and effect associated with the project development and to ensure that such development will not pose or at least minimize an impact on the public or pose any change on environment or community. Inevitably, these project developments lead to loss of natural resources and change in environmental condition, socio-economic condition, and community. Health impact assessment aims to study a relationship between health and environment associated with operation of project's activities during each time period that leads to a change in health determinants in terms of environment, social, public service and public health. The study will evaluate whether these changed health determinants lead to a change in health threats of which population group, especially population at risk that may require special attention, and how they affect individual health, community, and society. These changes or effects are communicable and non-communicable diseases, work-related injury, and social well being. After having identified these effects, the study will propose appropriate promotion and prevention measures that will lead to protection of human health in community. Health impact assessment for power plant project concerns the following aspects.

- Public health and public service: illness, adequacy of public health service
- Environmental health impact: traffic accident, accident related to chemical transportation, noise level, particulate matter, sulfur dioxide, nitrogen oxide and heavy metal
- Socio-economic aspect: social group formation, job and employment opportunity, or problems of safety in life and property, drugs, population immigration

Such above mentioned effects are studied for both construction and implementation periods. Scope of the project's health impact assessment can be summarized as shown in Table 1.5.5-1.

Table 1.5.5-1

Scope of health impact assessment for construction period and implementation period

Project period	Activity	Threat	Risk group	Impact	Impact assessment method/tool	Supporting data for impact assessment
<u>Construction period</u>	- Construction activities within the project area and transportation of materials/workers	- noise	- construction workers and residents in the project surroundings	- hearing system and quality of life in term of nuisance	- qualitative assessment using risk table for quantifiable threats	- environmental condition of the area, social survey result, and result of environmental impact assessment
		- particulate matter	- construction workers and residents in the project surroundings	- respiratory tract disease	- qualitative assessment using risk table for quantifiable threats	- environmental condition of the area, social survey result, and result of environmental impact assessment
		- work-related accident	- construction workers	- work-related injury	- qualitative assessment using risk table	- record of work-related accident occurrence during the project's construction period in the past
		- transportation	- residents in the project surroundings	- transportation related injury/accident	- qualitative assessment using risk table	- transportation volume associated with the projects' activities social survey result and result of environmental impact assessment

Table 1.5.5-1 (continued)

Project period	Activity	Threat	Risk group	Impact	Impact assessment method/tool	Supporting data for impact assessment
18	- Construction activity that allows temporary migration of non-registered population into the area	- wastes, wastewater, and manure	- construction workers and residents in the project surroundings	- respiratory tract disease	- qualitative assessment	- numbers of workers, social survey result, and result of environmental impact assessment
		- communicable disease	- construction workers	- respiratory tract disease	- qualitative assessment	- numbers of workers, environmental condition of the area, and social survey result
		- quantity and quality of water for domestic consumption	- construction workers and residents in the project surroundings	- inadequate supply of clean water for domestic consumption - respiratory tract disease	- qualitative assessment using risk table	- numbers of workers, social survey result, and result of environmental impact assessment
		- public service and public health	- construction workers and residents in the project surroundings	- over demand for public utility service such as school, water supply, electricity, etc. - accessibility to medical and public health service	- qualitative assessment	- numbers of workers, social survey result, and result of environmental impact assessment
		- disaster mitigation	- employees, workers, and residents in	- promptness of service and service coverage	- qualitative assessment	- social survey result and environmental condition of

Table 1.5.5-1 (continued)

Project period	Activity	Threat	Risk group	Impact	Impact assessment method/tool	Supporting data for impact assessment
19			the project surroundings			the area
		- social group formation	- residents in the project surroundings	- group formation for conducting community development activities	- qualitative assessment	- environmental condition of the area and social survey result
		- occupation/employment	- construction workers and residents in the project surroundings	- income per household and increasing employment rate	- qualitative assessment	- environmental condition of the area and social survey result
		- population growth and non-registered population	- construction workers and residents in the project surroundings	- unsafe condition for life and property, drug problems, and street fight problem	- qualitative assessment	- number of workers, environmental condition of the area and social survey result
Implementation period	- Coal transfer and production process that requires noise-generating machinery or equipment	- noise	- employees working close to noise generating source and residents in the project surroundings	- hearing system	- qualitative assessment using risk table for quantifiable threats	- environmental condition of the area, social survey result, and result of environmental impact assessment
	- Stack emission of air pollutants from boiler, which uses coal as fuel, into the	- particulate matter	- residents in the project surroundings (specifically child, pregnant women,	- respiratory tract disease, asthma, cough, decline of lung function, and increasing risk for heart	- Quantitative assessment by calculating Hazard quotient	- environmental condition of the area and result of environmental impact assessment

Table 1.5.5-1 (continued)

Project period	Activity	Threat	Risk group	Impact	Impact assessment method/tool	Supporting data for impact assessment
20	atmosphere.		elderly, and people with respiratory tract disease and heart diseases	disease		
		- NO ₂	- residents in the project surroundings (specifically child, pregnant women, elderly, and people with respiratory tract disease and heart diseases.	- decline of lung function	- quantitative assessment by calculating Hazard quotient	- environmental condition of the area and result of environmental impact assessment
		- SO ₂	- residents in the project surroundings (specifically child, pregnant women, elderly, and people with respiratory tract disease and heart diseases.	- decline of lung function and increasing bronchitis in asthma patient	- quantitative assessment by calculating Hazard quotient	- environmental condition of the area and result of environmental impact assessment
		- heavy metal such as Hg	- residents in the project	- illness associated with heavy metal toxicity	- quantitative assessment by	- result of environmental impact assessment

Table 1.5.5-1 (continued)

Project period	Activity	Threat	Risk group	Impact	Impact assessment method/tool	Supporting data for impact assessment
21			surroundings		calculating Hazard quotient and cancer risk	
		- acid rain formation	- residents and farmers in the project surroundings	- respiratory tract disease and skin disease - rainwater quality is not suitable for domestic consumption - damage to agricultural crops leading to a decrease in income (environmental impact)	- qualitative assessment using risk table	- environmental condition of the area, social survey result, and result of environmental impact assessment
	- Use of some seawater, which has already been used in cooling system for removal of SO ₂ from air emission emitted from boiler, may induce contamination of heavy metal in seawater since this seawater is drained into the sea eventually.	- contamination of heavy metal in seawater	- residents in the project surroundings	- illness associated with heavy metal toxicity	- quantitative assessment by calculating Hazard quotient and cancer risk	- result of environmental impact assessment

Table 1.5.5-1 (continued)

Project period	Activity	Threat	Risk group	Impact	Impact assessment method/tool	Supporting data for impact assessment
22	- Ash generated from coal combustion in boiler	- ash from coal combustion	- employees	- respiratory tract disease	- qualitative assessment using risk table	- project description
	- Chemicals used in this project that may be leaked or dispersed in case of emergency.	- sulfuric acid, sodium hydroxide, coagulant for water treatment, sodium hypochlorite, and ammonia anhydrous	- employees and residents in the project surroundings	- exposure causes irritation of skin, conjunctiva, and respiratory tract	- qualitative assessment using risk table	- project description
	- On-duty operation of employee	- work related accident (occupational health and safety)	- project's workers	- injury/handicap/death	- qualitative assessment using risk table	- project description and statistics of accident occurrence of affiliated companies
	- Transportation of chemicals used in production, and wastes generated from the production.	- accident related to chemical transportation, chemical leakage during transportation	- residents in the project surroundings, employees, and workers	- injury associated with transportation related accident - illness associated with chemical exposure	- qualitative assessment using risk table	- environmental condition of the area and social survey result
	- Commute to work of employee/worker	- accident	- employees and residents in the project surroundings	- injury associated with commuting related accident	- qualitative assessment using risk table	- number of project's employees and environmental condition of the area

Table 1.5.5-1 (continued)

Project period	Activity	Threat	Risk group	Impact	Impact assessment method/tool	Supporting data for impact assessment
23	- The project operation creates job and employment that may lead to migration of non-local workers into the area which resulting in change in economic condition of the community.	- social group formation	- residents in the project surroundings	- group formation for conducting community development activities	- qualitative assessment	- environmental condition of the area
		- occupation/employment	- residents in the project surroundings	- income per household and increasing employment rate	- qualitative assessment	- environmental condition of the area
		- public service and public health	- employees and residents in the project surroundings	- promptness of service and service coverage	- qualitative assessment	- numbers of project's employees and environmental condition of the area
		- population growth and non-registered population	- employees and residents in the project surroundings	- unsafe condition for life and property - drug problems - street fight problem	- qualitative assessment	- numbers of project's employees and environmental condition of the area
		- public service and public health	- employees and residents in the project surroundings	- over demand for public utility service such as school, water supply, electricity, etc. - accessibility to medical and public health service	- qualitative assessment	- numbers of project's employees and environmental condition of the area
		- disaster mitigation	- employees, workers, and residents in the project surroundings	- Promptness of service and service coverage	- qualitative assessment	- project description and environmental condition of the area

1.5.6 Environmental impact prevention and mitigation measures and environmental impact monitoring measures

Various measures for both construction and implementation periods are revised to cover environmental aspects, natural resources, and health by referring to the project's measures prescribed in the EIA report that is approved by Expert Committee for consideration of EIA report of energy related project. The measures are then adjusted to be consistent with the information obtained from the revision of impact assessment, particularly in the aspect of health impact assessment, and the suggestions received from various public hearing events.

1.6 Consideration criteria for the project's alternatives

1.6.1 Alternatives for project site

The project's construction area is a vacated land inside the existing power plant facility. This land has been prescribed for specific purpose of industrial development. In addition, this area still consists of various public utility systems such as coal receiving harbor, conveyor, cooling water drainage canal, and industrial water distribution system. Consequently, it is not necessary to construct certain public utilities thereby minimizing impact on surrounding environment and promoting efficient use of resources. Since the project is located near the sea, seawater can be used in the project's cooling system which helps in minimizing an impact on water resources in the area.

1.6.2 Alternatives for production technology

This project can be regarded as one of the world's cleanest coal fired power plants. The project's design has incorporated highly efficient advanced removal systems for nitrogen oxides, sulfur dioxide, and suspended particulate matters. Its sulfur dioxide emission and nitrogen dioxide emission are far below the Thai and World Bank standards as well as the EU standards for coal fired power plant which are among the most stringent in the world. In addition, this project must contribute to the community development fund in order to promote level of community development for the surrounding communities such as educational development, hygiene, career development, improvement of quality of life, and social development. It is expected that the project must contribute to this fund around 100 million baht a year. Finally, to fully comply with legal guidelines and regulations regarding permit application under the Independent Power Producers (IPP) program, the joint venture has invested in air pollution

control technology to reduce the existing emission from the power plant such that emissions of sulfur dioxide and nitrogen dioxide are reduced below the existing level after the project has been operated. Since it is located in Map Ta Phut area, this project has committed to reduce nitrogen oxide and sulfur dioxide emissions (Max Actual) at the existing power plant facilities. The nitrogen oxide and sulfur dioxide emissions of the new project shall not exceed 80% of the amount reduced. As a result, the overall air quality in Map Ta Phut is improved.

2. Project description

2.1 Project site

The thermal power plant is located in Map Ta Phut Industrial Estate, Mueang Rayong District, Rayong province (as shown in Figure 2.1-1 and Figure 2.1-2) with land area of approximately 85 rai. The land use is divided into 2 parts. The first part (of about 35 rai), which is located in the vacated land of the existing 640-MW power plant of Glow SPP3 Co., Ltd. (hereafter referred to as “the existing plant” with the area of about 180 rai), is used for the power plant process and supporting utilities. The second part (of about 50 rai) is a rented land from the Industrial Estate Authority of Thailand (IEAT) to the north but outside of “the existing plant” area, and is used for a coal stockyard, and a run-off pond. In the future, another power plant project will be developed in “the existing plant” area (refer to Figure 2.1-2) that is the 401-MW cogeneration and steam plant of Glow Energy Public Company Limited, which uses natural gas as fuel.

2.2 Project layout

Project layout showing the production area/ auxiliary systems and coal stockyard area is shown in Figure 2.2-1 and Figure 2.2-2, respectively. Satellite image showing overall layout is shown in Figure 2.2-3. Land use for each activity of the project is shown in Table 2.2-1. Part of the project area that is located in the vacated land of “the existing plant” consists of production area, transformer area, maintenance shop, and public utility system. The coal stockyard area that is located outside the boundary of “the existing plant” area consists of coal stockyard, run-off pond, and green area. About 5.15% of the project area is allocated as green area which is co-utilized by several facilities (refer to Figure 2.1-2 and Table 2.2-1).

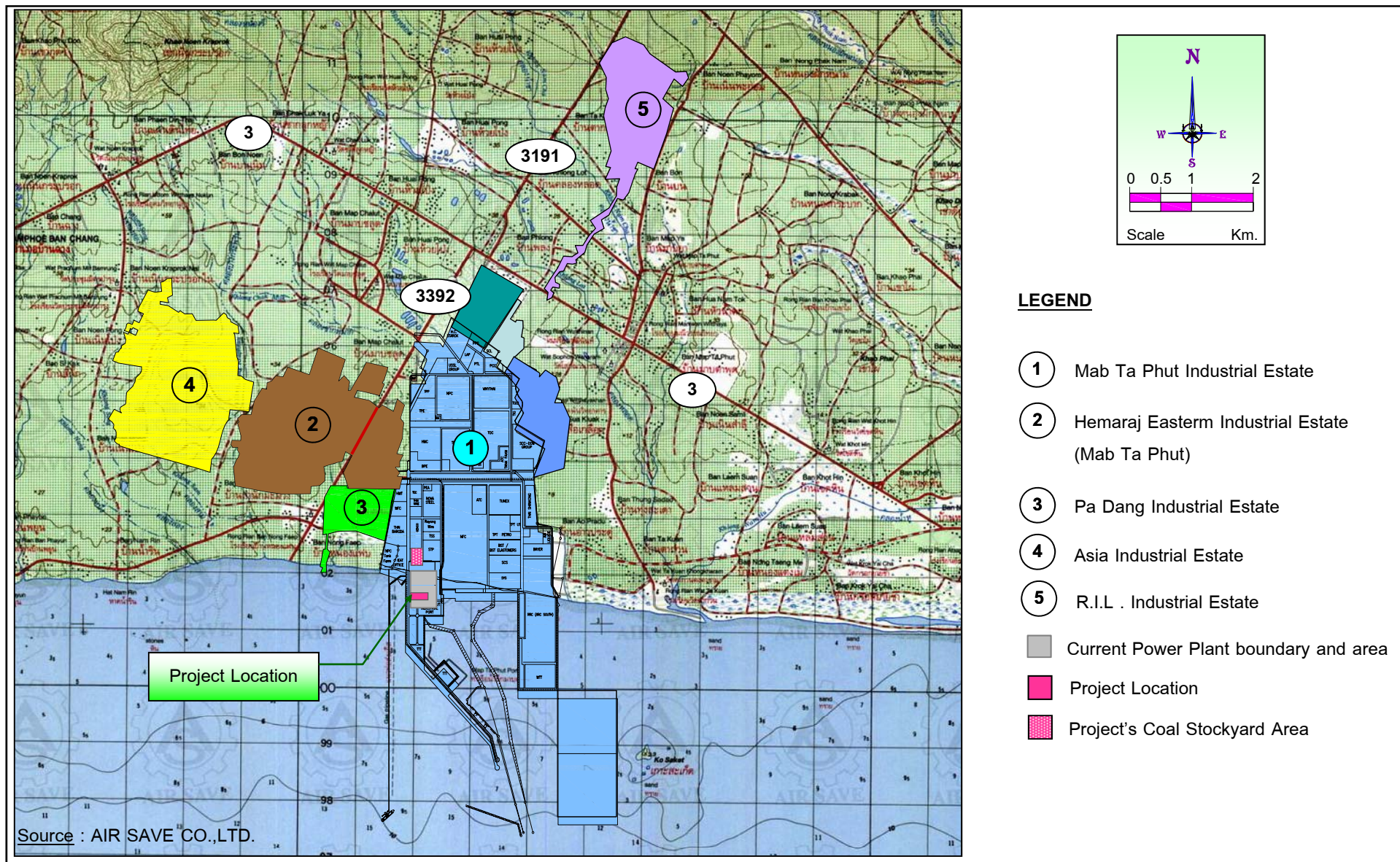


Figure 2.1-1 Project Location

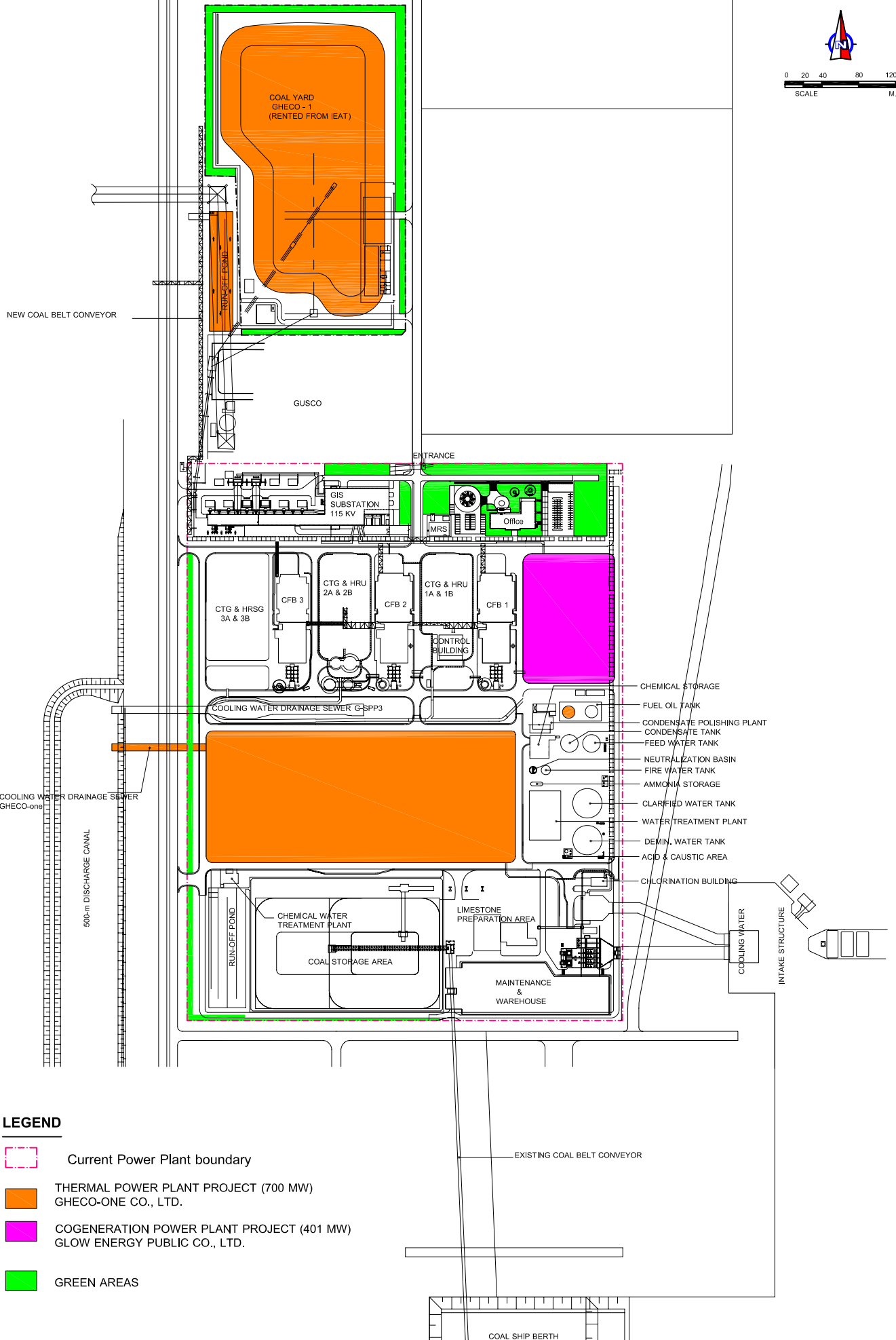


FIGURE 2.1-2 PROJECT LOCATION INSIDE THE EXISTING POWER PLANT BOUNDARY

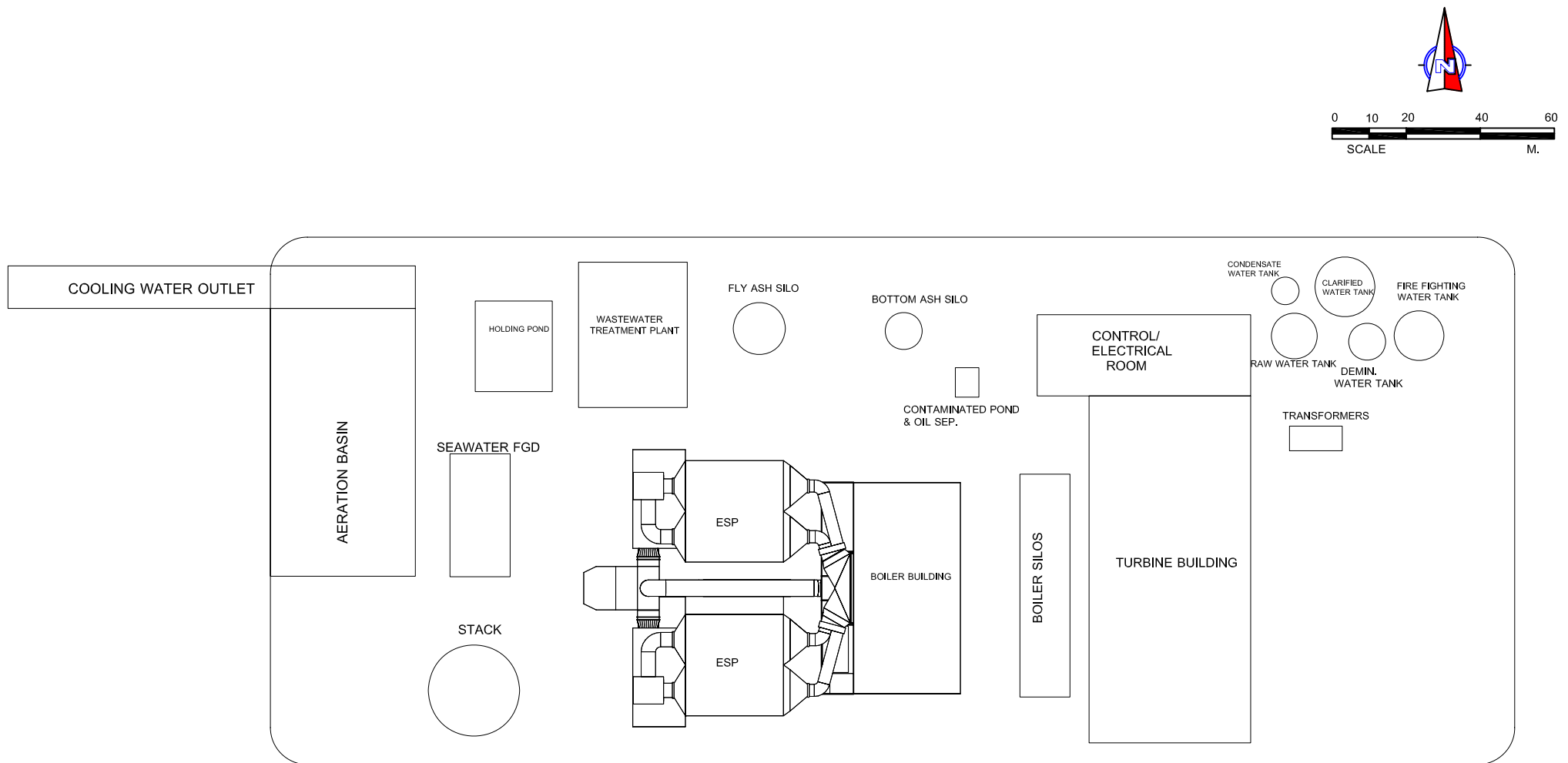


FIGURE 2.2-1 PLANT LAYOUT OF THE PRODUCTION PROCESSES

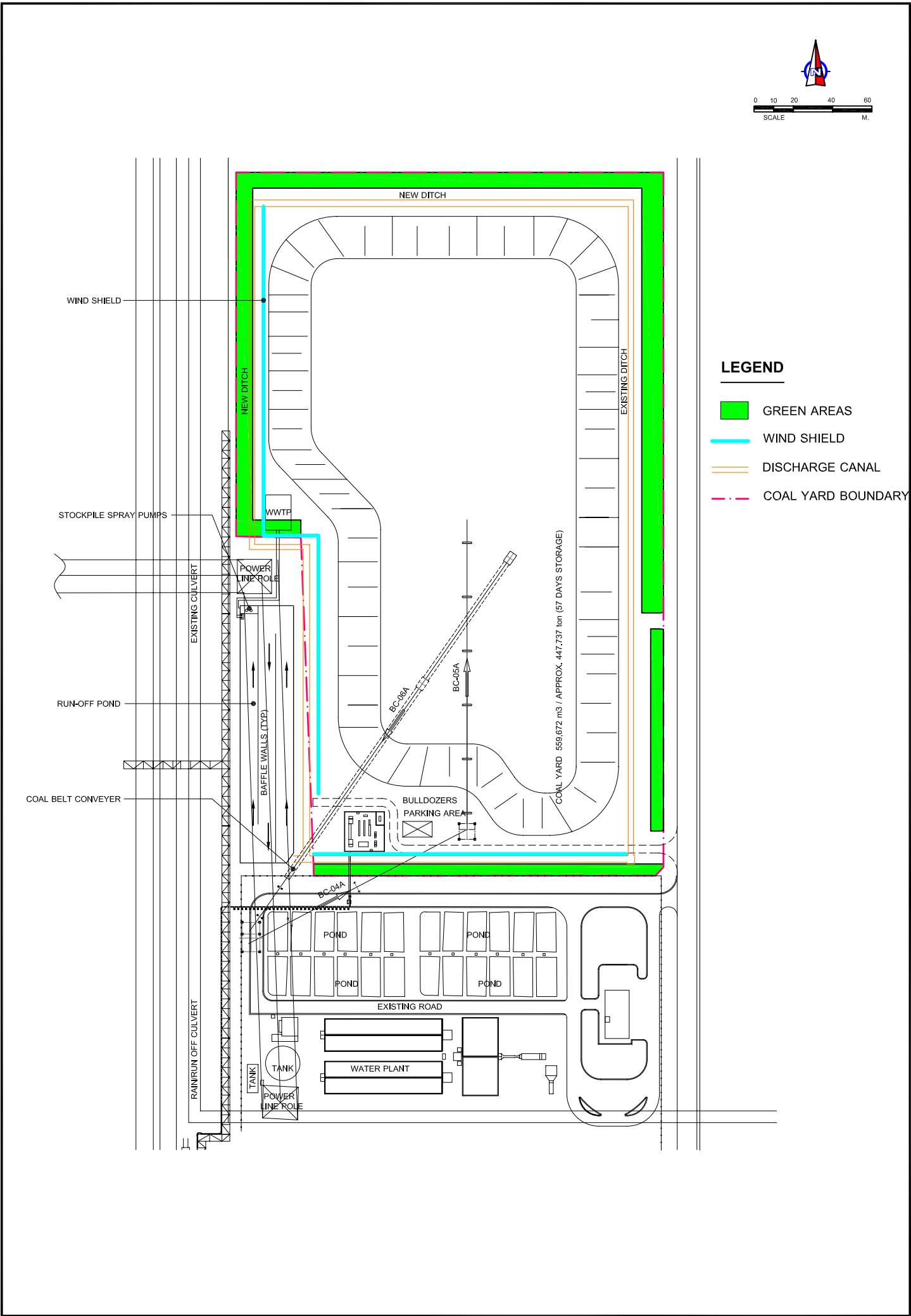


FIGURE 2.2-2 THE APPLICATION PLANT DIAGRAM OF COAL STOCKYARD AREA

TABLE 2.2-1
PROJECT LAND USE

LAND USE	PROJECT AREA		
	SQ.M.	RAI	%
1 Process area	6,342	3.96	4.66
2 Process supporting systems			
- transformer&substation and control building	1,689	1.06	1.24
3 Coal yard and Run-off Pond			
- coal yard	58,000	36.25	42.65
- run-off pond	15,000	9.38	11.03
- green area	7,000	4.38	5.15
4 Utilities			
- chemical storages	2,170	1.36	1.60
- wastewater treatment plant	2,388	1.49	1.76
5 Maintenance building	1,800	1.13	1.32
6 Vacant area	41,611	26.01	30.60
Total	136,000	85.0	100

Remarks :

- The project shares office building with the existing power plant.
- The project coal yard is located to the north direction of the existing power plant boundary.

Source: The EIA report approved by ONEP in May 2008

After considering the information in Section 2.1, it is found that there will be 3 power plant projects being operated in this area. These projects are the 401-MW cogeneration and steam plant of Glow Energy Public Company Limited, this 700-MW thermal power plant project of Gheco-One Co., Ltd., and the 640-MW cogeneration power plant of Glow SPP3 Co., Ltd. These power plants have co-utilized certain part of public utility systems, public services, and auxiliary systems. Glow SPP3 Co., Ltd. is solely responsible for managing all public utility systems, public services, and auxiliary systems in “the existing plant” area. Summarized data on responsible person and pattern of juristic relations of public utility systems, public services, and auxiliary systems that the project co-utilizes with “the existing plant” are shown in Table 2.2-2.

2.3 Fuel

The project uses bituminous coal as principal fuel which has very low sulfur content (not exceeding 1% of sulfur). Most preferred importing source of coal is Indonesia, followed by Australia. The project assures that these supplying sources can adequately supply good quality coal throughout the project life since the existing coal reserve in Indonesia is about 105,000 million tons. Comparing to coal production capacity of Indonesia in 2009, it is found that such mentioned reserve can supply coal for about 400 more years. Considering amount of coal used throughout the project life, it is less than 1% of Indonesian coal reserve.

Procedure used to control quality of coal utilized in the project is summarized in Figure 2.3-1. The control criteria is the use of bituminous coal with maximum sulfur content not exceeding 1% as fuel which is specified as a specification in purchase agreement between the project and a coal supplier. Imported coal quality data is recorded (according to attachment of customs documentation) as well as the company’s coal quality analysis result (consisting of sulfur ratio, ash ratio, heavy metals, and minor constituents in coal).

Coal is transported via sea transport, unloaded at the port of “the existing plant”, and transferred to stockyard by using enclosed conveyor (locations of port, coal stockyard, and conveyor are shown in Figure 2.2-3). The project utilizes about 1,968,600 tons/year of coal while its coal stockyard has storing capacity of about 300,000 tons of which can be used to produce power at least for 45 days.

Table 2.2-2

**SHARED FACILITIES AND UTILITIES AMONG POWER PLANT PROJECTS IN
EXISTING POWER PLANT BOUNDARY**

FACILITIES/UTILITIES	OWNED BY	CO-USERS	TYPE OF LEGAL RELATION
Land use	G-SPP3	G-SPP3 & GHECO-1	GHECO-1 rents from G-SPP3 to locate its production processes and related utilities.
Raw water	G-SPP3	G-SPP3 & GHECO-1	GHECO-1 buys it from G-SPP3 who receives raw water from the IEAT.
Clarified water (clarified water system)	G-SPP3	G-SPP3 & GHECO-1	GHECO-1 buys it from G-SPP3 who owns the clarified water system.
Demineralized water (demineralized water system)	G-SPP3	G-SPP3 & GHECO-1	GHECO-1 buys it from G-SPP3 who owns the demineralized water system.
Sub-station	G-SPP3	G-SPP3 & GHECO-1	GHECO-1 rents it from G-SPP3 to install electric equipment of the project.
Seawater intake station	G-SPP3	G-SPP3 & GHECO-1	GHECO-1 rents it from G-SPP3 to install water pumps of the project.
500-meter discharge canal	G-SPP3	G-SPP3 & GHECO-1	GHECO-1 rents it from G-SPP3 to discharge its effluent. ^{1/}

Remarks : ^{1/} Existing coal conveyor system connecting ship berth to the existing power plant coal yard belongs to the existing power plant, while the new system connecting the existing system to the existing coal yard belongs to the project.

- G-SPP3 = Glow SPP3 Co., Ltd. responsible for the existing power plant
- GHECO-1 = Gheco-One Co., Ltd. responsible for the project

Source: The EIA report approved by ONEP in May 2008

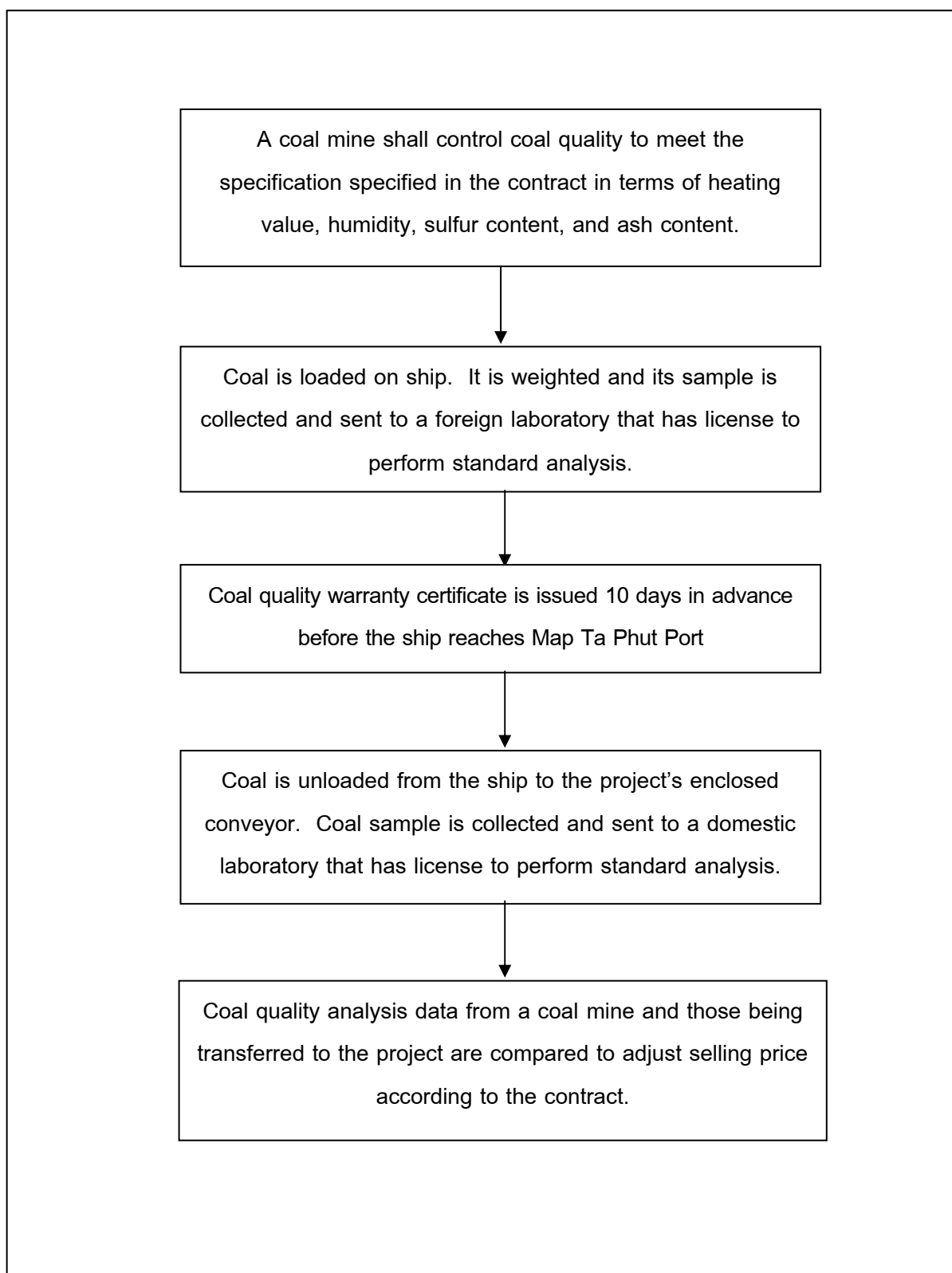


Figure 2.2-3 Coal quality control procedure

Analysis results of general characteristics and constituents of bituminous coal as previously mentioned are shown in Table 2.3-1. It is found that sulfur content is in the range of 0.1-1.0%. Analysis results of heavy metals (arsenic, cadmium, mercury, lead) that may be contaminated in the coal are shown in Table 2.3-2. It is found that arsenic concentration is in the range of 0.73-0.85 mg/kg, while cadmium, mercury, and lead are undetectable since their concentrations are below detection limits of employed analytical method.

The project has reserved diesel oil for use as fuel only during start up period of a boiler, by constructing a 1,700-m³ diesel oil reserve tank within a boundary of concrete bund of diesel oil tank farm of “the existing plant” where an occupied area has already been set aside for construction of additional tank. This concrete bund has capacity to hold all volume of diesel oil in case its storage tank is leaked. Location of the project’s diesel oil reserve tank is shown in Figure 2.2-1.

2.4 Chemicals

Most chemicals in this project are used in auxiliary system and public utility systems. These chemicals are sulfuric acid, sodium hydroxide, coagulant, sodium hypochlorite, ammonia/ammonium anhydrous, and lubricating oil. Details of these chemicals’ consumption rates, transportation, and storage can be summarized as shown in Table 2.4-1. Material safety data sheet (MSDS) of each chemical is summarized as shown in Table 2.4-2 and Table 2.4-3. The chemicals posing health hazards mostly are in form of corrosive liquid which can pose health risk in case of inhalation or skin exposure. Moreover, these chemicals are not in the list of volatile organic compounds prescribed in the Notification of National Environment Board No.30 (B.E. 2550) regarding one year volatile organic compounds in ambient air standards, and in the announcement of the Pollution Control Department regarding 24 hour volatile organic compounds in ambient air observing concentrations. These chemicals are also not considered as carcinogens in the database of International Agency for Research on Cancer (IARC).

2.5 Products

This project is considered as an Independent Power Producer (IPP); therefore, its only product is electricity that will be sold to EGAT. The project has gross power output of 700 MW. About 40 MW of electricity is used within the project thereby making net power output available for sell only 660 MW. The project will transmit its electricity to EGAT via a transmission line of “the existing plant” which has been connected with EGAT’s Rayong Electricity Station 2 (as shown in Figure 2.5-1).

Table 2.3-1

The characteristics and composition of coal that used in the plant

Details	Characteristics and composition of coal		
	Coal producer ^{1/}	Present power plant ^{2/}	Unit
- Total moisture (as received basis)	10-30	18-26	%
- Inherent moisture of coal (air dried basis)	12-20	7-14	%
- Total ash (as received basis)	1-9	4-8	%
- Total sulfur (as received basis)	0.1-1.0	0.1-1.0	%
- Volatile matter (as received basis)	34-46	34-42	%
- Fixed carbon (as received basis)	35-55	37-46	%
- Gross calorific value (as received basis)	4,600-6,300	5,040-6,514	Kcal/kg

Remark : ^{1/} Refer to the analysis of the characteristics and composition of coal from manufacturer

^{2/} Refer to the analysis of the characteristics and composition of coal from 640-MW power plant facility of Glow SPP3 Co., Ltd. (2010)

Table 2.3-2

The analysis result of heavy

Details	Characteristics and composition	
- Arsenic	0.73-0.85	mg/kg
- Cadmium	ND (<2)	mg/kg
- Mercury	ND (<0.1)	mg/kg
- Lead	ND (<10)	mg/kg

Remark : - ND = Non-detectable (Detection limit of cadmium mercury and lead about 2,0.1 and 10 mg/kg respectively)

- The composition of heavy metal from coal by sent the sample to the allowed organization from DIW to analyze.

TABLE 2.4-1
PROJECT'S CHEMICALS

CHEMICAL	SOURCE	PURPOSES	AMOUNT (TONS/YEAR)	TRANSPORT TYPE	FREQUENCY (TRIPS/YEAR)	STORAGE TANK CAPACITY (M ³)
1. Sulfuric acid (H ₂ SO ₄)	domestic	- for condensate polisher regeneration and wastewater neutralization - for treatment of leachate from run-off pond ^{1/} - for treatment of ESP/FGD washed water ^{2/}	41	truck	21	15 3 3
2. Sodium hydroxide (NaOH)	domestic	- for condensate polisher regeneration and wastewater neutralization - for treatment of leachate from run-off pond ^{1/} - for treatment of ESP/FGD washed water ^{2/}	41	truck	21	15 3 3
3. Coagulant	domestic	- for treatment of leachate from run-off pond ^{1/} - for treatment of ESP/FGD washed water ^{2/}	1	truck	1	1.2 1.2
4. Sodium hypochlorite	on-site	- for treatment of intake seawater	1,225	pipng	-	15
5. Ammonia	domestic	- for treatment of boiler water	4	truck	1	5
6. Ammonium anhydrous	domestic	- as a reactant in SCR	1,183	truck	57	100
7. Lube oil	domestic	- for maintenance of machines/equipment	15	truck	2	200-liter drums and kept in a chemical storage building

Remarks - ^{1/} The project does not discharge leachate from the run-off pond out of the project area, except in case of run-off pond overflowing. In such case, the project will have the leachate treated chemically before discharge.

- ^{2/} The washed water from ESP/FGD occurs only when such equipment is being cleaned.

Source: The EIA report approved by ONEP in May 2008

Table 2.4-2

Physical and information security-related raw materials / chemicals. And products related to the project.





Chemical	Physical	Potential	NFPA Code 704 ^{1/}	Personal protective Equipment	Fire Fighting Measure
- Sulfuric acid.	<ul style="list-style-type: none"> - Liquid, colorless - Odorless - Soluble 	<ul style="list-style-type: none"> - Inhalation of fumes can cause irritation or corrosive burns to the mucous membranes of respiratory tract. - Skin contact may cause dry skin, rash 		<ul style="list-style-type: none"> - Vapor and dust respiratory - Gloves - Safety glasses. - Chemical Protective clothing 	<ul style="list-style-type: none"> - Use water spry - Dry chemical powder, foam, carbon carbon dioxide.
- Sodium hydroxide.	<ul style="list-style-type: none"> - Solid, white, - Odorless - Corrosive. 	<ul style="list-style-type: none"> - Inhalation of fumes or acid mist can cause irritation or corrosive burns to the upper respiratory tract. - Skin contact may cause dry skin, rash 		<ul style="list-style-type: none"> - Vapor and dust respiratory - Gloves - Face shield 	<ul style="list-style-type: none"> - Use most appropriate method to extinguish fire. - Do not use water
- Coagulant	<ul style="list-style-type: none"> - Solid (a white crystal.) - Odorless 	<ul style="list-style-type: none"> - Inhalation of dust can cause irritation of respiratory tract with coughins. 	-	<ul style="list-style-type: none"> - Vapor and dust respiratory - Gloves - Safety glasses. 	<ul style="list-style-type: none"> - Use most appropriate method to extinguish fire.

Table 4.2-2 (continued)

Chemical	Physical	Potential	NFPA Code 704 ^{1/}	Personal protective Equipment	Fire Fighting Measure
- Sodium hypochlorite	- Liquid ,Green to yellow - Chlorine-like (strong)	- Inhalation of fumes can cause irritation or corrosive burns to the mucous membranes of respiratory tract. - Skin contact may cause dry skin, rash		- Vapor and dust respiratory - Gloves - Safety glasses.	- Use water spry - Dry chemical powder, foam, carbon carbon dioxide.
- Ammonia	- Gas, colorless - tang - Corrosive.	- Inhalation of fumes more than 25 ppm can cause irritation or corrosive burns to upper respiratory tract. - Skin contact may cause rash		- Vapor and dust respiratory - Gloves - Safety glasses. - Face shield	- Use water spry

Remark : ^{1/} National Fire Protection Association (Blue: Health Hazard, Red: Flammability Hazard, Yellow: Instability Hazard)


Source: Pollution Control Department, 2010, <http://msds.pcd.go.th/>

- www.chemtrack.org/

- GHECO-One Co., Ltd. (2010)

Table 2.4-3

NFPA 704 Rating Explanation for Health Hazard, Flammability Hazard, and Instability Hazard

Hazmat diamond	Rating No.	Blue: Health Hazard	Red: Flammability Hazard	Yellow: Instability Hazard
	4	Very short exposure could cause death or major residual injury.	Will rapidly or completely vaporize at normal atmospheric pressure and temperature, or is readily dispersed in air and will burn readily.	Readily capable of detonation or explosive decomposition at normal temperatures and pressures.
	3	Short exposure could cause serious temporary or moderate residual injury.	Liquids and solids that can be ignited under almost all ambient temperature conditions.	Capable of detonation or explosive decomposition but requires a strong initiating source, must be heated under confinement before initiation, reacts explosively with water, or will detonate if severely shocked.
	2	Intense or continued but not chronic exposure could cause temporary incapacitation or possible residual injury.	Must be moderately heated or exposed to relatively high ambient temperature before ignition can occur.	Undergoes violent chemical change at elevated temperatures and pressures, reacts violently with water, or may form explosive mixtures with water.
	1	Exposure would cause irritation with only minor residual injury.	Must be heated before ignition can occur.	Normally stable, but can become unstable at elevated temperatures and pressures.
	0	Poses no health hazard, no precautions necessary.	Will not burn when exposed to temperature of 815.5 °C for 5 minutes.	Normally stable, even under fire exposure conditions, and is not reactive with water.

Remark: Besides rating for health hazard, flammability hazard, and instability hazard, the white "special notice" area can contain several symbols.

They are Reacts violently or explosively with water (W), oxidizing (OX), acidic (Acid), alkaline (Alk).

Source: Pollution Control Department, 2010



FIGURE 2.5-1 CONNECTING POINT BETWEEN PROJECT AND EGAT'S TRANSMISSION LINES

2.6 Transportation

(1) Construction period : this period is expected to take about 38 months. Transportation of construction material and workers mainly relies on National Highway No.3 and National Highway No.3191 with maximum frequency of about 50 vehicles/day (transportation of construction material 25 vehicles/day and transportation of construction workers 25 vehicles/day).

(2) Implementation period : transportation during this period is mainly conducted for transportation of fuel and chemicals, and transportation of the project's employees which can be prescribed below.

- Transportation of coal: a supplier delivers coal to the project by ship. Coal is unloaded at a port of "the existing plant" before being transferred through an enclosed conveyor to the project's coal stockyard. Frequency of coal transport via ship is about 33 trips/year. When combining with coal transportation of "the existing plant", total coal transport will be about 52 trips/year (about 4 trips/month). Coal unloading and transfer to the project area takes about 5-7 days/trip. At present, the port has capacity to manage 60,000-ton ship which is able to handle the project's coal transporting ship adequately.

- Transportation of chemical: overall chemical transportation via truck is about 103 trucks/year by using mainly National Highway No.3 and National Highway No.3191.

- Transportation of wastes: wastes are classified into 2 types. One is wastes generated from production process (bottom ash and fly ash) which are sent to licensed waste process for disposal or used as substituted material in cement kiln, with maximum frequency of 43 vehicles/day. The other is wastes generated from auxiliary systems such as spent resin, spent catalyst, used lubricating oil, etc. and wastes generated from employees' activities. This latter has maximum transporting frequency of 11 vehicles/day.

- Transportation of employees: the project has about 100 employees. It has arranged vans and buses to transport employees. Certain employees travel to work by their personal car. It is anticipated that transportation frequency using van, bus, and personal car is 3 vehicles/day, 2 vehicles/day, and 15 vehicles/day, respectively.

2.7 Production process

Major equipments are boiler and Steam Turbine Generator (STG), 1 set each (details of these equipments are shown in Table 2.7-1). Power production process can be divided into 2 major steps that are steam generation step and power generation step, which can be prescribed as follows. (Production flow diagram and mass balance are shown in Figure 2.7-1 and Figure 2.7-2, respectively).

(1) Steam production - High-pressure steam is produced from the pulverized coal fire (PC) boiler. At the beginning of the steam production process, coal is transported from the stockyard to a silo for temporary storage and then sent to crushers and grinders to pulverize coal to proper powder size for feeding as primary fuel into the boiler combustion chamber. The flue gas comes in contact with heat transfer tubes inside which de-mineralized water is being circulated and heated up into steam. In turn, this steam is fed to the steam turbine to drive the generator to generate electricity. The flue gas exiting the boilers is consisted of NO_x , SO_2 and TSP (fly ash). These pollutants are suppressed and controlled within the emission standard before being emitted to atmosphere.

(2) Power generation - High-pressure steam generated by the boiler is injected into steam turbine converting it into rotating mechanical power to drive its shaft and the generator shaft that is coupled together. The generator shaft with its built-in stator is then spinning over magnetic field producing electrical current between two terminals where exist voltage potential. Steam exiting the steam turbine at low energy level is then cooled and condensed into condensate and pumped back into the boiler for reheating.

2.8 Auxiliary system and public utility system

2.8.1 Water supply system

(1) Construction period - It is expected to have as many as 2,500 construction workers (during certain period). Workers' housing is located outside the project area and outside the boundary of the industrial estate. Water consumption rate by construction workers is expected to be about $125 \text{ m}^3/\text{day}$, while water used in construction activities is expected to be about $20 \text{ m}^3/\text{day}$. Consequently, overall water demand during construction period is about $145 \text{ m}^3/\text{day}$. The project receives water from the 640-MW power plant facility of Glow SPP3 Co., Ltd. (the existing plant) for above mentioned uses. A contractor is required to adequately provide construction workers with bottled drinking water.

TABLE 2.7-1
PROJECT'S PROCESS EQUIPMENT

EQUIPMENT	UNIT	DETAIL
1. Generators (1 set) <ul style="list-style-type: none"> - shaft speed - output at generator terminals (gross power) - voltage 	rpm MW kv	3,000 700 23
2. steam turbine <ul style="list-style-type: none"> - Type - HP steam inlet flow - HP steam inlet temperature - HP steam inlet pressure - IP steam inlet flow - IP steam inlet temperature - IP steam inlet pressure - LP steam inlet flow - LP steam inlet pressure 	- t/hr °C bar (a) t/hr °C bar (a) t/hr bar (a)	1 HP + 1 IP+ 2 LP 2,100 566 242 1,727 566 52 1,575 5
3. Boiler (1 set) <ul style="list-style-type: none"> - Main fuel / start-up fuel - steam output flow - HP/Reheat (IP) steam output temperature - HP steam output pressure - Coal input, LHV - NO_x control - SO₂ control - TSP control 	- t/hr °C bar (a) MJ/s - - -	Bituminous coal / Diesel 2,100 566 242 1,601 Selective Catalytic Reduction (SCR) Sea Water Flue Gas Desulphurization (SW-FGD) Electrostatic Precipitator (ESP)

Source: The EIA report approved by ONEP in May 2008

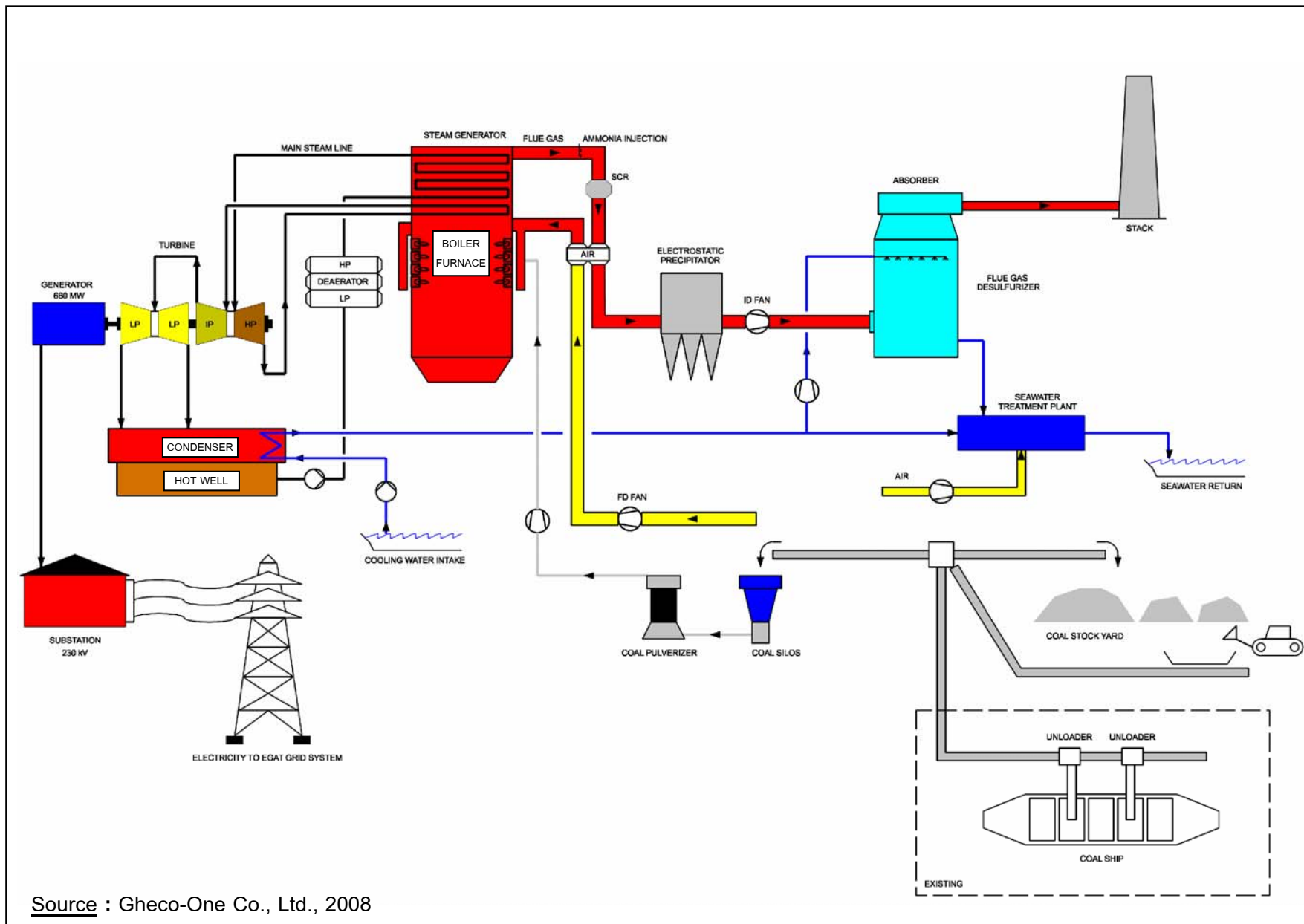
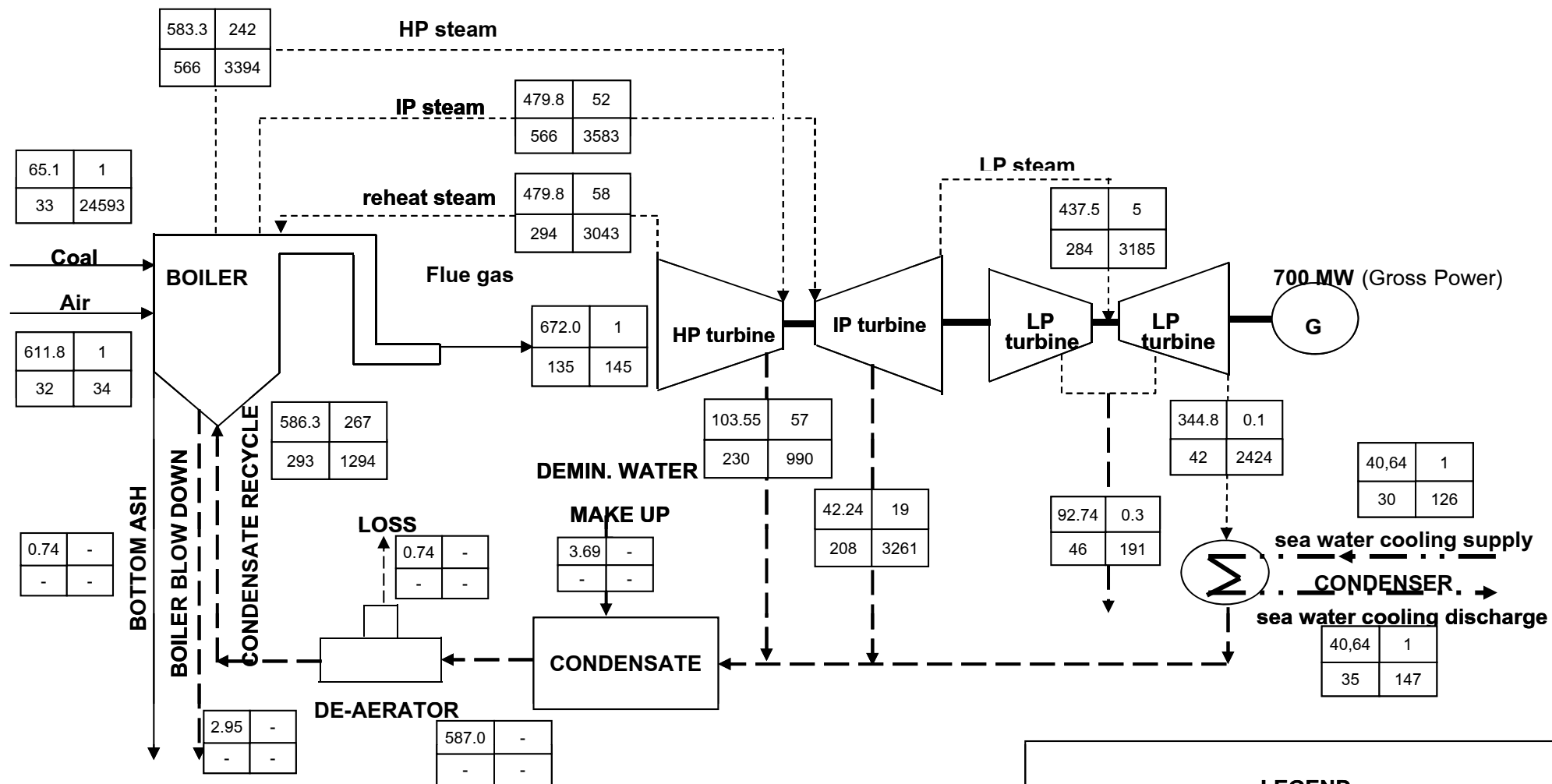


FIGURE 2.7-1 PROCESS FLOW DIAGRAM



Source : Gheco-One Co., Ltd., 2008

FIGURE 2.7-2 MASS AND ENERGY BALANCE

(2) Implementation period : overall freshwater demand is 1,062 m³/day (or 1.51 m³/MW). Since the project is located near the coast, seawater is available to be utilized in cooling system as substitute for freshwater. The project also receives freshwater from the 640-MW power plant facility of Glow SPP3 Co., Ltd. (the existing plant) for uses during this period. Nonetheless, “the existing plant” now has installed clear water production unit to produce water for its own use and to sell to outside factories. The project’s water uses can be divided into 4 types that are raw water, clear water, de-mineralized water, and seawater (as detailed in Table 2.8.1-1 and Figure 2.8.1-1).

The project uses about 42 m³/sec of seawater which mostly is for cooling purpose at condenser to condense used steam into condensate before circulating back to steam production step. Some seawater is used for cooling at various equipments (as shown in Figure 2.8.1-2). Certain used seawater from cooling system is used again in a SO₂ removal unit to remove sulfur dioxide generated in a boiler (as shown in Figure 2.8.1-3 and Figure 2.8.1-4).

2.8.2 Cooling system

The project utilizes seawater as cooling water in various equipments including a condenser by designing as once-through cooling water system. Overall seawater consumption rate is about 42 m³/sec which is divided into 40-41 m³/sec at a condenser and 1-2 m³/sec at other equipments. Certain portion of used seawater (about 6-7 m³/sec) is used again to remove sulfur dioxide generated in a boiler before emitting through boiler’s stack. After passing the SO₂ removal unit, used seawater is collected into a ditch or an aeration basin to normalize its pH and to completely dissolve SO₂ or transform into sulfate. All used seawater will be drained back to the sea through the 500-m seawater drainage ditch which is in the south-west of “the existing plant”.

The existing plant has already constructed principal structure of seawater intake and pumping station since the plant construction (in the south-east of the existing plant area). At an entrance of seawater intake, bar screen is installed to remove garbage and traveling screen is installed to screen out small aquatic animals in pumped water. These screens also prevent clogging and damages of pumps and equipments of cooling system. However, at present these structures are only 40% utilized. Consequently, it is not necessary to construct these structures for this project development. Only 4 sets of pumps are additionally installed for this project.

TABLE 2.8.1-1
WATER CONSUMPTION

ACTIVITY	QUANTITY (CU.M./DAY)			
	RAW WATER	CLARIFIED WATER	DEMINERALIZED WATER	SEAWATER
1. DOMESTIC USE	-	5	-	
2. PROCESS CONSUMPTION				
2.1 Coal yard make up	340	-	-	-
2.2 Spray in fly ash silo	360	-	-	-
2.3 Miscellaneous drain	-	10	-	-
2.4 Boiler water make up	-	-	319	-
2.5 Condensate polisher make up			28	
2.6 Cooling system and for SW-FGD unit	-	-	-	3,621,720
TOTAL	700	15	347	3,621,720

Remarks : Raw water, clarified water and demineralized water is supplied from the existing power plant.

Source: The EIA report approved by ONEP in May 2008

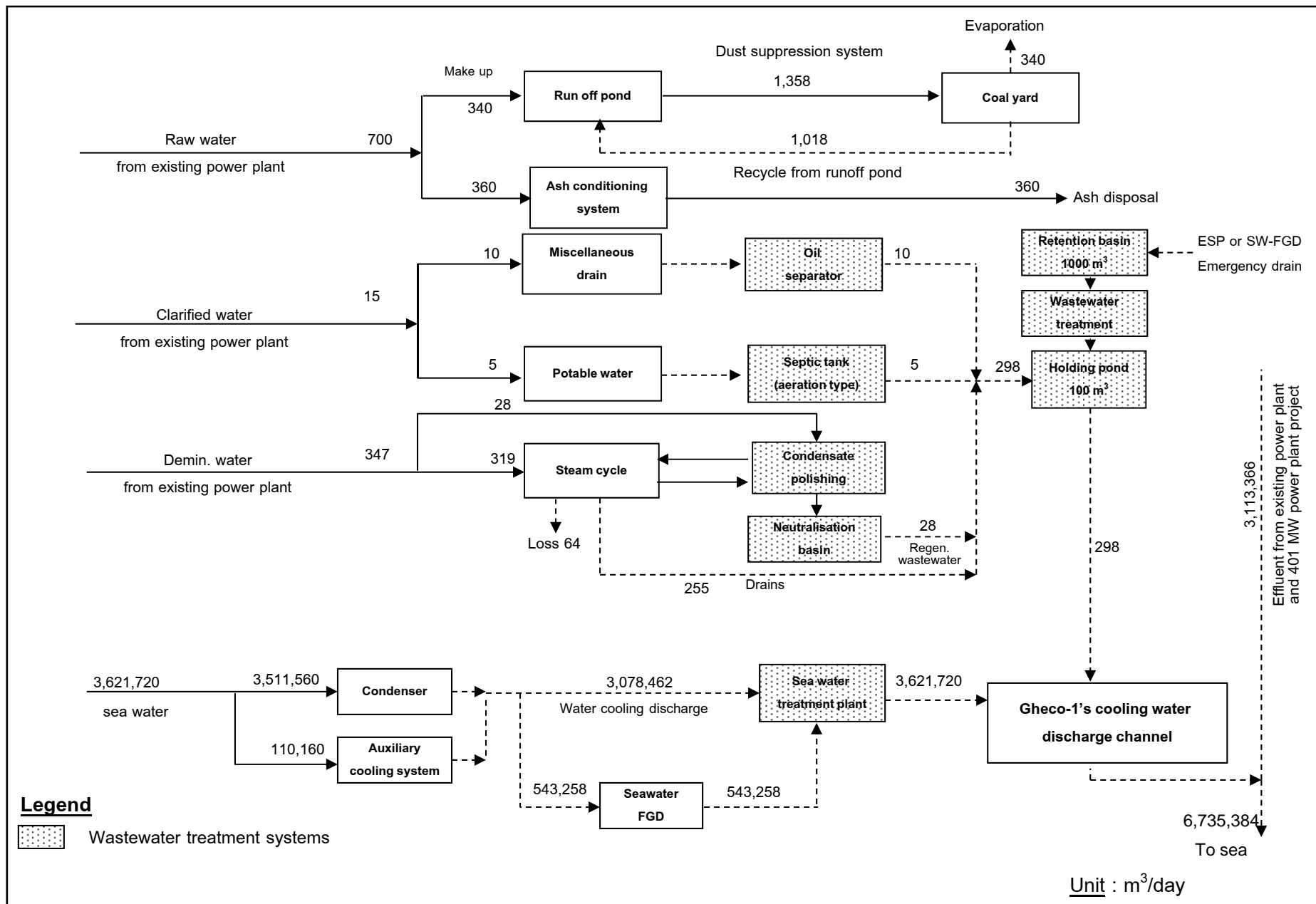


FIGURE 2.8.1-1 WATER BALANCE OF 700 MW POWER PLANT PROJECT

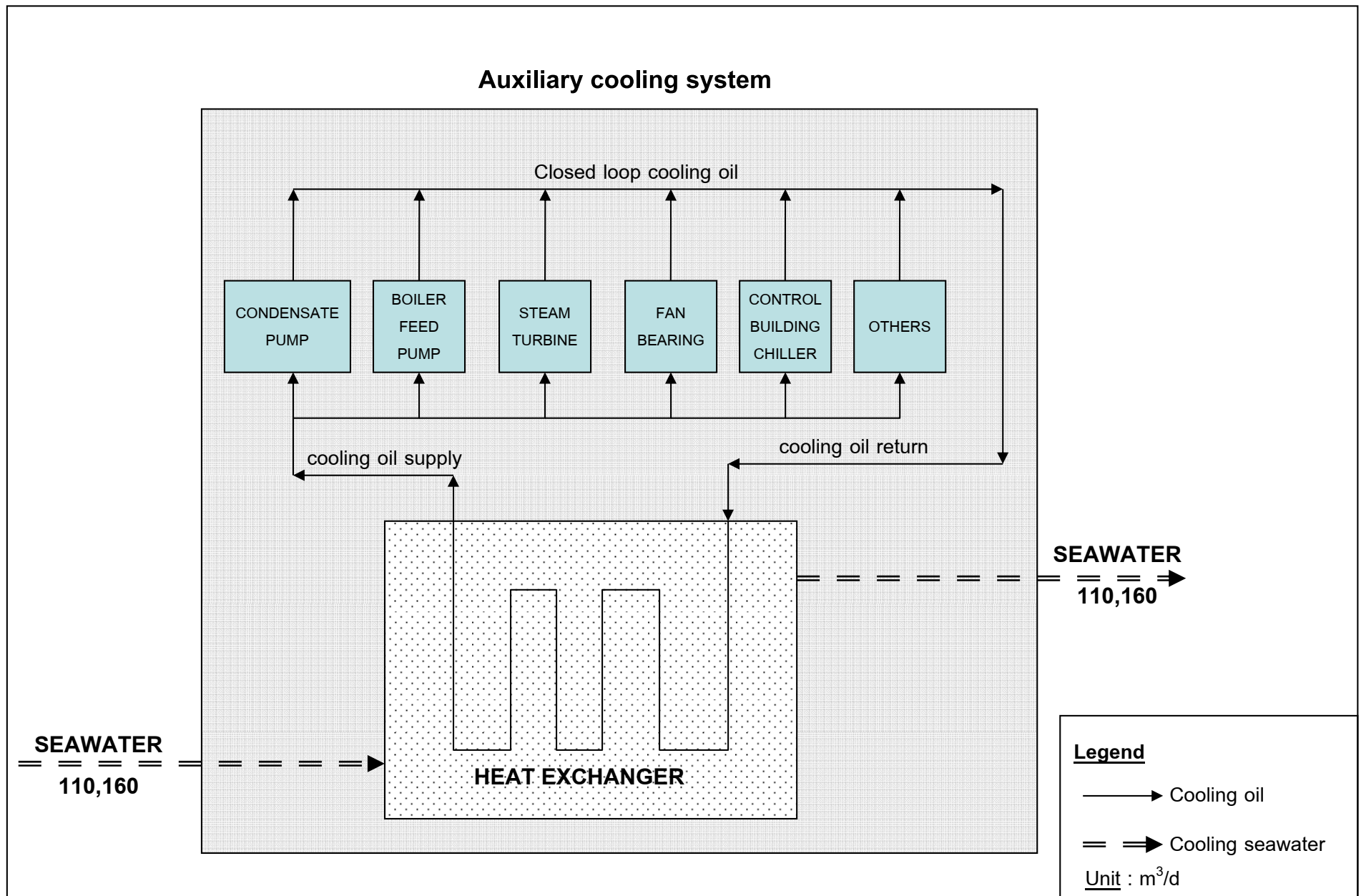


FIGURE 2.8.1-2 AUXILIARY COOLING SYSTEM

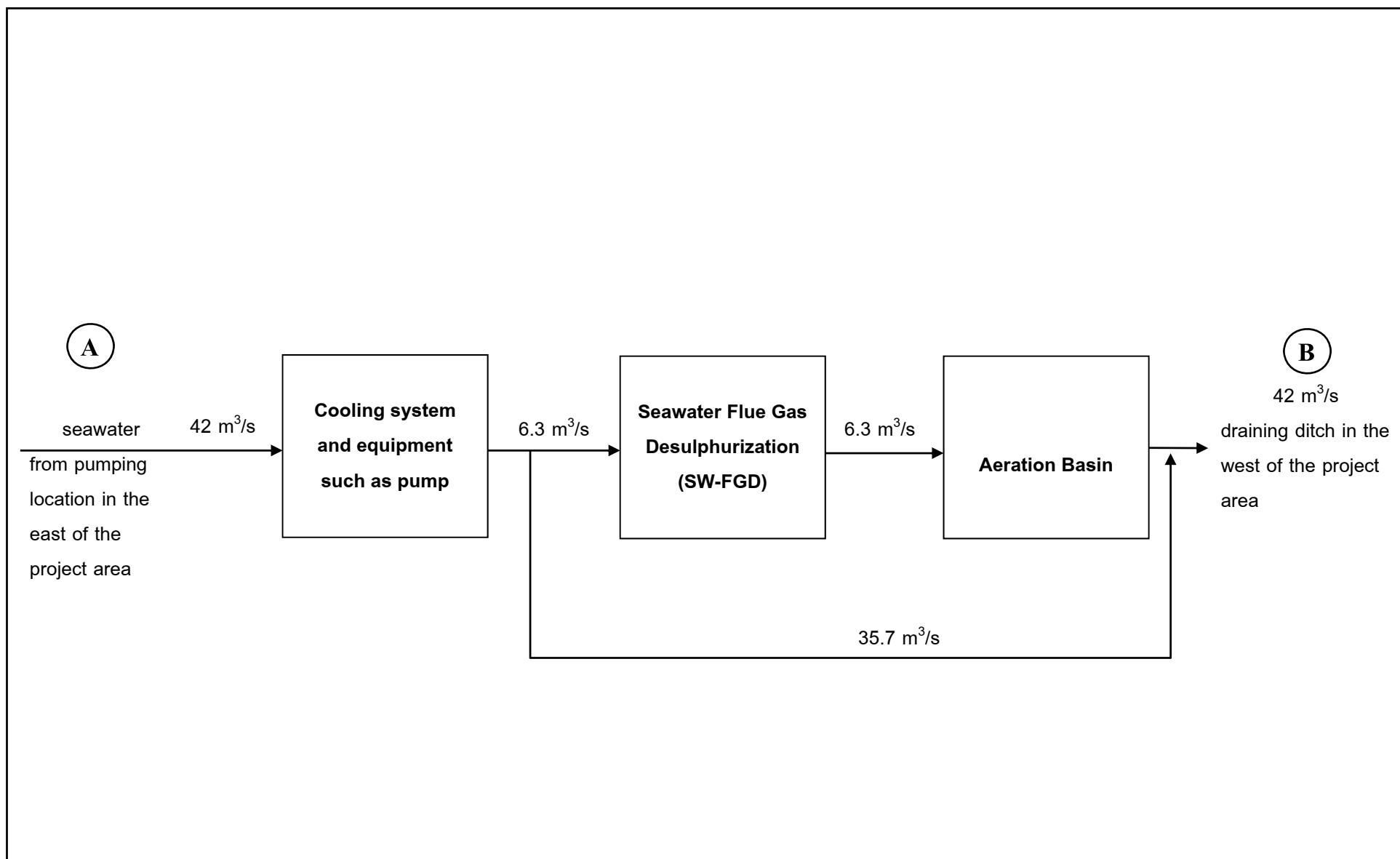


Figure 2.8.1-3 Flow diagram for the project's utilization of seawater



Figure 2.8.1-4 Sea pump position and outfall pit

2.8.3 Management of coal stockyard area.

Coal is transferred from the existing plant's port through a conveyor system and stored at the project's stockyard with area of about 50 rai (only 36.25 rai is used for coal storage, the rest is for run-off pond, wind shield, and green area). The stockyard is located outside the existing plant area in the north. It is clearly separated from the existing plant's coal stockyard and is designed to have wind shield to prevent dust distribution by installing on both sides of the stockyard (refer to Figure 2.2-2) which are in the south and the west directions. The north of the stockyard is adjacent with a landfill of General Environmental Conservation Public Co., Ltd. (GENCO) which is about 20 meters high that can be considered as large wind shield. However, if there is a change in land use of GENCO's landfill, the project will revise its measure to ensure appropriate impact prevention and mitigation. Wind shield is designed to have holes about 50% of cross-sectional area to reduce wind speed facing the wind shield. The wind shield is about 50 feet tall (or about 15 meters) which is consistent with the height of the project's coal pile. The project's wind shield has wind speed reduction efficiency of about 20-60% (example of wind shield is shown in Figure 2.8.3-1).

2.8.4 Coal conveyor system

Coal conveyor system that transfers coal from the port to the stockyard can be divided into 2 parts as follows.

- Coal conveyor system of the existing plant: it is an existing conveyor system that starts from the port and ends at the existing plant's coal stockyard (refer to Figure 2.2-3). It is designed as an enclosed system to prevent distribution (as shown in Figure 2.8.4-1). Its maximum transferring capacity is 1,500 tons/hour, while the existing plant uses only 125 tons/hour of coal. This project uses about 235 tons/hour of coal. Nonetheless, the existing plant and this project separately transfer their coal based on their different shipments.

- Coal conveyor system of this project: it is connected with the conveyor system of the existing plant so that coal can be transferred to the project's stockyard (refer to Figure 2.2-3). The project's conveyor is a pipe conveyor or a tube conveyor as shown in Figure 2.8.4-2 with transferring capacity of 1,500 tons/hour, while the project uses only about 235 tons/hour of coal. The conveyor is laid on steel foundation. When coal transfer is started, the conveyor will automatically wrap into a closed cylinder and will open when reaching the end destination. This type of conveyor has advantage of being self-automatically closed system thereby helping in reduction of dust distribution, being smaller system, and being flexible for transportation through curvy direction or change in direction.

FIGURE 2.8.3-1 PROJECT'S WIND SHIELD STRUCTURE

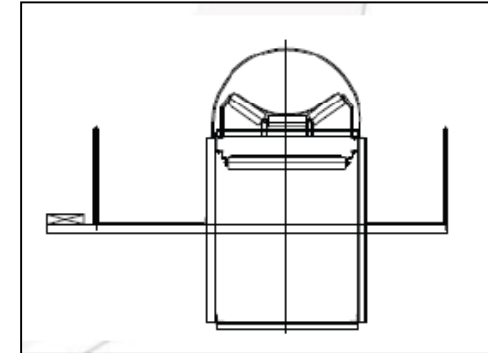
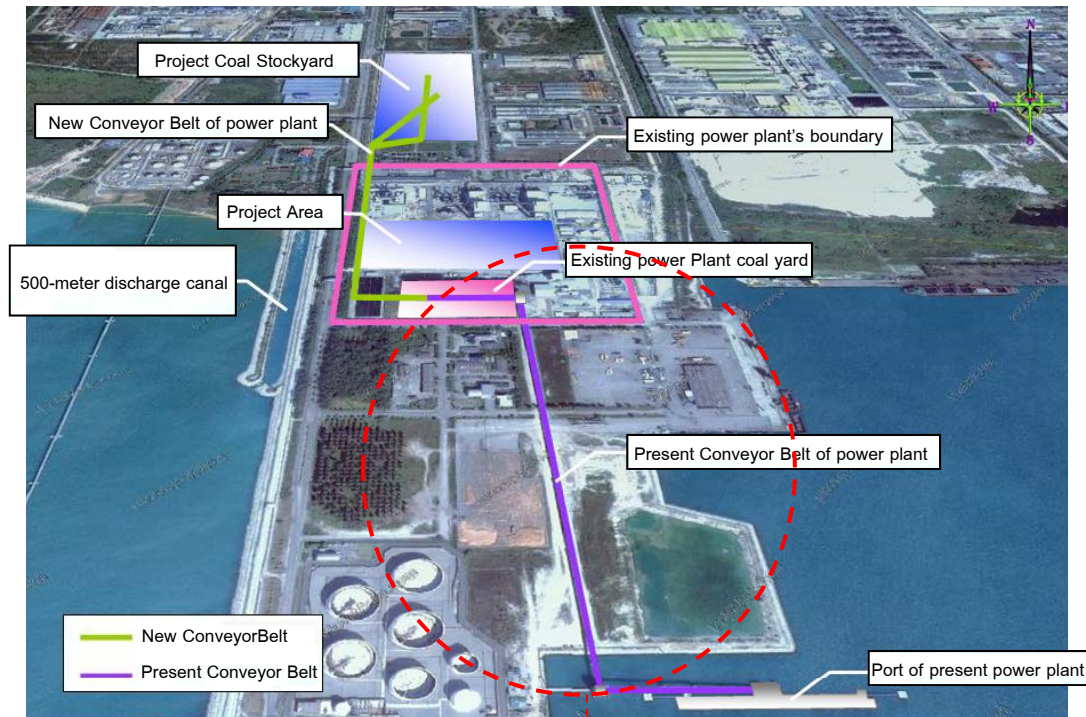


Figure 2.8.4-1 Coal Conveyor Belt of present power plant

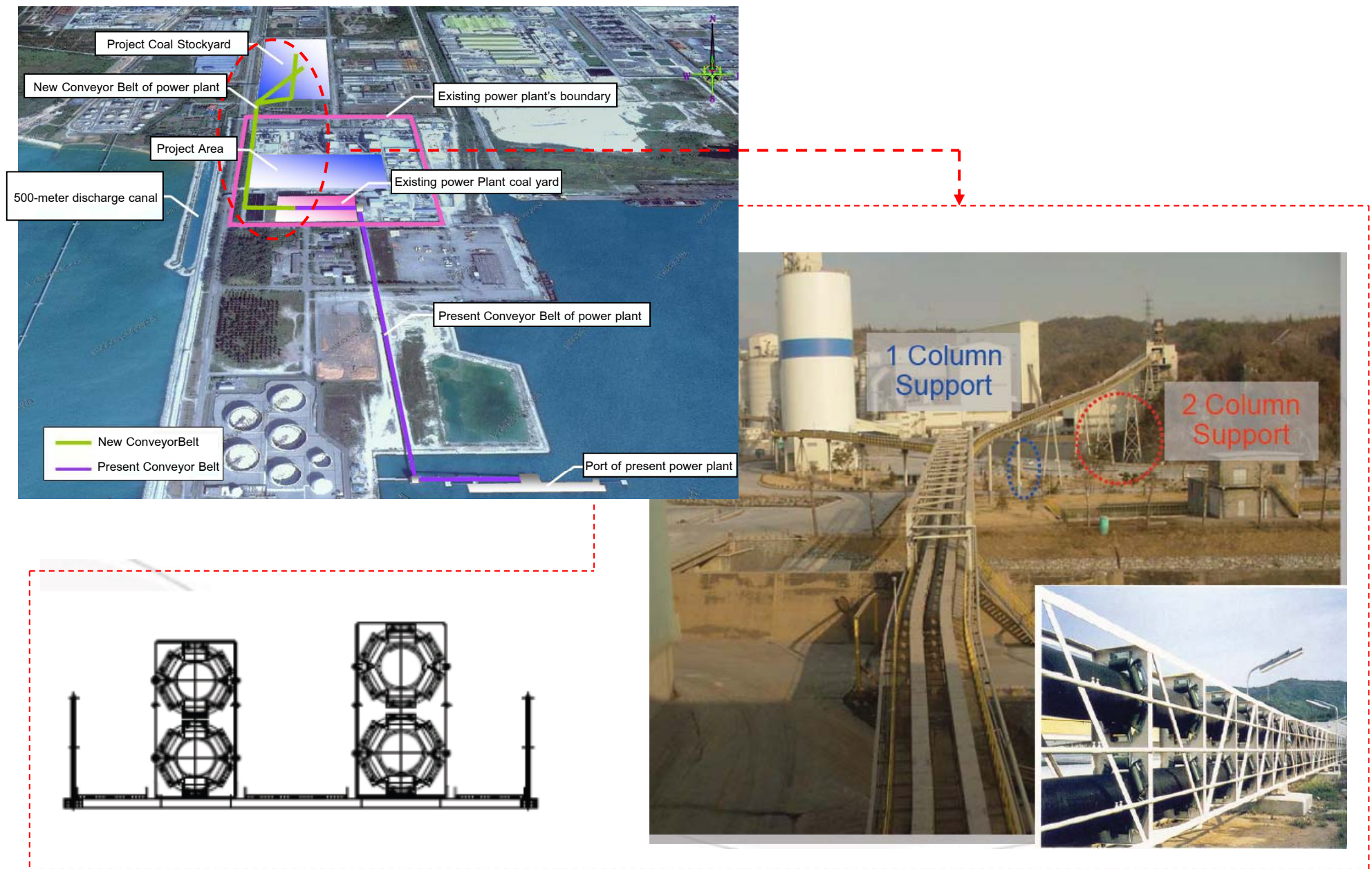


Figure 2.8.4-2 New Coal Conveyor Belt of the plant

2.8.5 Coal pulverization system

A pulverizer is used to crush coal into powder before injecting into the project's boiler. This pulverizer is standard equipment and a part of this boiler type, thereby calling this boiler type as pulverized coal fired boiler (PC). A boiler has 6 sets of pulverizers (5 sets in operation and 1 standby set) which are located near a boiler inside a boiler building. Each set of pulverizer is an enclosed system to prevent coal dispersion (as shown in Figure 2.8.5-1). In addition, preventive maintenance plan is established to minimize potential of coal dispersion from a pulverizer by regularly inspecting machinery, equipment, joints, and seals. If tendency to cause damage or malfunction is found, the project will fix or change such equipment immediately before it becomes damaged or malfunctioned. Additionally, there is one set of standby pulverizer to be used when any working pulverizer is malfunction.

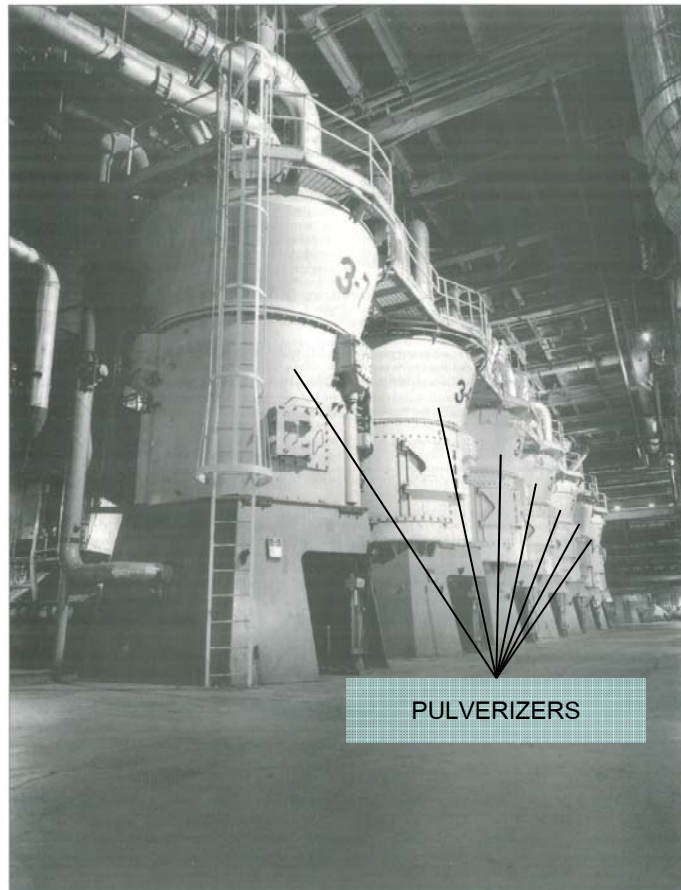
2.8.6 Drainage and flood prevention system

(1) Construction period the project has constructed drainage system to drain rainwater from the project area into the existing plant's draining ditch that has already been designed to handle rainwater from the project area.

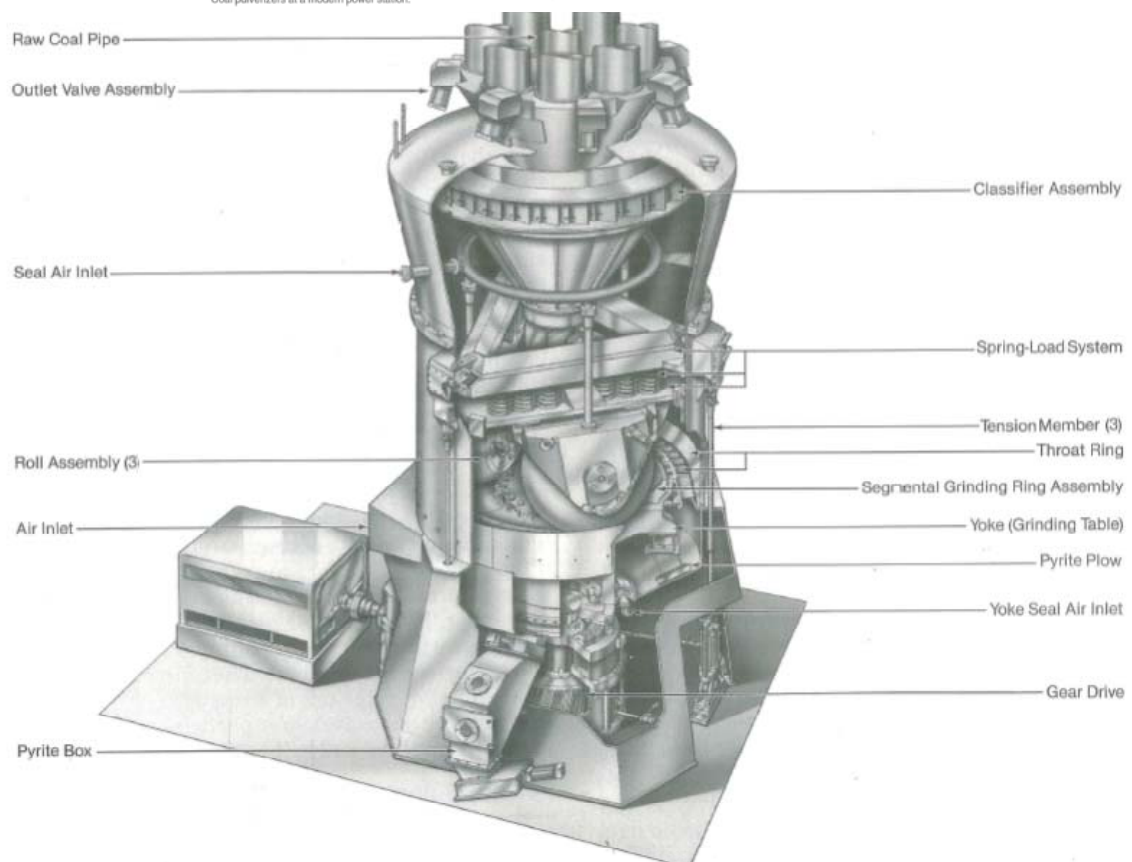
(2) Implementation period the project has clearly separated its rainwater drainage system from wastewater drainage system. Rainwater drainage system can be divided into 2 parts that are drainage system for uncontaminated rainwater and drainage system for potentially contaminated rainwater, which can be described as follows.

- Drainage system for uncontaminated rainwater: the project has designed this drainage system in the building area with roof or production unit area without chemical use. This uncontaminated rainwater is collected into the project's drainage ditch

- Drainage system for potentially contaminated rainwater: it is rainwater falling in the area with potential contamination. There are 2 types of this area. One is coal stockyard area. At the stockyard, the project has constructed draining ditch around the stockyard to collect all run-off into 12,000-m³ run-off pond. Normally, this run-off will not be discharged to outside environment but rather be recirculated for watering the stockyard. However, the project has prepared a run-off treatment system in case of emergency that may need to discharge this run-off to outside environment. The other type is other production areas such as transformer area and pump station, which constitutes around 1,075 m². These areas may be contaminated with oil leaking from related equipments. The first 30 millimeter of rainwater falling in this area is collected into contaminated rainwater holding pond (rainwater management flow chart is shown in Figure 2.8.6-1). If contamination is found in the rainwater holding pond, the project will treat this rainwater with a 10-m³ oil separator.



Coal pulverizers at a modern power station.



Source : Gheco-One Co., Ltd., 2008

FIGURE 2.8.5-1 SAMPLE OF PROJECT'S PULVERIZERS IN A COVERED BUILDING

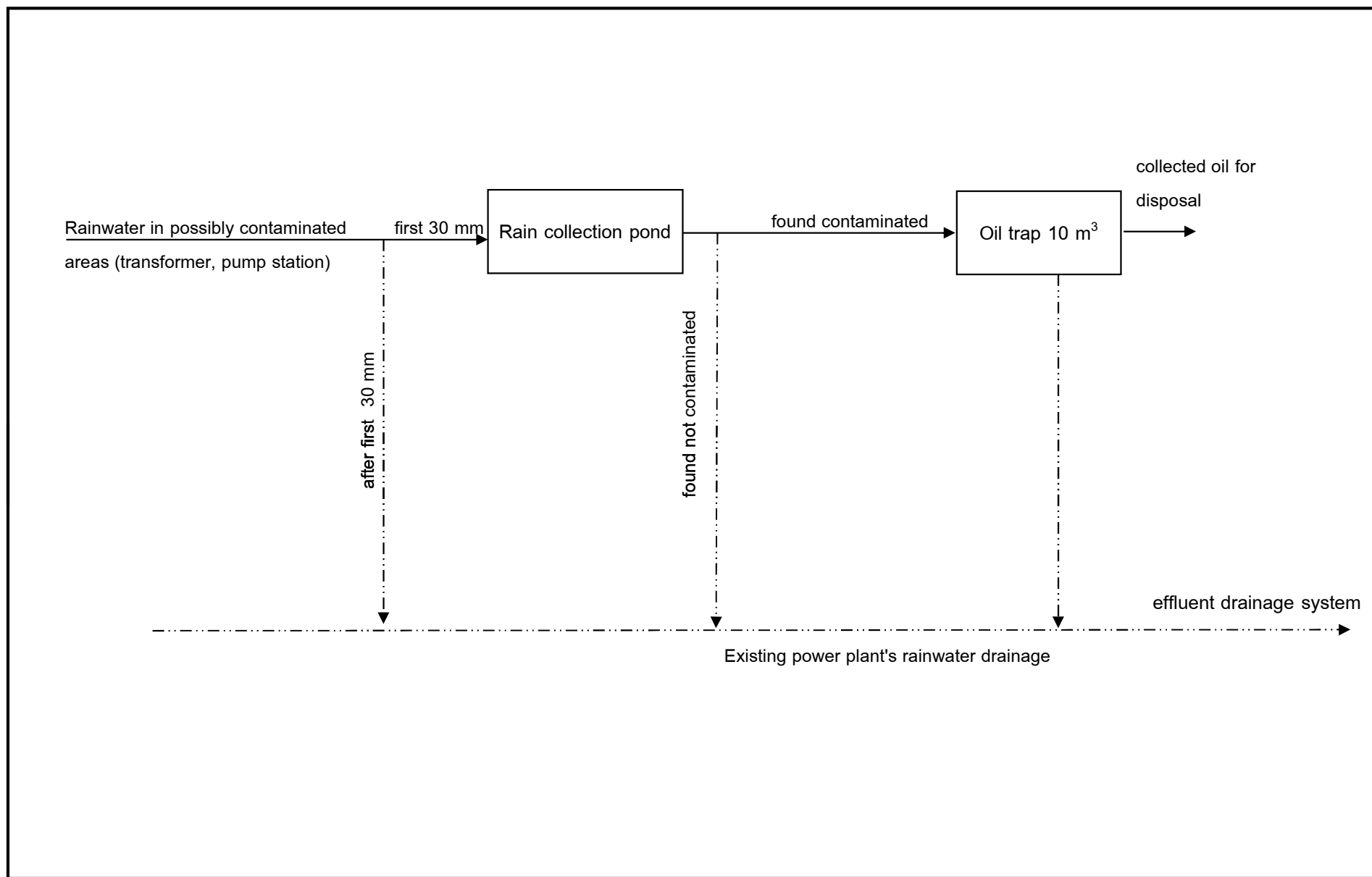


FIGURE 2.8.6-1 CONTAMINATED RAINWATER MANAGEMENT DIAGRAM

2.8.7 Sodium hypochlorite production system

Sodium hypochlorite is used as biocide to kill microbes in seawater that is used in the project's cooling system. The project produces its sodium hypochlorite by using electro-chlorination system (sodium hypochlorite production flow cart is shown in Figure 2.8.7-1) and pumped seawater as raw material. The electro-chlorination system has production capacity of 3.5 tons/day (consisting of 2 production units, one in operation and the other for standby). Produced sodium hypochlorite is stored in 15-m³ tank.

2.9 Pollution control

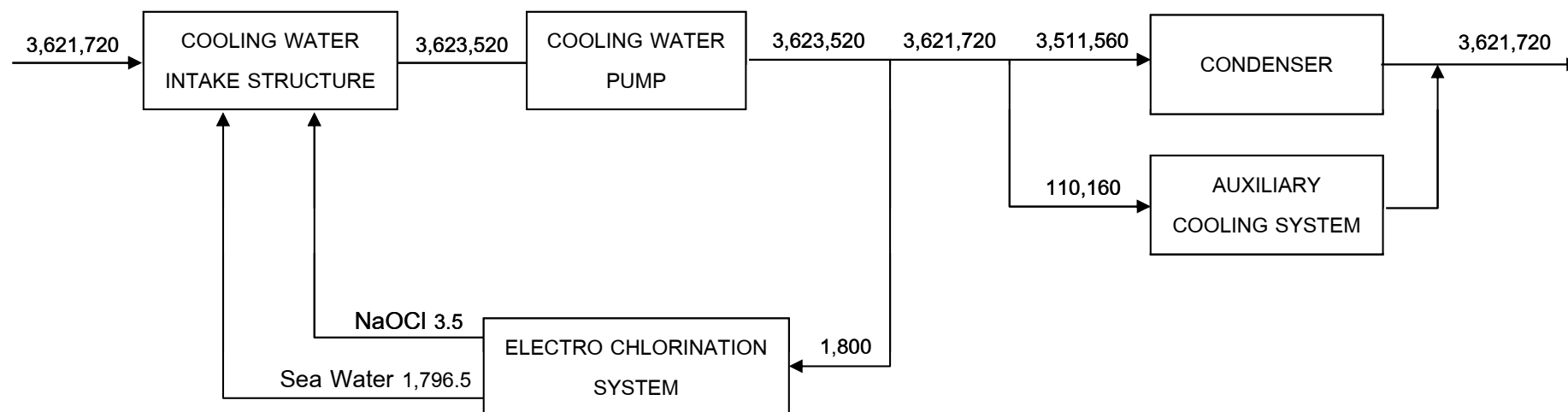
2.9.1 Air pollution

(1) Construction period - generated air pollutants are particulate matter from construction activity and particulate matter from transporting vehicle for construction material. The project has required its contractor to spray water in the construction area having potential of dust dispersion (specifically in case of no rain), to maintain construction equipment and machinery in good condition, and to set up vehicle speed limit within the construction area to minimize these generated pollutants.

(2) Implementation period - the project's major air pollution generating source is one set of boiler (has only 1 stack) that uses bituminous coal with less than 1% sulfur content as fuel. Significant air pollutants generated from fuel combustion of boiler are nitrogen oxides (NO_x), sulfur dioxide (SO₂), and particulate matter.

The project's approach in controlling air pollution is based on management principle of the National Environment Board's resolution at the meeting no.6/2550 on 9 April 2007 such that overall emission rate of NO_x and SO₂ in the area is not increased when comparing to the emission rate prior to the project development, as well as maximum concentration at ground level of air pollutants generated from existing generating sources prior to the project development. To achieve that, the following procedures have been employed.

(a) The project has employed Best Available Technology (BAT) for its air pollution control system which can control air pollutant emission rate at well below the Thai's national standard and also consistent with the EU standard (as shown in Table 2.9.1-1). These technologies are as follows.



Unit: tons/day

FIGURE 2.8.7-1 FLOW CHART OF SODIUM HYPOCHLORITE PRODUCTION PROCESS

TABLE 2.9.1-1**CONCENTRATION AND LOADING OF AIR POLLUTION**

STACK	STACK CHARACTERISTIC		EXHAUST GAS			CONCENTRATION ^{2/}			LOADING ^{2/} (g/s)		
	HEIGHT (m)	DIAMETER (m)	TEMP. (°C)	VELOCITY (m/s)	FLOW RATE ^{1/} (Nm ³ /s)	NO _x (ppm)	SO ₂ (ppm)	TSP (mg/Nm ³)	NO _x	SO _x	TSP
PC Boiler	150	6.8	80	17.8	703.0	56	53	55	74.07	97.53	38.67
STANDARD^{3/}						350	320	120			

Remarks : ^{1/}At 1 atm, 760 mm.Hg, 25 °C dry condition and 7% excess O₂

^{2/}Designed values (at excess O₂ 7%)

^{3/}Standard from Ministry of Industrail Works : concentration of exhausted gas from power plant, 2004

Source: The EIA report approved by ONEP in May 2008

- **Use of Pulverized Coal Fire Boiler (PC Boiler)** PC boiler can be considered as one of clean coal combustion technology. Coal is pulverized into fine powder before being injected into a combustion chamber with air which enhances efficiency of coal combustion when comparing to other technologies. Comparing to other technologies (at the same production capacity), it uses less fuel thereby generating less air pollutants.

- **Control of NO_x** The project has designed a prevention/control of NO_x generated from boiler into 2 steps by using low NO_x burners for boilers and installing Selective Catalytic Reduction (SCR) system which can control the emission of NO_x from the boiler stack at not exceeding 56 ppm or 74.07 g/s, or about 28% of the standard limit (standard limit of 200 ppm v/v). SCR system has efficiency to remove about 76.57% of NO_x as detailed in Table 2.9.1-2 (when controlling the operation at 400 °C, NH₃/NO_x of 0.8).

- **Control of SO₂** The project has designed a prevention/control of SO₂ generated from boiler into 2 steps by using very low sulfur content of coal (not exceeding 1%) and installing Seawater Flue Gas Desulphurization (SW-FGD) which can control the emission of SO₂ from the boiler stack at not exceeding 53 ppm or 97.53 g/s, or about 29.4% of the standard limit (standard limit of 180 ppm v/v). The project's SW-FGD has efficiency to remove about 92.51% of SO₂ as detailed in Table 2.9.1-3.

- **Control of TSP** The project has installed Electrostatic Precipitator (ESP) which can control emission of fine dust (TSP) from the boiler stack at not exceeding 55 mg/m³ or about 68.8% of the standard limit (standard limit of not exceeding 80 mg/m³). The project's ESP has efficiency to remove about 99.34% of TSP as detailed in Table 2.9.1-4.

(b) Prior to the project operation, the 640-MW cogeneration plant facility of Glow SPP3 Co., Ltd. (in operation since 1999) has invested in improvement of its production unit and air pollution control system which can reduce emissions of NO_x and SO₂ generated from actual operation down to 142.43 g/s and 130.68 g/s, respectively (the 640-MW cogeneration plant facility had its EIA report on reduction of air pollutant emission rate approved on 29 May 2008, according to the letter no. 1009.7/4025). The improvement was carried out to prepare for the development of 2 new power plant projects that will be located in a vacated land of the 640-MW cogeneration plant facility. These 2 projects are this project and the 401-MW cogeneration and steam plant of Glow Energy Public Company Limited. Another purpose of the improvement in air pollution control system is to ensure compliance of the National Environment Board's resolution at the meeting no.6/2550 on 9 April 2007 such that overall emission rate of NO_x and SO₂ of these 2 new power plant projects will be about 71.61% and 75.15% of the reduced emission rate of the 640-MW cogeneration plant facility (as shown in Table 2.9.1-5).

TABLE 2.9.1-2
NOx REDUCTION EFFICIENCY OF PROJECT'S SCR

<u>1. NO_x generation from coal combustion</u>			
- coal feed rate (designed)	=	65.1 kg/s	(A)
- NO _x emission factor (AP 42 for PC Boiler & Low NO _x burner)	=	4.85 kg NO _x /ton coal	(B)
- NO _x generated	=	(A) x (B) g/s	
	=	315.74 g/s	(C)
- flow rate (designed)	=	703.04 Nm ³ /s	(D)
- NO _x concentration	=	(C) x 1000/(D) mg/Nm ³	
	=	449.11 mg/Nm ³	
	=	239 ppm	(E)
<u>2. NO_x emission controlled</u>			
- NO _x loading	=	74.07 g/s	(F)
- flow rate	=	703.04 Nm ³ /s	(D)
- NO _x concentration	=	(F) x 1000/(D) mg/Nm ³	
	=	105.36 mg/Nm ³	
	=	56 ppm	(G)
<u>3. NO_x reduction efficiency</u>			
	=	[(E)-(G)] x 100/(E)	
	=	76.57 %	
<u>4. SCR (from vendor)</u>			
Temperature (designed)	=	400 °C	
NH ₃ /NO _x ratio	=	0.8	

Source: The EIA report approved by ONEP in May 2008

TABLE 2.9.1-3**SO₂ REDUCTION EFFICIENCY OF PROJECT'S SW-FGD****1. so₂ generation from coal combustion**

- coal feed (designed)	=	65.1 kg/s	(A)
- S content	=	1 %	(B)
- S reacted in combustion	=	(A) x (B)/100	
	=	0.651 kg/s	(C)
- SO ₂	=	(C) x 2	
	=	1.302 kg/s	
	=	1,302 g/s	(D)
- flow rate (designed)	=	703.04 Nm ³ /s	(E)
- SO ₂ concentration	=	(D) x 1000/(E) mg/Nm ³	
	=	1852.0 mg/Nm ³	
	=	707.51 ppm	(F)

2. Max actual emission

- SO _x loading	=	97.53 g/s	(G)
- flow rate	=	703.04 Nm ³ /s	(E)
- SO ₂ concentration	=	(G) x 1000/(E) mg/Nm ³	(H)
	=	138.73 mg/Nm ³	
	=	53 ppm	(I)

3. SO₂ reduction efficiency

	=	[(F)-(I)] x 100/(F)	
	=	92.51 %	
seawater flowing into FGD	=	22,636 m ³ /hr	
total seawater discharged	=	280,800 m ³ /hr	
SO ₂ removal	=	1,204 g/s	
SO ₂ 1 g dissolved as SO ₄ ²⁻	=	1.5 g/s	
SO ₄ ²⁻ increased in seawater	=	1,807 g/s	
	=	23 mg/l	

Source: The EIA report approved by ONEP in May 2008

TABLE 2.9.1-4**TSP REDUCTION EFFICIENCY OF PROJECT'S ESP**

<u>1. TSP generation from coal combustion</u>				
- coal feed (designed)	=	65.1 kg/s		(A)
- ash content (max)	=	10 %		(B)
- fly ash ratio	=	90 %		(C)
- fly ash generated	=	(A) x (B) x (C) / (10000) kg/s		(D)
	=	5.86 kg/s		
	=	5,860 g/s		(E)
- flow rate (designed)	=	703.04 Nm ³ /s		(F)
- TSP concentration (designed)	=	(E) x 1000/(F) mg/Nm ³		
	=	8,335.23 mg/Nm ³		(G)
<u>2. TSP emission control</u>				
- TSP loading	=	38.67 g/s		(H)
- flow rate (designed)	=	703.04 Nm ³ /s		(F)
- TSP concentration	=	(H) x 1000/(F) mg/Nm ³		
	=	55 mg/Nm ³		(I)
<u>3. TSP reduction efficiency</u>	=	[(G)-(I)] x 100/(G)		
	=	99.34 %		

Source: The EIA report approved by ONEP in May 2008

TABLE 2.9.1-5

AIR EMISSION MANAGEMENT IN THE EXISTING POWER PLANT AREA AFTER THE OPERATION OF 2 NEW PROJECTS

PROJECT	AIR EMISSION RATES (g/s)									
	NO _x					SO ₂				
	EXISTING CONTROLLED EMISSION RATE	ACTUAL EMISSION RATE	NEW CONTROLLED EMISSION RATE	DIFF. (NEW - ACTUAL RATE)	EMISSION RATE OF NEW PROJECTS/ DEDUCTION RATE OF EXISTING PLANT X 100 (%)	EXISTING CONTROLLED EMISSION RATE	ACTUAL EMISSION RATE	NEW CONTROLLED EMISSION RATE	DIFF. (NEW - ACTUAL RATE)	EMISSION RATE OF NEW PROJECTS/ DEDUCTION RATE OF EXISTING PLANT X 100 (%)
1. Existing power plant ^{1/}	375.43	310.53	168.1	-142.43	71.61	397.8	343.87	213.19	-130.68	75.15
2. Thermal power plant 700 MW	0	0	74.07	74.07		0	0	97.53	97.53	
3. Combined cycle cogeneration power plant 401 MW	0	0	27.92	27.92		0	0	0.67	0.67	
Total	375.43	310.53	270.09	-40.44		397.8	343.87	311.39	-32.48	

Remark - ^{1/} Deduction of air emission rate (NO_x and SO₂) is conducted at 3 units of circulating fluidized bed (CFB)

Source: The EIA report approved by ONEP in May 2008

2.9.2 Wastewater management

(1) Construction period: wastewaters generated during construction period are wastewater generated from construction activity and that generated from construction workers. Wastewater generated from construction workers is expected to be about 125 m³/day. The project requires its contractor to provide adequate number of compact treatment system or mobile toilet, and to collect this wastewater for disposal by licensed waste processor.

(2) Implementation period

1) Generating source and wastewater quantity wastewater generated during the implementation period can be divided into 2 parts that are wastewater generated from domestic consumption of employees and that generated from production process and auxiliary system as shown in Table 2.9.2-1 (refer to Figure 2.8.1-1).

2) Wastewater treatment system the project has constructed its wastewater treatment systems to be clearly separated from that of the existing plant by consisting of compact wastewater treatment tank (septic tank), neutralization tank, oil separator, aeration tank, run-off treatment system, and treatment system for effluent from ESP or SW-FGD, which can be summarized as follows.

- **Septic tank**, it treats wastewater generated from domestic consumption of employees before discharging into the project's effluent holding pond. It has maximum treatment capacity of at least 5.0 m³/day.

- **Neutralization tank**, it treats wastewater generated from remediation of condensate quality improvement system with the volume of not less than 90 m³, while each time about 84 m³ of wastewater is generated.

- **Oil separator**, it removes oil from water. Clear water is sent to the project's rainwater draining ditch. Oil separator's volume is at least 10 m³, while wastewater and rainwater enter into the oil separator at maximum rate of 3.1 m³/hr.

- **Aeration tank**, it is a draining ditch for cooling water where air nozzles are installed along the ditch. Its purpose is to neutralize seawater that is used in SO₂ removal system at a boiler, and to completely transform sulfide ion into sulfate form and

TABLE 2.9.2-1**WASTEWATER QUANTITY AND TREATMENT**

SOURCE	QUANTITY (M ³ /DAY)		TREATMENT
	FRESH WATER	SEAWATER	
1 Domestic wastewater	5	-	septic tank (aeration type) and discharged to holding pond
2 Process wastewater			
- condensate polisher	28	-	neutralization tank and discharged to holding pond
- miscellaneous drain	10	-	oil separator and discharged to holding pond
- boiler blow down	255	-	directly discharged to holding pond
- cooling water blow down and blow down from SW-FGD	-	3,621,720	discharged to Glow SPP3 discharge canal to reduce temperature and discharged to the sea afterward

Remarks : - The treated wastewater (totally 298 cu.m./day) will be discharged to a 100-cu.m. holding pond (>24 hour retention time) before further discharged to sea together with cooling water.

Source: The EIA report approved by ONEP in May 2008

become stable before being discharged into 500-m seawater draining canal which is drained into the sea eventually (draining ditch for effluent from cooling system is originally about 500 meters long as shown in Figure 2.9.2-1).

- **Run-off treatment system** Normally, this run-off from stockyard will not be discharged to outside environment, since it is designed to collect it into 12,000-m³ run-off pond. Run-off in the pond is used to watering the stockyard to prevent dust dispersion and to control coal temperature which most of water evaporates into the air. In case that this run-off pond cannot adequately store the run-off such as when there is consistent heavy rain, the run-off in the pond is sent to chemical treatment unit to remove heavy metals, trace elements, suspended solids, and to neutralize before being discharged to outside environment. This chemical treatment unit has capacity to treat at least 100 m³/hour and consists of pH adjustment tank, coagulation tank, flocculation tank, and sedimentation tank (as shown in Figure 2.9.2-2).

- **Treatment system for effluent from ESP and SW-FGD** normally there is no wastewater generated from ESP and SW-FGD, except in case of maintenance which will generate about 480 m³. The project will collect this wastewater into 1,000-m³ emergency retention basin and send to chemical treatment unit to remove suspended solids and to neutralize before discharging into effluent holding pond. This treatment unit has capacity to treat at least 30 m³/hour of wastewater.

3) Effluent management, effluent is treated water (fresh water) that is collected into the 100-m³ effluent holding pond where wastewater is retained for quality inspection before being discharged into the project's draining ditch. However, if the effluent is found off-quality, the project will collect this effluent for retreatment until the quality is complied with the standard before discharging.

2.9.3 Waste management

(1) Construction period, some portion of generated solid wastes can be sold or recycled. Non-recyclable portion is collected and sent to a licensed waste processor for disposal. Another portion of solid wastes generated from domestic consumption of construction workers is about 1.8 tons/day. The project requires its contractor to adequately provide waste collection bins with lid along several places within the construction area, and to appoint workers responsible for waste collection before contacting a licensed waste processor for disposal service.



Source: The EIA report approved by ONEP in May 2008

Figure 2.9.2-1 500-meter discharge canal from cooling system before drian into the sea

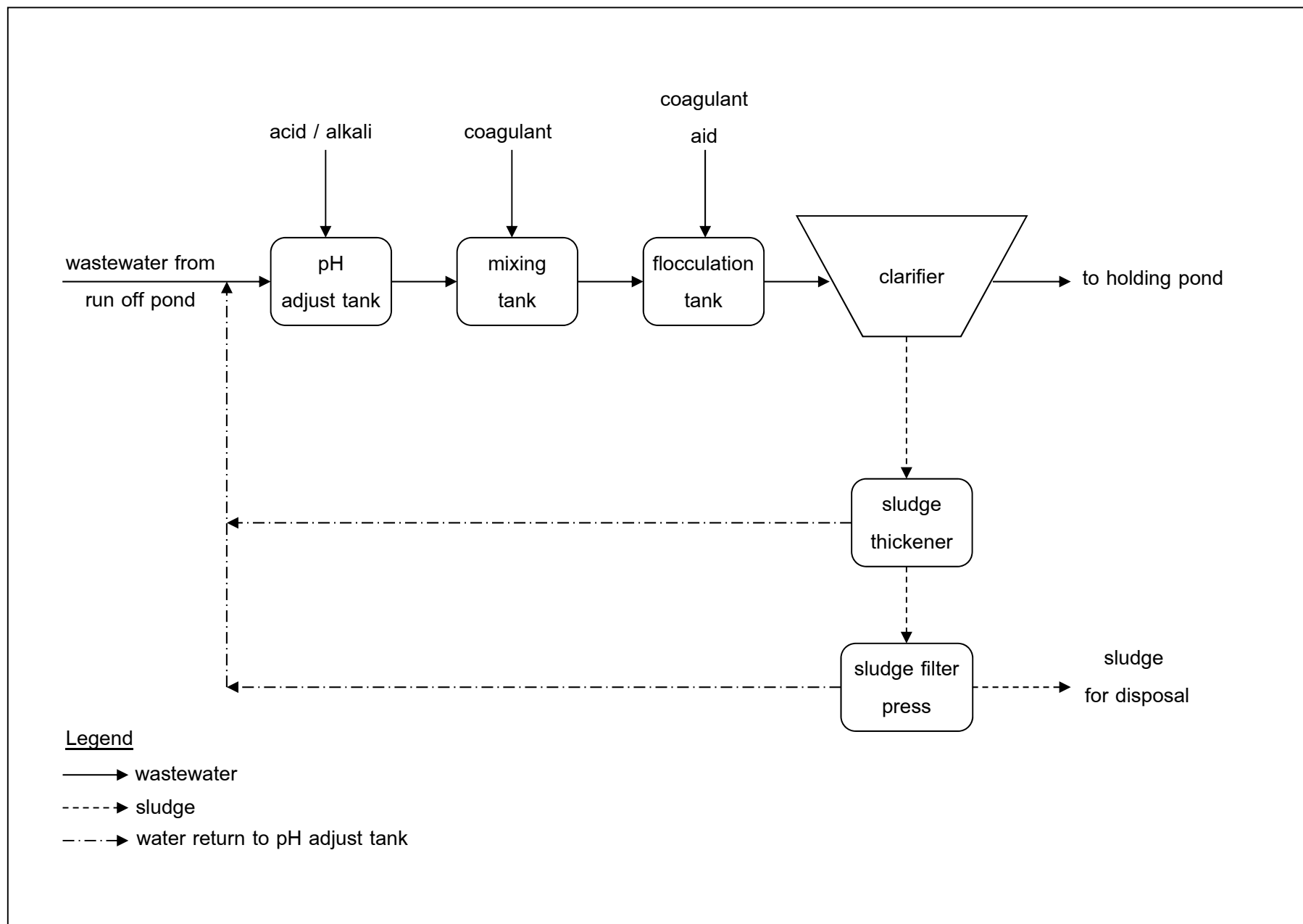


FIGURE 2.9.2-2 RUN-OFF POND'S LEACHATE TREATMENT SYSTEM

(2) Implementation period, the project operation has 2 waste generating sources that are production process and employees' activities. These generated wastes can be classified into 2 types that are hazardous wastes and non-hazardous wastes. These wastes are sent to a licensed waste processor for disposal. In addition, the project has implemented 3Rs policy to ensure waste minimization and recycling maximization (details of waste management are shown in Table 2.9.3-1).

2.9.4 Noise control.

(1) Construction period, significant noise generating activities are land leveling and foundation construction. The project requires its contractor to cease noise generating activities during nighttime (19.00-07.00), to adequately provide appropriate personal protective equipment such as ear plugs and ear muffs for workers being exposed to loud noise, and to regularly maintain construction equipment and machinery as scheduled (according to the instruction manual of such equipment).

(2) Implementation period, significant noise generating machineries are steam turbine, generator, pulverizer, cooling water pump, and water intake pump. The project controls noise level generated from these equipments at not exceeding 85 dB(A) (at 1-meter distance), except for the steam turbine that is controlled at not exceeding 90 dB(A) (as shown in Table 2.9.4-1). Additionally, appropriate personal protective equipment such as ear plugs and ear muffs are adequately provided for employees working in the loud noise area.

TABLE 2.9.4-1
NOISE LEVEL FROM MACHINES/EQUIPMENT

MACHINES/EQUIPMENT	NOISE LEVEL AT 1 METER (dB(A))
1. Steam turbine	90
2. Turbine generator	85
3. Coal mills and fans	85
4. Cooling water pump	85

Source : Gheco-One Co., Ltd., 2008

TABLE 2.9.3-1

SOLID WASTE MANAGEMENT

TYPE	QUANTITY ton/year	MANAGEMENT
1 Solid waste from processes		
- boiler bottom ash	22,500	- stored in silo prior to being transported out by firms authorized by government agency to use as substituting material in cement factories.
- fly ash from ESP	202,000	- stored in silo prior to being transported out by firms authorized by government agency to use as substituting material in cement factories.
- expired resins	1	- stored in 200-liter containers prior to transported out by firms authorized by government agency for further eradication.
- expired catalysts	185 tons/ 3 yrs.	- kept it in existing modules all the time prior to transported out by firms authorized by DIW
- waste oil from oil sepearator	0.5	} Stored in 200-liter containers prior to transported out by firms authorized by DIW for further eradication or fuel blending in cement factories.
- expired lubricant	15	
- expired insulator	3	} Store in 200-liter containers prior to transported out by firms authorized by DIW for further eradication.
- expired battery	0.75	
- expired electric circuit	0.75	
- chemical containers	7.5	
2 Domestic solid waste		
- decomposable waste	14	- Collect in garbage bins placed at various locations, and transported out for disposal by licensed disposal agencies.
- Recyclable waste	11.2	- Collect in recyclable-waste garbage bins placed at various locations, and sort out in different types, prior to contact buyers to remove for reuse/recycling.
- Hazardous waste	2.8	- Collect in garbage bins placed at various locations, and transported out for disposal by firms authorized by DIW.

Remark : DIW = Department of Industrial Works

Source: The EIA report approved by ONEP in May 2008

2.10 Employee

(1) Construction period, construction activities and commissioning take about 38 months with as many as 2,500 workers (only certain period). These workers reside outside the project area.

(2) Implementation period, it is expected to have about 100 employees working during the implementation period. One production year has 350 days (or about 8,400 hours/year). Administrative organization chart is shown in Figure 2.10-1.

2.11 Occupational health and safety

(1) Construction period : The project requires its contractor to strictly follow the occupational health and safety plan.

(2) Implementation period : The occupational health and safety action plan is established so that executives and employees can follow strictly. This plan consists of various aspects that are safety management policy and planning, management of working environment, safety system or safety equipment, working with chemicals, and emergency response plan/inspection plan/maintenance plan. Details of installation of the project's fire prevention and suppression equipment are shown in Table 2.11-1, and the project's emergency response plan level 1 is shown in Figure 2.11-1.

2.12 Public relations, Community relations, and complaint handling plan

(1) Public relations and Community relations : The project has adopted IEAT's community programs and jointly cooperated with the IEAT in various public relations and community activities. The IEAT community programs are definite and have long been effective in reaching to the communities to successfully identify specific concerns they may have on the project and therefore appropriate resolutions to follow. The public relations and community relations works has divided target group into 2 groups, each group consists of following activities.

- Industrial community group consists of factories in and surrounding the Map Ta Phut Industrial Estate. These forums are used to share and exchange knowledge and experiences among members and disseminate information regarding the project for building confidence in the communities.

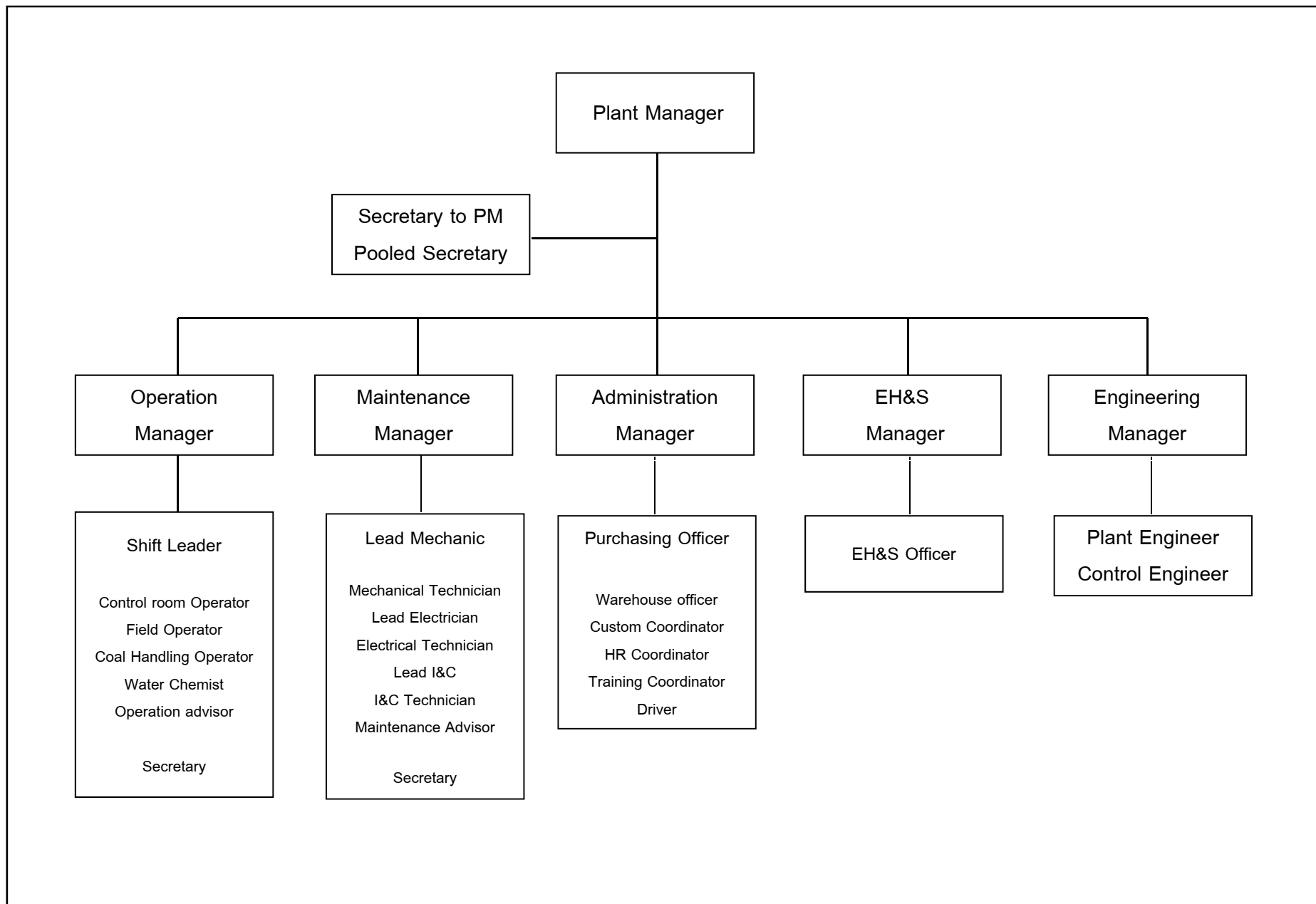


FIGURE 2.10-1 PROJECT'S ORGANIZATION CHART

TABLE 2.11-1**Fire extinguishers of the project**

Type	Unit	Area	Number	Standard
1. sprinkler system		warehouse, maintenance & storage area, turbine building, boiler building	5	NFPA 13 -standard for the installation of sprinkler systems
2. deluge water system	system	transformer area, turbine building	2	NFPA 15 -standard for water spray fixed systems for fire protection
3. CO ₂ system	system	control/electrical room	2	
4. fire hydrants	point	process&supporting area, coal yard	30	NFPA 14-standard for the installation of standpipe and hose systems
5. foam mobile unit	set	diesel storage tank	1	NFPA 11-Standard for low expansion foam systems
				NFPA 11A-Medium & High expansion
6. fire extinguishers	tank	warehouse, maintenance & storage area, turbine building, boiler building Control/electrical room, Transformer area, Process & supporting area, coal yard	64	NFPA 10-standard for portable fire extinguishers
7. fire detector	point	warehouse, maintenance & storage area, turbine building, boiler building transformer area	74	NFPA-72-national fire alarm code
8. fire water system				
- fire water tank 2,000 m ³	tank	process&supporting area	1	NFPA-20-standard for the installation of stationary pumps for fire protection
- diesel fire pump 2,000 GPM	set	near the reserve fire tank of the project	1	
- jockey pump (electric pump) 100 GPM	set	near the reserve fire tank of the project	1	

Remark : Project has the reserve fire tank and fire pump separate from present power plant.

Source : Gheco-One Co.,Ltd. (2008)

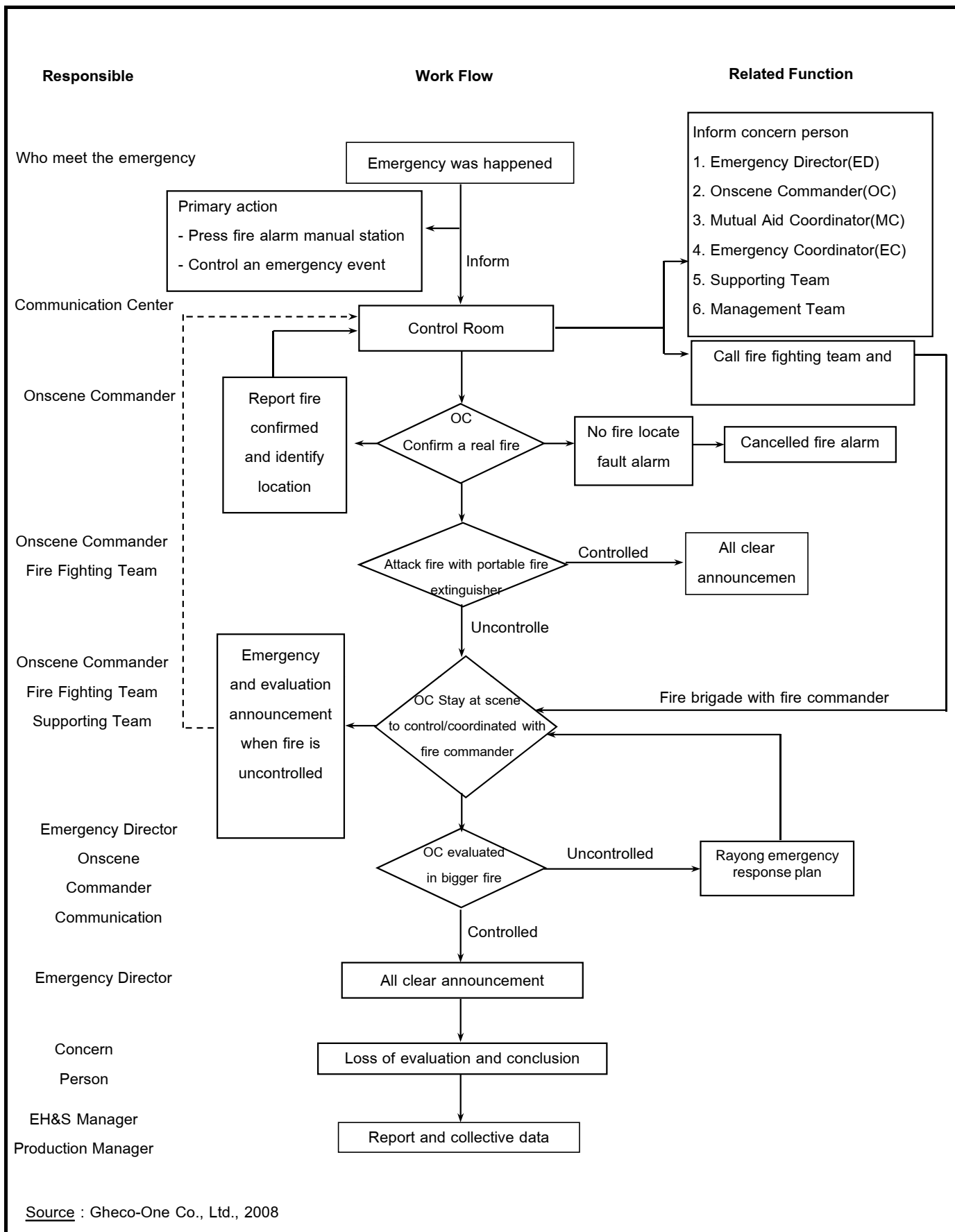


FIGURE 2.11-1 EMERGENCY RESPONSE PLAN LEVEL 1

- Residential community group consists of surrounding residential communities to the industrial estate. These forums are to inform, educate, and disseminate information about the project and its environmental mitigations and actions, and to support the communities through creating job opportunities first for local residents who are qualified, skill training, plant visits and various field trips. The ultimate aim is to produce positive perceptions and harmonious living between both industrial communities and residential communities. Thus far, the project has carried out various community relations activities such as English Camp Project, Save the Sea Project, Blood Donation Project, Candle Festival Activity, and Kathin Harmony Activity. The project and GLOW affiliates have also participated in “Community friend group” project which aims to develop the industrial operation toward clean and environmental friendly industry with sincere effort to immediately resolve the problem and promote sustainable relationship between industry and community. Initially, there are 4 industrial entrepreneurs in Map Ta Phut area participating in this project. They are PTT affiliates, SCG affiliates, BLCP power plant, and DOW Chemical affiliates. The implementation of this “Community friend group” project is detailed below.

Goal: To promote open and transparent communication between industry and community, to strengthen trust between each other, and to ensure the community of industry’s intention to fully support the community.

Duty:

- To educate community and enhance better understanding.
- To act as Call Center to receive information when incidents occur and to coordinate with related agencies in order to facilitate immediate correction.
- To monitor and report on progress of corrective action.

Implementation:

Working task group of “Community friend group” consists of representatives from all companies and divides the task into 3 following areas.

1) Green Operation, the working task group of “Green Operation” operates in “friends help friends” manner such that industries must help each other and agree in the mutual agreement to be a good role model in environmental and safety management area by performing better than the legal requirement and the international standard, improving continuously, sharing knowledge and experience in order to upgrade their industrial

standard, and developing their self-evaluation process to truly become Green Manufacturing. The action plan for the members is described as follows.

- Cooperate with government sector and community to develop an eco-industrial town that establishes good environmental and safety management practice and strictly carries out the environmental and health prevention and monitoring measures as prescribed in the EHIA study.
- Help one another, like “friend helps friend”, by sharing knowledge and experiences.
- Participate and agree to inspection, and allow community to participate in the inspection process in terms of the operation and monitoring of environmental pollutants and safety.
- Establish impact mitigation measures and communication and cooperation procedure to be carried out in case of an emergency, including conduct a rehearsal to ensure readiness of the factory and community.

2) Beyond CSR: Taking care the community to ensure good quality of life. The working task group of “Beyond CSR” is an intention of the industry to take good care of the community beyond CSR like family members in order to upgrade the community’s quality of life. The task group also helps in correcting the community’s problem and responding to the need of the community by emphasizing on health and educational promotion of the community covering the area of Tambon Map Ta Phut, Tambon Huoi Pong, and Tambon Neon Pra, Tambon Thap Ma, Tambon Map Kha, and Tambon Ban Chang.

Health issue

- Cooperate with government sector in conducting health examination for the community to generate systematic database system.
- Support nursing personnel by giving 200 scholarships to nursing students within 4 years (see more information in Appendix O).

Education issue

- Promote capacity building and opportunity for youths to continue study in higher education.
- Improve quality of school to reach level of nationally well-known schools and provide scholarship to allow continuing education until higher education level.

3) Communication - communicating to promote understanding: The working task group of “Communication” aims to support the industry in developing environmental and safety management to become clean and environmental friendly industry. Also, disseminate knowledge and understanding and provide an opportunity for public participation in monitoring the environmental and safety management of the industry.

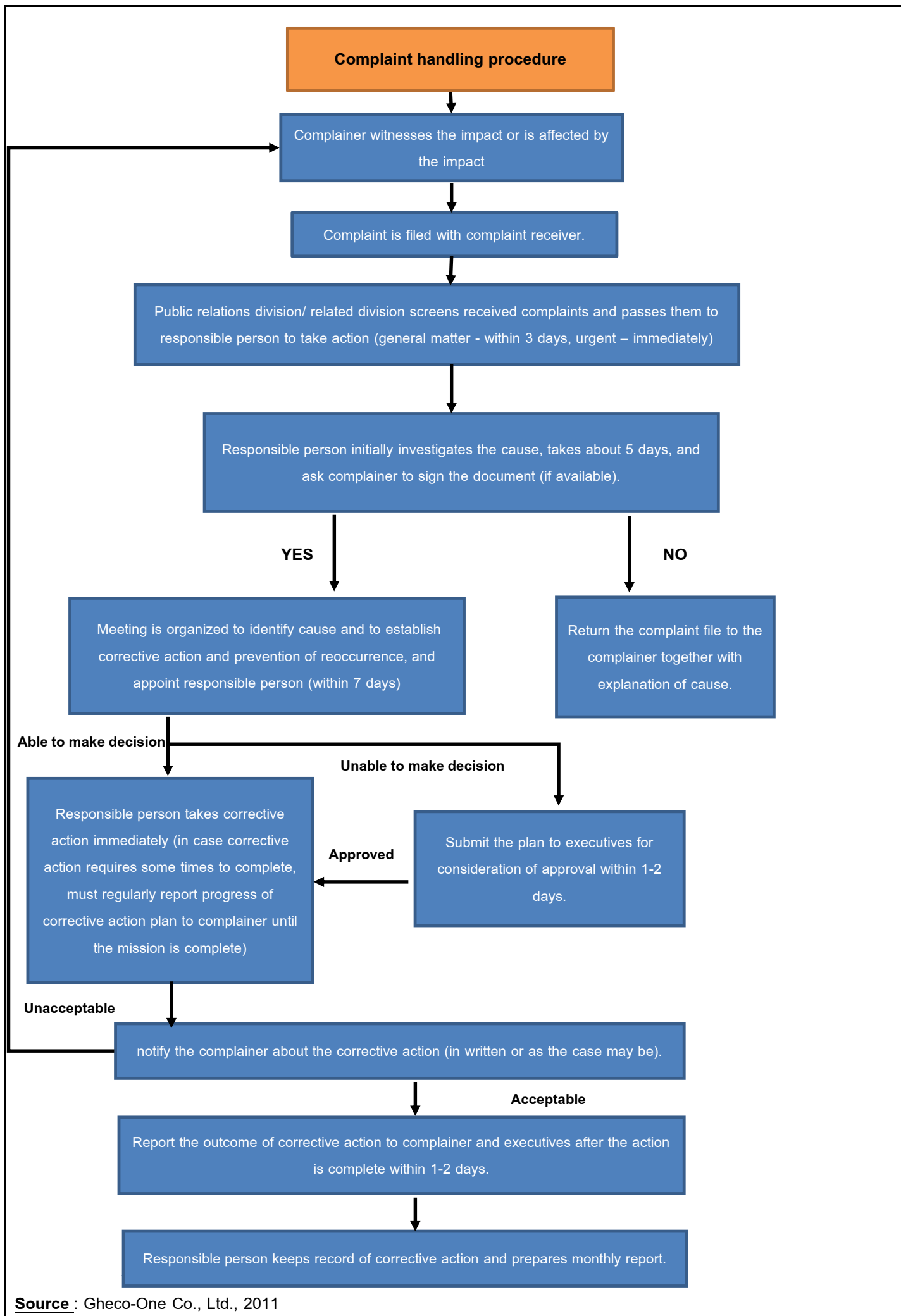
- Establish “Community friend center” to communicate and educate the community, and to receive complaint and facilitate for immediate corrective action.
- Communicate and promote knowledge in handling an emergency for all communities since the steps of notification, operating procedure, and providing assistance.
- Organize community stage to disseminate knowledge on clean and environmental friendly industry and to receive feedback from community for continual improvement.
- Publish information and performance report according to the “community friend” action plan.

(2) Complaint handling plan - The project has established action plan and operating procedure for handling complaints (Figure 2.12-1) where communities can voice their concerns, worries, complaints, thoughts and suggestions regarding the implementation of the project, including the project's employees, surrounding communities or nearby factories. This will help in investigating the cause of the problem and identifying corrective action right away.

2.13 Green area

The project has allocated about 7,000 m² as green area or about 5.15% of its total area (refer to Figure 2.2-1, Figure 2.2-2, and Table 2.2-1).

3. Summary of Environmental Impacts, Environmental Impact Prevention and Mitigation Measures and Environmental Quality Monitoring Measures from construction and implementation of the thermal power plant project are shown in Table 3-1 and Table 3-2. Underlined measures are revised or additional measures of measures being lastly approved by ONEP.



Source : Gheco-One Co., Ltd., 2011

FIGURE 2.12-1 ACTION PLAN FOR COMMUNITY PETITION ON ENVIRONMENTAL IMPACT

Table 3-1

Summary of environmental components and values, significant environmental impacts, environmental impact prevention and mitigation measures and environmental quality monitoring measures of the thermal power plant project of Gheco-one Company Limited (which is a project that may seriously affect the community with respect to the quality of the environment, natural resources and health)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
1. General matters	-	<ul style="list-style-type: none">- Strictly follow the environmental impact mitigation measures and monitoring measures presented in the form of environmental action plan. Report the implementation results of the action plan to Office of Natural Resources and Environmental Policy and Planning for consideration within the period specified in the action plan and conforming to the Office's reporting process.- Control air emission rates from the power plant project in accordance with the air emission reduction plan of Glow SPP3 Co., Ltd. in conjunctions with the power plant project of Glow Energy Public Co., Ltd. to conform to the National Environmental Board's criteria on emission standard (following the 6th/2550 meeting held on 9th April	

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
		<p>2007). The emission results from the three plants shall be presented on a display board at the entrance of present power plant, and linked to other parties involved.</p> <ul style="list-style-type: none"> - After the mathematical model's input data has been corrected to be reliable by Industrial Estate Authority of Thailand, this set of input data shall be used for air quality assessment. If the results of air quality assessment from such model are higher than the air quality standard, Gheco-one shall reduce its air emissions to meet the standard. - Create an air emission database from the project's actual air emissions to be used for air quality's monitoring and problem solving by other related parties. - Create a database of fuels used within the project, including fuel types, 	-

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
		<p>volume, properties (physical and chemical), sources and means of transportation, to be used for verification by other related parties.</p> <ul style="list-style-type: none"> - Create a database of volume of cooling water consumed within the project, and set up a plan to reduce the consumption of cooling water. - Cooperate, support and promote any organizations specialized in marine resources' conservation and revitalization throughout the project operation. - To remove solid waste out of the project site, Gheco-one shall be obliged to the Ministry of Industry Notice Subject: Removal of Waste and Unusable Materials 2005 (B.E. 2548), or related regulations enforced by the government. - Once Gheco-one hires a sub-contracting company to design /construct/operate its power plant 	

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
		<p>project, Gheco-one shall address its environmental action plan within the contract and ensure the sub-contracting company to strictly comply with the action plan.</p> <p>- If the monitoring results from project operation expose a sign of environmental problem, Gheco-one shall solve and improve the cause of problem immediately. If there is any incident that might effect the environmental quality, the company shall inform to Rayong Province, Industrial Estate Authority of Thailand, the Office of Natural Resources and Environmental Policy and Planning, and other related parties so that these parties can participate in solving those problems.</p> <p>- <u>In case Gheco-one Co., Ltd. needs to modify its project description or its environmental impact prevention and</u></p>	

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
		<p><u>mitigation measures and environmental quality monitoring measures that were proposed in the approved EIA report, the company must notify approval /permit-issuing agencies as described below.</u></p> <p><u>* If approving or permitting agency considers that such modification provides better or as good as benefit to the environment when comparing to specified measures in the approved EIA report, the agency must record such modification according to criteria and condition specified in relevant regulations and make a copy of such recorded modification and notify ONEP.</u></p> <p><u>* If approving or permitting agency considers that such modification may affect critical contents in the approved EIA report, the agency must submit such modification report to ONEP so it can be proposed to related</u></p>	

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
		<p><u>Expert committee for consideration of approval. After the approval of such modification, the agency must notify the result of such modification to ONEP.</u></p> <ul style="list-style-type: none"> - If there are any problems or concerns from local communities regarding the project operation, Gheco-one shall solve such problems in order to minimize conflicts in the communities - If the project has not been constructed within 2 years since the Office of Natural Resources and Environmental Policy and Planning approved the project's EIA report, the project shall review the environmental impacts and action plan in the EIA report, and submit the report to the Office of Natural Resources and Environmental Policy and Planning for further consideration. - Since the National Environment Board has announced Map Ta Phut area as pollution control zone, the 	

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
		<p>thermal power plant project of Gheco-one Company Limited which is located in this zone must follow pollution reduction plan of such pollution control zone.</p> <ul style="list-style-type: none"> - <u>Gheco-one Company Limited must submit a report on performance of its environmental impact prevention and mitigation measures and environmental quality monitoring measures to ONEP, Rayong Provincial Natural Resources and Environment Office, IEAT, Office of Energy Regulatory Commission of Thailand, and related local authorities every 6 month.</u> - <u>Have policy to open the project for community visit (thermal power plant project).</u> - <u>In case that any project's activity may pose impact on community during certain period, such as operation test of noise generating equipment or generation of large steam volume, the</u> 	

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
		<u>project must notify the community in advance through several means such as information post or community board. In case of an emergency, the project must notify the public according to the provincial emergency response plan.</u>	
2. Physical resources 2.1 Topography the study area covers part of Mueang Rayong District and Ban Chang District, Rayong province. The south of the study area is adjacent to the sea. Area above that has geographical condition as beach and beach ridge, while in the central area until the north has condition of tidal flat and flood plain. Several canals flow through the study area. Most areas especially in the north, the central and the south are currently developed for factories and industrial estates. There are also some areas to be developed as industrial area and industrial port. In	Construction and implementation periods The project is located in the area of Map Ta Phut Industrial Estate that has been specifically prepared for expansion of industrial development and currently leveled for construction of an industrial project. Moreover, the project is sited in the vacated land of the existing plant (the 640-MW power plant facility of Glow SPP3 Co., Ltd.) that has already constructed or developed into industrial facility, port, and conveyor system for transferring coal from the port to the existing plant	-	-

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>addition, the study area in the central around Ban Chang Sub-district there is sandy beach which is a tourist destination called Nam Rin Beach.</p>	<p>area. The project therefore can utilize this existing port and conveyor system. Consequently, the impact on topographical condition of the study area posed by the project operation will be at low level.</p>		
<p>2.2 Geology and Soil Science the geology of the study area is mostly terrace deposits. Soil resource mostly found in the study area is Sattahip series that has low fertility and mineral content. It is suitable for planting coconut, pineapple, or livestock farming. In addition, reviewing data on earthquake risky area shows that Rayong province area which is the site of the study area is located in zone 1 that has low risk of earthquake. Moreover, there is no active fault found in the study area is not known to be a center of earthquake.</p>	<p>Construction and implementation periods</p> <p>The project is located in the area of Map Ta Phut Industrial Estate that has currently been prepared for industrial development. After considering the project description, no activity that will significantly affect geology and soil science of the study area is found. Considering the geological condition of the study area, it is found that most geological condition is terrace deposits which no accumulation of rare minerals or important economic minerals is evident. Consequently, the impact on geological condition and soil science of the study area posed by the project</p>	<p align="center">-</p>	<p align="center">-</p>

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
	operation during construction and implementation periods will be at low level.		
<p>2.3 Air quality - data from various agencies conducting air quality monitoring routinely in the study area around communities surrounding the project area at 15 stations during 2007-2009 are collected. These agencies are Asia Industrial Estate, Hemaraj Eastern Industrial Estate (Map Ta Phut), Map Ta Phut Industrial Estate, Industrial Estate Authority of Thailand (IEAT), Pollution Control Department (PCD), and the 640-MW power plant facility of Glow SPP3 Co., Ltd. The findings can be summarized as follows.</p> <p>1) Total suspended particulate (TSP): it is found that 24-hr average TSP concentrations were in a range of 9-280 $\mu\text{g}/\text{m}^3$. The highest concentration was found at Wat Map Chalood in 2008, which was 85% of the standard</p>	<p>Construction period</p> <p>Major pollutant during the project's construction period is particulate matter which may be generated during area grading or leveling and transportation of construction materials. Dispersion of particulate matter generated from such activities depends on several factors such as working characteristics and extent, soil components, soil humidity, wind speed, construction period, etc. Size of particulate matter generated from construction activity mostly is larger than 10-20 μm which can easily settle to the ground and disperse only in short distance. Consequently, affected people from such activity are mainly construction workers in the project area.</p>	<p>Construction period</p> <p>Transportation of workers and construction materials</p> <ul style="list-style-type: none"> - The trucks must be properly covered in order to prevent spilling of the loading materials and dust dispersion. - Limit the speed of the vehicles in the construction area of not exceeding 40 km/hr. - Remove dirt and soil that might be stuck on the truck's wheels before leaving the construction area <p>Construction area</p> <ul style="list-style-type: none"> - Spray water over the construction area to prevent dust dispersion from construction activities at least 2 times per day (except in raining period). 	<p>Construction period</p> <p>Parameters : Inspect TSP dust and PM-10 (averaged 24 hours)</p> <p>Sampling stations : 2 stations (Figure 1-1)</p> <ul style="list-style-type: none"> * At the fence of existing power plant * Ban Nong Fab <p>Frequency : 2 times a year, 7 consecutive days per each time</p>

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>limit (the ambient air quality standard of $330 \mu\text{g}/\text{m}^3$). Considering the current air quality monitoring results in 2009, it is found that 24-hr average TSP concentrations were in a range of 12-159 $\mu\text{g}/\text{m}^3$ which the highest concentration was evident at Wat Nong Fab.</p> <p>2) PM-10: the data is presented in 2 forms that are 24-hr average concentration and 1-yr average concentration. The monitoring results of 24-hr average PM-10 concentrations in Map Ta Phut area during 2007-2009 were in the range of 5-364 $\mu\text{g}/\text{m}^3$ which mostly were within the standard limit (the ambient air quality standard of $120 \mu\text{g}/\text{m}^3$), except certain areas which the concentrations exceeded the standard limit for certain time period specifically during dry season (November-February). Considering the current air quality monitoring results in 2009,</p>	<p>Implementation period</p> <p>Considering information on air pollutant generating sources and control of air pollution emitted from the project, it is found that major air pollutants are NO_x, TSP, and SO_2. Minor pollutants from other sources and those concerned by the public and stakeholders (as received from various public hearing events) are particulate matter generated from coal stockyard, heavy metal contaminated</p>	<ul style="list-style-type: none"> - Inspect and maintain the machines and engines used for construction to be in good condition and in accordance with the instruction manual of each unit. - Prohibit to waste materials or garbage in construction area. - <u>to provide knowledge on danger of particulate matter and prevention method.</u> <p>Implementation period</p> <p>Coal procurement</p> <ul style="list-style-type: none"> - Use bituminous coal that contains maximum sulfur content of not exceeding 1% as stated in the purchasing contract. - Create a database of imported coal (following the attachment of customs process), including analytical results of the project's coal imported (consisting of sulfur content, ash content, heavy metal and trace 	<p>Implementation period</p> <p>Ambient air quality</p> <p>Parameters : NO_x (1 hour), SO_2 (1 hour and 24 hour), TSP (24 hour), PM-10, wind speed and direction</p> <p>Sampling stations : 4 stations (Figure 1-2)</p> <ul style="list-style-type: none"> * Map Ta Phut Health Care Center * Map Chalood Temple * Muang Mai Map Ta Phut * Ban Nong Fab <p>Frequency : 2 times a year, 7</p>

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>violations of standard limit at various stations were found in the range of 5-18 times/year. One-year average PM-10 concentrations were in the range of 32-70 $\mu\text{g}/\text{m}^3$ which mostly were within the standard limit, except those in 2007 at Muaeng Mai Map Ta Phut and in 2009 at Ban Krok Yai Cha that exceeded the standard limit.</p> <p>3) NO₂: 1-hr average NO₂ concentrations in Map Ta Phut area mostly were in a range of 0-188 $\mu\text{g}/\text{m}^3$. The highest concentration was found at Wat Map Chalood in 2007, which was about 58.8% of the standard limit (the ambient air quality standard of 320 $\mu\text{g}/\text{m}^3$). Considering the current air quality monitoring results in 2009, it is found that the NO₂ concentration was in a range of 0-166 $\mu\text{g}/\text{m}^3$ which the highest concentration was evident at Ta Guan Commune.</p>	<p>in coal, effect of rainwater quality on agriculture, and VOCs. For control of major pollutants generated from a boiler, the project has designed the system to control emission of these air pollutants from a boiler well below the standard limit such that emissions of NO_x, SO₂, and TSP are 28.0%, 29.4%, and 68.8% of that standard limits, respectively. Assessment of impact posed by these major and minor pollutants can be prescribed as follows.</p> <p>(a) Comparative impact assessment on air quality using air quality modeling by considering overall picture of air pollutant generating sources in Map Ta Phut area before and after the project operation</p> <p>Since information on air pollutant generating sources and control of air pollution emitted from the project at current condition is not different from</p>	<p>element contents).</p> <p>Management at coal yard</p> <ul style="list-style-type: none"> - Use a close system belt conveyor equipped with water sprinkle to minimize coal dust dispersion while being blown at the coal yard belt end. - Compress the coal pile at appropriate density (approximately 1.2 tons/m³). - Install water sprinkle around the coal yard in order to prevent ignition of the coal as well as dust diffusion. - <u>To prepare a backhoe for isolate igniting coal which the isolation and suppression of igniting coal is done in accordance with international standard for management of coal stockyard.</u> - <u>To specify fuel storage area or coal stockyard as no-smoking area or no spark area.</u> - Plant evergreen trees around the coal yard and the trees should be tall 	<p>consecutive days per each time</p> <p><u>Parameters : AS, Cd, Hg, Pb</u></p> <p><u>Sampling stations : 1 stations</u></p> <p><u>* Ban Nong Fab</u></p> <p><u>Frequency : 2 times a year</u></p> <p>Air emissions at sources</p> <p><u>Measured with CEMs</u></p> <p>Parameters : NO_x, SO₂, TSP</p> <p>Sampling stations : PC boiler stack</p> <p>Frequency : Continuous</p> <p><u>Measured by stack sampling</u></p> <p>Parameters : NO_x, SO₂, TSP, PM-10</p> <p>Sampling stations : PC boiler stack</p> <p>Frequency : 2 times a year</p> <p><u>Parameters : AS, Cd, Hg, Pb</u></p> <p><u>Sampling stations : PC boiler stack</u></p> <p><u>Frequency : 2 times a year</u></p> <p><u>Parameters : to conduct coal</u></p>

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>For the monitoring results of 1-yr average NO₂ concentrations, it is found that the concentrations were in the range of 9-28 µg/m³ which the highest concentration was evident at Maptaphut Health Station in 2008, about 49.1% of the standard limit (the ambient air quality standard of 57 µg/m³). Considering the current air quality monitoring results in 2009, it is found that the 1-yr average NO₂ concentration was in a range of 10-24 µg/m³ which the highest concentration was evident at Maptaphut Health Station and Muaeng Mai Map Ta Phut.</p> <p>4) SO₂: 1-hr average SO₂ concentrations mostly were in the range of 0-539 µg/m³. The highest concentration was found at Muaeng Mai Map Ta Phut in 2007, which was about 69.1% of the standard limit (the ambient air quality standard of 780 µg/m³). Considering the current air</p>	<p>the information specified in the EIA report that was approved by ONEP in May 2008. Consequently, this comparative impact assessment can use the study result of such EIA report that has study scope covering the area in 20-kilometer radius of the project site. It can be concluded that the project operation is in compliance with National Environment Board's resolution at the meeting no.6/2550 on 9 April 2007 such that it has not increased overall emission rate of NO_x and SO₂ in Map Ta Phut area, and modeling result also shows that maximum concentration at ground level of air pollutants generated from existing generating sources prior to the project development and is not increased as well as concentrations of air pollutants in any area that has already exceeded the standard limit.</p> <p>(b) Prediction of air quality at various communities after the project</p>	<p>enough to fit the coal pile.</p> <ul style="list-style-type: none"> - Construct wind shields against the wind directions, south and west of the yard, with the height of around 15 meters. <p>Control of air emissions from PC boiler stack</p> <ul style="list-style-type: none"> - Control air emissions from the project's PC boiler stack as follows: <ul style="list-style-type: none"> ■ NO_x not exceeding 56 ppm and 74.07 grams/second ■ SO₂ not exceeding 53 ppm and 97.53 grams/second ■ TSP not exceeding 55 mg/Nm³ and 38.67 grams/second - Air emissions from the project's PC stack are allowed after the existing power plant has reduced their emission rates to be under the criteria approved by the National Environmental Board - Set up alarm signals for the air emission level to be heard in the 	<p><u>component analysis (sulfur, ash, arsenic, cadmium, mercury, and lead)</u></p> <p><u>Sampling stations : stockyard</u></p> <p><u>Frequency : 2 times a year</u></p> <p>Parameters : VOCs</p> <p>Sampling stations : PC boiler stack</p> <p>Frequency : 2 times a year</p> <p><u>Greenhouse gas emission assessment</u></p> <p>Parameters : CO₂</p> <p>Method : UNFCCC assessment method</p> <p>Frequency : <u>2 times a year</u></p>

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>quality monitoring results in 2009, it is found that the SO₂ concentration was in a range of 0-484 µg/m³ which the highest concentration was evident at Muaeng Mai Map Ta Phut.</p> <p>For 24-hr average SO₂ concentration, it is found that the concentrations were in the range of 0-138 µg/m³ which the highest concentration was evident at Maptaphut Health Station in 2007, about 46.0% of the standard limit (the ambient air quality standard of 300 µg/m³). Considering the current air quality monitoring results in 2009, it is found that the 24-yr average SO₂ concentration was in a range of 0-134 µg/m³ which the highest concentration was evident at Muaeng Mai Map Ta Phut.</p> <p>For 1-yr average SO₂ concentration, it is found that the concentrations were in the range of 5-</p>	<p>operation</p> <p>Prediction of air quality (NO₂ and SO₂) at various communities in Map Ta Phut area after the simultaneous operation of this project and the 401-MW cogeneration and steam plant of Glow Energy Public Company Limited in the future is carried out by using AERMOD model as a tool to predict distribution of these pollutants from the project to communities. The predicted concentrations are then combined with existing maximum pollutant concentrations in the communities obtained from the current measurement (prior to the project operation), which can be described as follows.</p> <p>- Maximum 1-hr and 1-yr average concentrations of NO₂ at various communities were in the range of 46-199 µg/m³ and 10-24 µg/m³, respectively, which were within the standard limit. The maximum 1-hr</p>	<p>control room. These alarms can be divided into 2 levels: high level alarm and high high level alarm. After the alarm has been heard, the following practices shall be done:</p> <ul style="list-style-type: none"> ■ For the “high level alarm” (set up at 90% of the controlled emission rate), the operators have to inspect the conditions of operation unit and emission control system. The maintenance or adjustment must be done immediately. ■ For the “high high level alarm” (set up at 98% of the controlled emission rate), the operators should reduce or stop the production. The maintenance of the emission control systems must be done and ensured the emission rates before restart-up the operation. - the stack exceeds the limitation, the values of emission rate that exceed the limitation and period of 	

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>43 $\mu\text{g}/\text{m}^3$ which the highest concentration was evident at Muaeng Mai Map Ta Phut in 2007, about 43% of the standard limit (the ambient air quality standard of 100 $\mu\text{g}/\text{m}^3$). Considering the current air quality monitoring results in 2009, it is found that the 1-yr average SO_2 concentration was in a range of 5-35 $\mu\text{g}/\text{m}^3$ which the highest concentration was evident at Muaeng Mai Map Ta Phut.</p> <p>5) VOCs: the previous monitoring results from various stations within the study area (during 2007-2009) show that the concentrations of 6 VOCs (vinyl chloride, dichloromethane, chloroform, trichloroethylene, 1,2-dichloropropane, and tetrachloroethylene) were well below the standard limit, while concentrations of 1,3-butadiene, 1,2-dichloroethane, and benzene exceeded the standard limit in certain time period.</p>	<p>average concentration was about 62.19% of the standard limit (the ambient air quality standard of 320 $\mu\text{g}/\text{m}^3$), while the maximum 1-yr average concentration was about 42.8% of the standard limit (the ambient air quality standard of 57 $\mu\text{g}/\text{m}^3$).</p> <p>- Maximum 1-hr, 24-hr, and 1-yr average concentrations of SO_2 at various communities were in the range of 27-504 $\mu\text{g}/\text{m}^3$, 19-136 $\mu\text{g}/\text{m}^3$, and 5.4-35.4 $\mu\text{g}/\text{m}^3$, respectively, which were within the standard limit. The maximum 1-hr average concentration was about 64.6% of the standard limit (the ambient air quality standard of 780 $\mu\text{g}/\text{m}^3$). The maximum 24-hr average concentration was about 45.3% of the standard limit (the ambient air quality standard of 300 $\mu\text{g}/\text{m}^3$), and the maximum 1-yr average concentration was about</p>	<p>exceeding emissions must be recorded, and also root cause analysis and preventive plan must be undertaken.</p> <p>- Appoint a skilled person to control the combustion and emission control systems.</p> <p>Emission control systems and management</p> <p>- Provide the PC boiler burner with low NO_x burners.</p> <p>- Install selective catalytic reduction (SCR) with reduction efficiency of at least 76.57% to control NO_x emissions.</p> <p>- Install electrostatic precipitator (ESP) with reduction efficiency of at least 99.34% to control TSP emissions.</p> <p>- Install seawater flue gas desulphurization (SW-FGD) with reduction efficiency of at least 92.51% to control SO_2 emissions.</p>	

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>However, concentrations of 1,3-butadiene and 1,2-dichloroethane during 2007-2009 had tendency of decreasing, while benzene concentration seemed stable.</p>	<p>35.4% of the standard limit (the ambient air quality standard of 100 $\mu\text{g}/\text{m}^3$).</p> <ul style="list-style-type: none"> - Maximum 24-hr average concentrations of TSP were in the range of 60-160.4 $\mu\text{g}/\text{m}^3$. The maximum 24-hr average concentration was about 48.6% of the standard limit (the ambient air quality standard of 330 $\mu\text{g}/\text{m}^3$). - The current monitoring results of 24-hr average concentration of PM-10 mostly were within the standard limit, except for certain time period specifically during dry season which the concentrations exceeded the standard limit. Therefore, the project operation has tendency to pose impact on air quality in terms of PM-10, specifically in the dry season. If assuming that all particulate matter emitted from the project's stack is PM-10, the modeling result shows that the 	<ul style="list-style-type: none"> - Prepare sufficient spare parts of air emission control systems in order to immediately replace when encountering the failure. - Set up preventive maintenance program for the machines related to air emission control systems. The plan shall be set in accordance with the system manuals. <p>Measurement and presentation of air emission values</p> <ul style="list-style-type: none"> - Install Continuous Emission Monitoring System (CEMs), record the measurement data derived from CEMs, and audit CEMs in accordance with the theory continuously. - Establish 1 ambient air quality monitoring station (AAQMS) to back up air quality data for the air quality monitoring center which is under the Industrial Estate Authority of Thailand. The proper location of the station will be discussed later with Pollution 	

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
	<p>most affected area exposing to maximum concentration of 10 $\mu\text{g}/\text{m}^3$ is Khao Huoi Ma Had in the north-east of the project area. Considering impact on various communities, it is found that the concentrations were increased by 0.7-1.8 $\mu\text{g}/\text{m}^3$ during certain period.</p> <p>- The current monitoring results of 1-yr average concentration of PM-10 mostly were within the standard limit, except for certain time period. If assuming that all particulate matter emitted from the project's stack is PM-10, the modeling result shows that the predicted concentrations at various communities before and after the project operation are not significantly different. Most concentrations were within the standard limit, except at Maptaphut Health Station and Ban Krok Yai Cha that slightly exceeded the standard limit.</p>	<p>Control Department and the Industrial Estate Authority of Thailand.</p> <p>- Present the measurement results of air emission rates from CEMs, including NO_x, SO_2, and TSP, to the public via emission display board of the existing power plant located at the front gate of the plant.</p> <p>- Present the project's operating result regarding environmental measures (especially air emissions) to the public and involved agencies in order to enhance public participation (in observation of the project's environmental implementation) through various channels such as emission display board, air quality monitoring center of IEAT, newsletter, the project's environmental annual report or website, etc.</p> <p>- In case the CEMs have a problem, the project has to apply a portable gas detector to measure air</p>	

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
	<p>(c) Evaluation of particulate matter concentration at coal stockyard</p> <p>Amount of particulate matter generated at the coal stockyard is directly proportional to wind speed in the area. For the effect of wind shield on wind speed, it is found that the wind shield has ability to reduce wind speed that blows over the stockyard down to 20-60%. Consequently, the wind shield has about 40-80% efficiency to reduce generation of particulate matter at the stockyard as prescribed below.</p> <p>- Without wind shield installation: maximum average wind speed in the area at worst case scenario was 6 knots, or about 6.9 miles/hour, which would generate particulate matter at maximum rate of 4.97 pounds/acre-hour, or 0.16 mg/m²-sec. The stockyard area is 160 meter wide and 300 meter long. Consequently, the</p>	<p>emissions in every 2 hours, and fix the CEMs immediately.</p> <p>- <u>to support related agencies in dissemination of knowledge on acid rain.</u></p> <p>Transferring equipment and silo</p> <p>- Install a silo to collect ESP ashes which are transferred into the silo through a close transferring system.</p> <p>- Use specific trucks to transport ashes out of the project in order to prevent the dispersion of ashes to the environment.</p>	

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
	<p>project's stockyard can generate particulate matter at maximum rate of 7.68 g/s.</p> <p>- With wind shield installation: wind shield can reduce wind speed down to 20-60%. In worst case scenario that wind speed is only decreased to 60%, particulate matter is therefore generated at the stockyard at the rate of 4.61 g/s.</p> <p>Based on the prediction of generated particulate mater, it is found that particulate matter generation rates for cases of without wind shield installation and with wind shield installation are 7.68 g/s, and 4.61 g/s, respectively. In worst case situation, particulate matter concentration generated at the project's stockyard is $45 \mu\text{g}/\text{m}^3$ for a case without wind shield installation, while it is $27 \mu\text{g}/\text{m}^3$ for a case with wind shield installation. After the project operation, maximum</p>		

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
	<p>particulate matter concentrations at Ban Nong Fab are not exceeding 232.3 $\mu\text{g}/\text{m}^3$ and 214.3 $\mu\text{g}/\text{m}^3$ for a case without wind shield installation and a case with wind shield installation, respectively, which are still within the standard limit (330 $\mu\text{g}/\text{m}^3$).</p> <p>(d) Assessment of impact on other aspects of air quality</p> <p>- <u>Heavy metal</u> ,the measurement results of heavy metal that may be emitted from the power plant facility's stack of Glow SPP3 Co., Ltd. using bituminous coal with similar quality, show arsenic concentration of 0.0001 mg/m^3 or about 0.0006% of the standard limit while cadmium, mercury, and lead are undetectable since their concentrations are below detection limits of employed analytical method. Detection limit for cadmium, mercury, and lead analysis are 0.004 mg/m^3, 0.0006 mg/m^3, and 0.02 mg/m^3, respectively.</p>		

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
	<p><u>Remark:</u> Although the component analysis of heavy metal in coal used in this project shows concentration levels less than the instrument's detection limit and the measured heavy metal concentration probably emitted from power plant facility of Glow SPP3 Co., Ltd. came out at very low value, heavy metal concentration must be assumed at the instrument's detection limit in order to allow comprehensible assessment of health impact caused by heavy metal generated from the project operation. Quantitative risk assessment is employed to predict distribution of heavy metals to the environment. This predicted concentration is then used in assessing health effect. Nevertheless, this procedure gives overestimated result which can be considered that impact assessment is employed under worst case situation.</p> <p>- <u>Rainwater quality and</u></p>		

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
	<p><u>agriculture</u> air pollutants that may affect rainwater quality are NO_x and SO₂ since they can react with water vapor and transform into acid thereby decreasing pH of rainwater. Nonetheless, the project's air pollution control and management is carried out to comply with National Environment Board such that there is investment on reduction of NO_x and SO₂ emissions from the power plant facility of Glow SPP3 Co., Ltd. before the project operation and the project's emission rate is controlled at not exceeding 80% of the reduced emission rate. Consequently, after the project operation overall emissions of NO_x and SO₂ in Map Ta Phut area will be decreased. This control measure has pose positive impact on rainwater quality.</p> <p>- VOCs: Considering the measurement results of ambient</p>		

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
	<p>concentrations of 9 VOCs in Map Ta Phut area, it is found that ambient concentrations of 1,3-butadiene, 1,2-dichloroethane, and benzene exceeded the standard limit. However, concentrations of 1,3-butadiene and 1,2-dichloroethane during 2007-2009 had tendency of decreasing, while benzene concentration seemed stable. Considering the project's chemical utilization, none of these 9 controlled VOCs is used as well as chemicals in a list of human carcinogen. The measurement results of VOCs emitted from a stack of boiler that uses bituminous coal from the same source as the project, show very low concentration of VOCs.</p>		
<p>2.4 Noise level the noise measurement data from various agencies conducting noise level monitoring routinely in the area during 2007-2009 are collected. These agencies are Map Ta Phut</p>	<p>Construction period</p> <p>Assessment of noise impact on community caused by the project operation considers the impact posed by the project's noise generating source</p>	<p>Construction period</p> <ul style="list-style-type: none"> - Prohibit any construction activities that generate the loud noise between 19.00-07.00 hrs. - Construct temporary fences 	<p>Construction period</p> <p>Parameters : Leq-24 hour and L₉₀</p> <p>Sampling stations : 2 stations</p> <p>* the fence in front of the existing power plant</p>

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>Industrial Estate, Hemaraj Eastern Industrial Estate (Map Ta Phut), Asia Industrial Estate, and the 640-MW power plant facility of Glow SPP3 Co., Ltd. There are total of 7 monitoring stations that are Wat Nong Fab, Wat Map Chalood, Wat Ta Guan Kongkaram, Youth Center, Wat Prachummitr Bamrung, Nam Rin Villa Residence, and along the fence of Glow SPP3 Co., Ltd. The data show that most noise level measurements are well within the standard limit (the standard noise level of not exceeding 70 dB(A)), except in 2007 at Wat Nong Fab that the level exceeded the standard limit. According to a report on performance of its environmental impact prevention and mitigation measures and environmental quality monitoring measures of Asia Industrial Estate, the cause of noise violation was from activity at Wat Nong Fab that used</p>	<p>together with existing noise level in the community (prior to the project operation). Impact is assessed on the community that is closest to the project area which is Nong Fab Commune. It is found that during the construction period the 24-hr equivalent continuous sound level (Leq-24) at Nong Fab Commune is slightly increased. The latest measurement at Wat Nong Fab in April 2010 was increased from 53.1 dB(A) to 54.3 dB(A) (an increase of 1.2 dB(A)), which is about 77.6% of the standard limit (the standard noise level of not exceeding 70 dB(A)). Assessment of impact on disturbing noise level shows that during the construction period the disturbing noise level at Nong Fab Commune reaches maximum level at 4.2 dB(A) which is still within the standard limit (the standard disturbing noise level of 10 dB(A)).</p>	<p>around the construction area.</p> <ul style="list-style-type: none"> - Inspect and maintain the machines and equipment used for construction to be in good condition and in accordance with the instruction manual of each unit. - Conduct public relations to the communities closed to the project on the project construction plan prior to beginning the construction work. - <u>Noise protection equipment such as ear plugs or ear muffs should be adequately provided to construction workers working in the noisy area</u> - <u>Provide knowledge on danger of noise and prevention method</u> 	<p>* Ban Nong Fab</p> <p>Frequency : 2 times a year, 5 consecutive days each time</p>

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>amplifier. However, all noise measurements at Wat Nong Fab in 2008 and 2009 were within the standard limit. Latest noise measurement at Nong Fab commune on 19-22 April 2010 shows 24-hr equivalent continuous sound level (Leq-24) in the range of 52.6-53.1 dB(A).</p> <p>The noise level along the fence of the 640-MW power plant facility of Glow SPP3 Co., Ltd. which is the nearest measurement location to the project area during 2008-2009 which was the project's construction period, was found to be in the range of 61.0-69.1 dB(A) which was still within the standard limit.</p>	<p>Implementation period</p> <p>Assessment of impact on noise level during the implementation period shows that Leq-24 at Nong Fab Commune after the project operation has not been changed from the latest measured Leq-24 at Wat Nong Fab in April 2010 of 53.1 dB(A), which is 75.9% of the standard limit (the standard noise level of not exceeding 70 dB(A)). Assessment of impact on disturbing noise level shows that during the implementation period the disturbing noise level at Nong Fab Commune reaches maximum level at 3.6 dB(A) which is still within the standard limit (the standard disturbing noise level of 10 dB(A)).</p>	<p>Implementation period</p> <ul style="list-style-type: none"> - Plant tall-shaped trees around the project boundary to reduce the noise impact on the local communities. - Install a silencer at the boiler's steam vent to reduce noise level. - <u>Control noise level outside the encloser of machinery such as steam turbine, generator, pulverizer, and pump, etc. not to exceed 85 dB(A).</u> <u>Employees working in the enclose area must wear protection equipment before starting operation.</u> - <u>Clearly post symbols or warning signs showing noise protective equipment requiring area.</u> - <u>Establish inspection plan or maintenance plan for machinery /equipment that are significant noise generating sources.</u> - <u>Notify public or community in advance when it is necessary to</u> 	<p>Implementation period</p> <p>Around the project area</p> <p>Parameters : Leq-24 hour and L₉₀</p> <p>Sampling stations : 2 stations</p> <ul style="list-style-type: none"> * the fence in front of the existing power plant * Ban Nong Fab <p>Frequency : Every 3 months, 5 consecutive days each time</p> <p>Inside the project area</p> <p>Parameters : Leq-8 hour</p> <p>Sampling stations : 2 stations</p> <ul style="list-style-type: none"> * <u>pumping station</u> * <u>boiler building, turbine building and pulverizer building.</u> <p>Frequency : Every 3 months, 5 consecutive days each time</p>

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
		<p><u>conduct noise generating activities during certain period.</u></p> <ul style="list-style-type: none"> - <u>Once starts operation, noise contour map within the production area must be established and revised every 5 years.</u> - <u>Specify the area with noise level exceeding 85 dB(A) as noise protective equipment requiring area.</u> - <u>Identify working distance of employees related to loud noise generation in accordance with the standard prescribed by Ministry of Labor.</u> - <u>Provide noise protective equipment for employees and supervise them to use such equipments.</u> - <u>Train and educate employees on danger of loud noise and prevention method.</u> 	
<p>2.5 Surface water quality and groundwater quality</p> <p>(1) Freshwater source:</p>	<p>Construction period</p> <p>The project has not constructed any structure or building into</p>	<p>Construction period</p> <ul style="list-style-type: none"> - <u>Construct draining ditch and bar screen in the project area/ worker</u> 	<p>-</p>

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>Freshwater sources found in the study area are Song Canal, Sam Canal, Bang Krarun Canal, public draining ditch near Pa Daeng Industrial Estate (formerly known as Bang Bird Canal), Chak Mak Canal, Lhod Canal, Nam Cha Canal, and Nam Hu Canal. Most of them are small canal and not very long. Flow direction is from the north-west or the north to the south of the study area which is the Gulf of Thailand. There is plenty of water during rainy season since these reservoirs receive rainwater from adjacent area and drain it to the sea, while low water quantity is evident in dry season. The public draining ditch near Pa Daeng Industrial Estate (Bang Bird Canal), Chak Mak Canal, Sam Canal, and Bang Krarun Canal are receiving waters for effluent discharged from factories since these canals flow</p>	<p>waterways that will result in a change of flow direction of surface water reservoir and groundwater. Moreover, there is no activity involving in utilization of surface water and groundwater. The project utilizes 500-m draining canal together with the 640-MW power plant facility of Glow SPP3 Co., Ltd. to drain effluent from cooling system to the sea. Consequently, it is not necessary to construct anything or conduct any activity that will affect seawater resource. Most of wastewater generated during this period is from domestic consumption of construction workers. The project has required its contractor to construct temporary toilet/bathroom with septic tanks in adequate number or to adequately provide mobile toilet, and to collect this wastewater and send to a licensed waste processor for disposal.</p>	<p><u>housing to prevent direct discharge into public waterways.</u></p> <ul style="list-style-type: none"> - Provide sufficient toilets for the workers in accordance with the public health standard. - Make sure that there is no blockage to the sewer. - Prohibit discarding waste in the sewer. - Install a screen to collect solid waste out of the rainwater before releasing to the rain gutter. - Occasionally remove dirt and construction materials from the sewer to prevent blocking. 	

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>through or near the area of industrial estates. Furthermore, these canals also flow through various communities that make them receiving waters for domestic wastewater discharged from communities as well.</p> <p>According to Final report of Technical Subcommittee on pollution prevention and mitigation in Map Ta Phut area and its surroundings (2010), the subcommittee studied monitoring measurements of surface water quality conducted by PCD covering public canals in pollution control zone, Rayong province. These canals are Chak Mak Canal, Nam Ho Canal, Huoi Yai Canal, Ta Kuan Canal, Lhod Canal, Nam Cha Canal, Bang Bird Canal, Bang Kra Prun Canal, Phayun Canal, Thap Ma Canal, Nong Khla Canal, Phak Nham Canal, and Krachet Canal. Water sampling is done 4 times a year.</p>	<p>For rainwater falling in the construction area, the project has required its contractor to construct temporary drainage ditch along the same alignment that will be used to construct the permanent drainage ditch in order to drain rainwater falling in the project area into the existing plant's drainage ditch (that has already designed for this purpose). Bar screen is also installed to remove garbage in rainwater before draining into the existing plant's drainage ditch. The contractor is not allowed to litter garbage and construction material scrap into water reservoirs or public waterways.</p> <p>Implementation period</p> <p>Considering wastewater generating sources and corresponding management method, it is found that the project has prepared adequate</p>	<p>Implementation period</p> <p>Wastewater (fresh water)</p> <p><u>Process area and office</u></p> <p>- Collect wastewater from domestic use into a septic tank before releasing</p>	<p>Implementation period</p> <p>Wastewater (fresh water)</p> <p>Parameters : BOD, SS, temperature, pH, TDS and DO</p> <p>Sampling stations : Holding pond</p>

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
Parameters being monitored are typical condition of water stream, color, odor, temperature, turbidity, salinity, pH, DO, NO ₂ -N, NO ₃ -N, NH ₃ -N, PO ₄ -P, Total Coliform and Fecal Coliform, BOD, suspended solid, and heavy metals. The study results can be concluded that <i>"10 parameters of public canals' water exceed the standard limits. These parameters are DO, nutrients (NO₃-N and NH₃-N), bacteria (Total Coliform and Fecal Coliform), heavy metals (As, Mn, Se, and Ni). Two groups of Coliform bacteria and heavy metals are found in the same canals and stations that are used to find these bacterial and heavy metals. Major cause of contamination is domestic wastewater discharged from nearby communities. The measurement results of 2009 showed that water quality in most public canals had only slight change when</i>	and appropriate wastewater/effluent treatment system for each pollutant generated at each generating source. The details of wastewater/effluent generating sources mentioned above are not different from those being indicated in the EIA report approved by ONEP in May 2008. The data on surface water quality, specifically coastal seawater that is the project's effluent receiving water, are also not significantly different from the existing condition. Consequently, the study of impact on water quality herewith will be primarily based on the information indicated in the approved EIA report, especially in the major aspect that may pose significant impact by the project's activities or major pollutants. This aspect is changing temperature of water in effluent receiving water caused by drainage of cooling system's effluent. In addition, there	to the holding pond. <ul style="list-style-type: none"> - Collect wastewater from condensate polisher to be treated at a neutralization tank before releasing to the holding pond. - Install a holding pond of at least 100 m³ for storing treated wastewater and inspecting its quality. The water whose quality is within the standard is drained out to the 500-meter canal and further to the sea. - Collect wastewater from the PC boiler to the holding pond. - Install a retention basin at the size of 1,000 m³ and a chemically-treated wastewater treatment system (as back-up system) to treat the wastewater from ESP or SW-FGD (in the case of washing of ESP or SW-FGD). - If the quality of treated wastewater from the retention basin does not conform to the standard, the water will be retreated in the system until its 	Frequency : Once a month Parameters : hydrocarbon, As, Pb, Hg, Se and Fe Sampling stations : 3 stations <ul style="list-style-type: none"> * Holding pond * Run-off pond * Wastewater from run-off pond Frequency : 3 times a year. Except the wastewater from run-off pond that is analyzed after being treated chemically. Wastewater (seawater) Parameters : temperature, pH, Salinity, conductivity, TDS, turbidity and DO Sampling stations : Project wastewater outfall Frequency : Once a week Parameters : BOD and SS

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p><i>compared to the measurement results of 2008”.</i></p> <p>According to Rayong Environmental Protection Newsletter, April-June volume (2009), published by Pollution control Department (PCD) and Rayong Environmental Protector, PCD has monitored water quality in public canals in Map Ta Phut area and surroundings by collecting water samples 4 times/year at 21 monitoring stations covering 9 canals. They are Chak Mak Canal, Nam Ho Canal, Huoi Yai Canal, Ta Kuan Canal, Lhod Canal, Nam Cha Canal, Bang Bird Canal, Bang Kra Prun Canal, and Phayun Canal. The study results can be summarized as follows.</p> <ul style="list-style-type: none"> - Most of public canals receive wastewater discharge from communities thereby contamination of total coliform and fecal coliform is obviously high. - Public canals receiving industrial 	<p>are other aspects concerned by stakeholders at various public hearing events such as contamination and distribution of residual chlorine compound in effluent receiving water that may be contaminated in cooling system's effluent, contamination and distribution of heavy metals in effluent receiving water and groundwater that may be caused by coal utilization, and impact on coastal corrosion</p> <p>(a) Prediction of changing temperature of water in effluent receiving water caused by drainage of cooling system's effluent the project uses large quantity of seawater for its cooling system (about 42 m3/sec). The project controls its production such that temperature of seawater after passing will not exceed 6 degree Celsius before being discharged into the existing 500-m draining canal together with the</p>	<p>quality conforms to the standard. The water is finally drained out via the 500-meter canal to the sea.</p> <ul style="list-style-type: none"> - Establish a maintenance procedure for all the wastewater treatment systems, and regularly follow the plan. <p><u>Coal yard area</u></p> <ul style="list-style-type: none"> - Install gutters around the yard to collect run-off water from the yard into the run-off pond. The water will always be reused to spray over the coal pile. Therefore, basically there is no such run-off water released from the run-off pond to the outside. - Install a chemically-treated wastewater treatment system to treat the run-off water from the pond that may happen in case of emergency case to ensure the water quality before draining out to the sea. - Overlay the coal yard ground with HDPE (high density polyethylene) 	<p>Sampling stations : Project wastewater outfall</p> <p>Frequency : Once a month</p> <p>Parameters : petroleum hydrocarbon, heavy metals (<u>As, Cd, Hg, and Pb</u>), <u>sulfate and sulfite</u></p> <p>Sampling stations : <u>Project's effluent discharging</u></p> <p>Frequency : 3 times a year</p> <p>Parameters : pH and TDS</p> <p>Sampling stations : Wastewater after being treated from neutralization basin</p> <p>Frequency : Once a month</p> <p>Seawater quality at sea</p> <p>Parameters : temperature, pH, salinity, conductivity, TDS, turbidity, DO and transparency</p> <p>Sampling stations : 7 stations</p> <p>* Station I, near the seawater intake station</p>

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>effluent discharges show high content of dissolved solids.</p> <ul style="list-style-type: none"> - Contamination with heavy metal is evident at some stations where concentrations of Cu, As, and Mn are slightly exceeding the standard limit (As and Mn are most common minerals found in soil and mostly found contaminated in water reservoirs in Thailand). - Domestic wastewater seems to have an effect on water quality in terms of BOD while cause of heavy metal contamination that leads to violation of standard is prevalence of these minerals in soil that results in high concentrations of heavy metals in surface water and groundwater. <p>(2) Coastal seawater quality</p> <p>A study of existing coastal seawater quality (prior to the project operation) was done by collecting monitoring data of coastal seawater quality</p>	<p>drainage of used seawater of the 640-MW power plant facility and the 401-MW cogeneration and steam plant of Glow Energy Public Company Limited that will be operated in the future. The total quantity of these 3 sources is controlled at not exceeding 41 m³/sec and the temperature of seawater after passing the cooling system is controlled at not exceeding 5 degree Celsius. Consequently, the prediction of changing temperature of water in effluent receiving water herewith is about assessment of overall impact that will be posed by simultaneous operation of these 3 mentioned power plants in the future by using mathematical modeling. The study results show that temperature of seawater at 1,000-meter distance from effluent discharging point of the 500-m draining canal is increased by 1.1 ± 0.32 degree Celsius at</p>	<p>to prevent the percolation of washed water into the ground.</p> <ul style="list-style-type: none"> - <u>monitor heavy metal contamination in the project's effluent</u> <p>Wastewater (seawater)</p> <ul style="list-style-type: none"> - Limit the consumption of seawater for the project's cooling system at the maximum rate of 42 m³/second. - Install automatic temperature and chlorine measuring devices at the cooling water outfall. The results are to be displayed at the control room, and also to be recorded. - Control the temperature difference of the seawater used in the project's condenser and SW-FGD of not exceeding 6 °C as follows: <ul style="list-style-type: none"> * Install continuous temperature measuring devices at the seawater pumping station and after the condenser and SW-FGD of the project. The results are displayed at 	<ul style="list-style-type: none"> * Station E, near 500-meter canal outfall * Station A, D and O, 500 meters from 500-meter canal outfall * Station B and C, 1,000 meters from 500-meter canal outfall <p>Frequency : Once a week</p> <p>Parameters : BOD, SS and residual chlorine</p> <p>Sampling stations : 7 stations</p> <ul style="list-style-type: none"> * Station I, near the seawater intake station * Station E, near 500-meter canal outfall * Station A, D and O, 500 meters from 500-meter canal outfall * Station B and C, 1,000 meters from 500-meter canal outfall <p>Frequency : Once a month</p> <p>Parameters : hydrocarbon, <u>As</u>, <u>Cd</u>, <u>Hg</u>, and <u>Pb</u></p>

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>routinely conducted by several agencies (during 2007-2009). These data sources are Map Ta Phut Industrial Estate and the existing 640-MW power plant facility of Glow SPP3 Co., Ltd. Monitoring locations for coastal seawater quality of these data sources consist of 12 locations. The results can be summarized as follows.</p> <p>- For basic parameters specifically DO, it is found that every measurement of each location during 2007-2009 provides the concentration within the seawater quality standard class 5 (for industrial purpose and port).</p> <p>- For nutrients parameters (PO₄-P, NH₃-N, NO₃-N), it is found that most of them are within the standard limit when comparing to the seawater quality standard class 5 (for industrial purpose and port), except the area nearby Map Ta Phut Port (SW4) that</p>	<p>maximum which is not exceeding the control standard at 2 degree Celsius (according to Notification of National Environment Board No.27 B.E.2549). In addition, the previous monitoring results of coastal seawater quality (monitoring every week during 2007-2009) show that maximum temperature of seawater at 1,000-meter distance from effluent discharging point of the 500-m draining canal was 33.2 degree Celsius. With the project operation in the future, water temperature would be increased to 34.3 ± 0.32 degree Celsius at maximum. This can be concluded that the impact will be at acceptable level.</p> <p>(b) Prediction of distribution of chlorine compound that may be contaminated in cooling system's effluent before seawater is used for cooling purpose in the project's</p>	<p>the central control room.</p> <p>* The operator is to control seawater consumption at the optimum rate in relation to the seawater temperature difference before and after the project and to the production capacity. If the temperature difference tends to exceed 6 °C, the project has to increase the seawater flow rate but not exceeding 41.9 m³/second totally, or reduce the production capacity if the maximum usage of water is reached.</p> <p>- Control the concentration of chlorine in the seawater drain of not exceeding 0.1 mg/liter as follows:</p> <p>* Install a continuous measuring device of chlorine concentration in the project's seawater outfall. The result will be displayed at the central control room.</p> <p>* The operator is to control sodium hypochlorite usage at</p>	<p>Sampling stations : 7 stations</p> <p>* Station I, near the seawater intake station</p> <p>* Station E, near 500-meter canal outfall</p> <p>* Station A, D and O, 500 meters from 500-meter canal outfall</p> <p>* Station B and C, 1,000 meters from 500-meter canal outfall</p> <p>Frequency : 3 times a year</p> <p><u>Parameters : contamination of heavy metal</u></p> <p><u>Sampling stations : sediment and aquatic animals' tissue</u></p> <p><u>Frequency : Once a year</u></p>

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>had PO₄-P concentration exceeding the standard limit in 2007. However, all concentrations in 2008-2009 were within the standard limit.</p> <p>- For heavy metal parameters (Fe, As, Se, Hg, Pb, Zn), it is found that most of them are well within the standard limit when comparing to the seawater quality standard class 5 (for industrial purpose and port), except Fe concentrations in some areas that exceeded the standard limit. These areas are SW6 (location of 500 meter distant from discharging point of the existing 640-MW power plant facility of Glow SPP3 Co., Ltd. in the south-west), SW9 (location of 500 meter distant from discharging point of the existing 640-MW power plant facility of Glow SPP3 Co., Ltd. in the south), SW10 (discharging point of the existing 640-MW power plant facility of Glow SPP3 Co., Ltd.), and SW12</p>	<p>condenser or other equipments and in the cooling systems of 640-MW power plant facility (the existing plant) and the 401-MW cogeneration and steam plant of Glow Energy Public Company Limited, it is necessary to add disinfectant to control microorganisms in seawater to prevent clogging of piping system and the project's heat exchanger. The project uses sodium hypochlorite as its disinfectant since it is safer than chlorine gas. The amount of added sodium hypochlorite is controlled appropriately in order to control residual free chlorine concentration remained in the effluent after passing the cooling system of these 3 projects not to exceed 0.1 mg/L or about 10% of the standard limit. According to the EIA report approved by ONEP in May 2008, distribution of chlorine compound that may be contaminated in cooling system's effluent was predicted by</p>	<p>appropriate rate in relation to the measured result. The concentration must be sufficient to control the microorganisms but not exceeding 0.1 mg/liter. If the concentration of chlorine tends to exceed 0.1 mg/liter, the operator has to lower the amount of used sodium hypochlorite in order to control the chlorine concentration to be within the limit.</p> <p>- Install bio boxes to inspect micro fouling organisms in the cooling system. This enables lowering the chlorine use in an appropriate manner without damaging the equipment.</p> <p>- control sulfate concentration in seawater that is used in SW-FGD by controlling sulfur content in coal as specified (maximum not exceeding 1 %), and control quantity and distribution of seawater being sprayed in SW-FGD to trap SO₂ in accordance with the controlled value.</p>	

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>(location of 500 meter distant from discharging point of the existing 640-MW power plant facility of Glow SPP3 Co., Ltd. in the north-west). Fe concentrations were exceeded the standard limit some times in 2007, however, all concentrations in 2008-2009 were within the standard limit.</p> <p>- For total petroleum hydrocarbons, it is found that most of them are well within the standard limit when comparing to the seawater quality standard class 5 (for industrial purpose and port), except the area of SW6 (location of 500 meter distant from discharging point of the existing 640-MW power plant facility of Glow SPP3 Co., Ltd. in the south-west) that the concentrations exceeded the standard limit some times.</p> <p>- For coliform bacteria parameter, it is found that most of them are well within the standard limit when</p>	<p>using mathematical modeling and found that no residual chlorine was found at 1,000-meter distance from effluent discharging point.</p> <p>Moreover, there is a concern on effect of hypochlorite use since it can react with natural organic matter in water and transform into trihalomethanes that are carcinogens. Typically, there is a standard limit prescribed for trihalomethanes in water supply to prevent consumers' health effect while seawater cannot be directly consumed. Nonetheless, the study team has studied the measurement data of trihalomethanes in various forms in seawater before and after its use in the cooling system of 640-MW power plant facility of Glow SPP3 Co., Ltd. of which sodium hypochlorite is also added in seawater for cooling system. The study results show that concentrations of trihalomethanes in forms of chloroform,</p>	<p>- Collect seawater used in cooling system and SW-FGD into an aeration basin to increase oxygen concentration in seawater and to allow complete transformation of sulfite into sulfate before being discharged into the 500-m draining canal and the sea eventually.</p>	

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>comparing to the seawater quality standard class 5 (for industrial purpose and port), except the area of SW1 and SW2 that the concentrations exceeded the standard limit some times in 2008. However, all concentrations in 2009 were within the standard limit.</p> <p>In addition, literature review on the study of existing heavy metal contamination in sediment and marine animal's tissue in the study area reveals that heavy metal currently accumulated in aquatic animal tissue in Map Ta Phut area is still at safe level. The study result can be summarized as follows.</p> <p>(a) According to Final report of Technical Subcommittee on pollution prevention and mitigation in Map Ta Phut area and its surroundings (2010), it can be concluded that throughout the study period there is no contamination</p>	<p>bromodichloromethane, dibromochloromethane, and bromoform in seawater before and after its use in the cooling system are very low and not different from one another. However, concentration of trihalomethanes in form of bromoform in seawater after its use in the cooling system is obviously increased when compared to its concentration in seawater before its use in the cooling system (increasing from 1.3 ug/L to 26 ug/L). However, such increased concentration is still very low when comparing to the standard limit for water supply (about 26% of that standard limit).</p> <p>(c) Impact on seawater quality regarding heavy metals</p> <p>1) <u>Heavy metals in run-off from the coal stockyard</u> the 640-MW power plant facility (the existing plant) has collected run-off from the coal stockyard into run-off pond and</p>		

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>of heavy metal in aquatic animal tissue in Map Ta Phut area that exceeds the seafood standard for consumable aquatic animal.</p> <p>(b) According to the research study “Risk assessment of marine pollutants in eastern seaboard industrial area” (Chaluay Musika and colleagues, 2009; The Institute of Marine Science, Burapa University), seawater and sediment samples around the coastal area of Laem Chabang Industrial Estate in Chonburi Province and Map Ta Phut Industrial Estate in Rayong Province were collected from 23 sampling stations during 2007-2008 to study the concentrations of heavy metals (i.e., Hg, Cd, Pb, Cu, Zn, Ni, Fe, and Mn). The study concluded that average risk of each heavy metal in seawater and sediment was still at low level for both dry season and rainy season and had similar value between Laem Chabang</p>	<p>recirculated it back to spray at the coal stockyard for prevention of particulate matter and control of temperature in coal pile. From the operation since 1999, the existing plant has never discharged its run-off to outside environment and never experienced overflow of run-off pond. Monitoring of run-off quality in run-off pond gives emphasis on heavy metals that may be contaminated in coal. The monitoring results show As concentration in the range of 0.0014-0.0023 mg/L or about 0.56% of the standard limit, while concentrations of Cd, Hg, and Pb are lower than the detection limits of their analytical methods of 0.004 mg/L, 0.001 mg/L, and 0.04 mg/L, respectively. Consequently, it can be concluded that heavy metal contamination in run-off from the coal stockyard is very low and insignificant when comparing to</p>		

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>Industrial Estate and Map Ta Phut Industrial Estate.</p> <p>(c) According to the thesis “Estimation of heavy metal intake from seafood consumption in the population of Muaeng District, Rayong Province” (Pimonwan Kerdthep, 2008; Department of Food and Pharmaceutical Chemistry, Faculty of Pharmaceutical Sciences, Chulalongkorn University), heavy metal concentrations in seafood such as Cd, Pb, As, and Hg was investigated and heavy metal intake from seafood consumption was estimated from the consumers in the area of Muaeng Rayong District, Rayong Province. The study showed that heavy metal contamination levels in 39 samples of 13 seafood types were lower than the standard limit of ministry of Public Health, except As concentration in Soft Cuttlefish, Splendid Squid, Yellow Stripe Trevally,</p>	<p>the effluent standard limit prescribed in the Notification of Ministry of Industry No.2 B.E.2539.</p> <p><u>2) Heavy metals in seawater used in cooling system</u> the power plant facility of Glow SPP3 Co., Ltd. has used seawater for cooling purpose. The measurement of heavy metal concentrations in seawater comparing between seawater at pumping point (before use) and seawater after passing the cooling system (before discharge) shows that heavy metal concentrations in seawater after passing the cooling system are not different from those in seawater at pumping point. Consequently, it can say that the operation of the power plant facility of Glow SPP3 Co., Ltd. has not posed any impact that leads to heavy metal contamination in seawater. In addition, the increasing heavy metal concentration in seawater after passing</p>		

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>Ornate Threadfin Bream, and Mussel that had contamination level slightly exceeding the standard limit. However, when comparing to Provisional Tolerable Weekly Intake (PTWI) suggested by World Health Organization (WHO), the concentration was still considered as at safe level.</p> <p>(3) Groundwater quality</p> <p>The existing groundwater quality in the study area (prior to the project operation) was studied by collecting monitoring measurement data of groundwater quality routinely conducted by several agencies (during 2007-2009). These data references are Map Ta Phut Industrial Estate (monitoring of groundwater quality 3 times a year) and Asia Industrial Estate (monitoring of shallow well water quality twice a year). There were 5 monitoring locations. Parameters being measured corresponding to the standard are</p>	<p>the cooling system (before discharge) is still lower than the effluent standard limit. Comparing to the standard limit of seawater reservoir quality, quality of seawater before discharging is also better than the effluent standard limit.</p> <p><u>Remark:</u> although the component analysis of heavy metal in coal used in this project shows concentration levels less than the instrument's detection limit and the measured heavy metal concentration probably emitted from power plant facility of Glow SPP3 Co., Ltd. came out at very low value, heavy metal concentration must be assumed at the instrument's detection limit in order to allow comprehensible assessment of health impact caused by heavy metal generated from the project operation. Distribution of heavy metals to the environment is predicted and the predicated concentration is then used in assessing health effect. Nevertheless,</p>		

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>heavy metals (As, Se, Hg, Cr, Cu, Cd, Pb, Mn, Ni, Zn) and VOCs (1,1,1-trichloroethane, 1,1,2-trichloroethane, 1,1-dichloroethylene, 1,2-dichloroethane, benzene, carbon tetrachloride, cis-1,2-dichloroethylene, dichloroethane, ethylbenzene, methyl chloride, styrene, tetrachloroethylene, toluene, total xylene, trans-1,2-dichloroethylene, trichloroethylene, vinyl chloride, 1,4-dichlorobenzene).It can be summarized that groundwater quality in shallow well with heavy metal monitoring shows all measurements during 2007-2009 were within the standard limit every time, while shallow well water quality with heavy metal and VOCs monitoring showed all measurements during 2007-2009 were within the standard limit every time (based on the groundwater quality standard prescribed in Notification of National Environment Board No.20 B.E.2543).</p>	<p>this procedure gives overestimated result which can be considered that impact assessment is employed under worst case situation.</p> <p>The study results on distribution of heavy metals to the environment can be summarized as follows.</p> <p>* Considering the information from EUROPEAN COMMISSION (2006) (Integrated Pollution Prevention and Control; Reference Document on Best Available Techniques for Large Combustion Plant) which refers to mass balance of heavy metal generated from coal utilization as fuel in a power plant that installs Electrostatic Precipitator (ESP) and Flue Gas Desulfurization (FGD), it is shown that heavy metal contaminated in coal is mostly remained in bottom ash and fly ash that is removed by ESP while some heavy metal may be emitted through the stack and removed by FGD. The project</p>		

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>In addition, according to Final report of Technical Subcommittee on pollution prevention and mitigation in Map Ta Phut area and its surroundings (2010), the subcommittee studied monitoring measurements of groundwater quality conducted by PCD covering 91 wells (45 groundwater well and 46 shallow well) and parameters of 11 heavy metals, 16 VOCs, and basic parameters. The study results can be concluded that <i>“in 2009 monitoring results of shallow water wells in pollution control zone of Rayong province showed 11 parameters exceeding the groundwater quality standard limit. These 11 parameters were 7 heavy metals (Cu, Cd, Pb, Mn, Ni, As, and Se) and 4 VOCs (dichloromethane, 1,2-dichlorethane, carbon tetrachloride, and vinyl chloride). However, most trouble some parameters were Mn and As which were heavy metals commonly</i></p>	<p>therefore has designed to use seawater to absorb SO₂ from the air emission generated from a boiler, known as Seawater FGD, which may induce contamination of heavy metal in seawater that is used in cooling system before being discharged into the seawater reservoir in the west of the project area.</p> <p>* The project pumps about 42 m³/sec of seawater to be used for cooling purpose at condenser and other equipments. It has also designed to use some portion of seawater after passing the cooling system to be used at Seawater FGD for removal of SO₂ from air emission generated from a boiler. Effluent from Seawater FGD is fed into an aeration tank before being discharged into the seawater reservoir in the west of the project area via the draining ditch.</p> <p>* Estimation of heavy metals</p>		

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p><i>found in soil in Thailand. Their percentage values of number of wells showing standard limit violation for measurements conducted in November 2009 were 15.22 and 8.7, respectively. For groundwater, there were 8 pollutants having their concentrations exceeding the standard limit. These pollutants were 5 heavy metals (Pb, Mn, Zn, As, and Se) and 3 VOCs (1,2-dichlorethane, dichloromethane, and vinyl chloride). Most trouble some parameters were Mn, As, and vinyl chloride. Their percentage values of number of wells showing standard limit violation for measurements conducted during November 2009 – January 2010 were 50, 38.9, and 22.22, respectively. Groundwater quality parameters in 2009 mostly were not different from those of 2008 and 2007. As, Fe, Zn, and Mn were most commonly found minerals in soils and groundwater in this area, and</i></p>	<p>that may be contaminated in seawater is a prediction of an increase in heavy metal concentration by comparing between concentrations in seawater at pumping location before being used in the project and those in seawater after passing the cooling system before being discharged into the sea. The calculation of heavy metal contamination in seawater shows that the increasing heavy metal concentration in seawater after passing the cooling system (before discharge) is still lower than the effluent standard limit. Comparing to the standard limit of seawater reservoir quality, quality of seawater before discharging is also better than the standard limit.</p> <p>(d) Impact on groundwater quality regarding heavy metals after considering the measurement results of effluent quality and run-off from the coal stockyard (at run-off pond) of the</p>		

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p><i>they are naturally originated. On the other hand, contamination of VOCs mostly was found in the area inside a factory”.</i></p>	<p>existing plant as mentioned in (c), it is found that heavy metal contamination in effluent is very low and insignificant. In addition, the project’s effluent holding pond, effluent draining ditch, and run-off pond are constructed with concrete which can prevent absorption of water into groundwater reservoir. Consequently, the impact on groundwater quality posed by the project operation is at low level.</p> <p>(e) Coastal corrosion the project is located in a vacated land of the 640-MW power plant facility of Glow SPP3 Co., Ltd. which is the result of land reclamation of IEAT. The project operation has not resulted in any more land reclamation. Impact that may be posed by the project operation may be generated from an increasing use of seawater pumping for cooling purpose. After simultaneous operation of this project and the 401-MW cogeneration and steam plant of Glow Energy Public</p>		

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
	<p>Company Limited. In the future, overall quantity of cooling water discharged into the existing plant's 500-m draining canal is about 83 m³/sec. Considering the measurement of water tide regarding the issue of coastal corrosion, it is found that quantity of cooling water discharged into the sea compared to large mass of seawater at discharging point is very low therefore the impact on change of water velocity that may induce coastal corrosion will be at low level.</p>		
<p>3. Biological resources and ecosystems</p> <p>3.1 Biological resources and terrestrial ecosystems</p> <p>(1) Forest Resources: Rayong province has 8 locations of forest area under National Forest Reserve Act and 2 locations of forest area under Royal Decree on National Park. All 8 national forest reserves cover area of 513,743</p>	<p>Considering the project description and the environmental condition regarding biological resources and ecosystems in the area, it is found that the existing condition is not significantly different from what being prescribed in the EIA report approved by ONEP in May 2008. Consequently, the assessment of impact on biological resources and ecosystems herewith is primarily based</p>	<p>Implementation period</p> <ul style="list-style-type: none"> - Install a traveling screen with the mesh size of not larger than 1 sq.cm. - Control the velocity of the seawater in front of the intake tunnel of not more than 0.3 m/s to help sea animals escape from the suction. - The seawater intake tunnel shall be designed to be at least 2 meters deep from the seawater surface to 	<p>Implementation period</p> <p>Parameters : Type, quantity, diversity and density of phytoplankton, zooplankton and benthos</p> <p>Sampling stations : 6 stations</p> <ul style="list-style-type: none"> * Station I, near the seawater intake station * Station A, D and O, 500 meters from 500-meter canal outfall * Station B and C, 1,000

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>rais consisting of 1) Prasae-Pangrad mangrove forest 2) Ban Pe forest 3) Klong Ra-reong forest and Khao Somget forest 4) Nong Sanom forest 5) Ban Na forest and Tung Khwai Kin forest 6) Ka-chet forest, Pe forest, and Klang forest 7) Hin Tang Mountain forest and 8) Huoi Ma-had forest, Nang Yong Mountain forest, and Krok Mountain forest. National parks in the area consist of Khao Laem Ya-Moo Koh Samet National Park and Khao Chamao-Khao Wong National Park. In addition, there are 1 wildlife sanctuary that is Khao Ang Rue Nai Wildlife Sanctuary and 2 arboretums that are Pe Arboretum and Nong Sanom Arboretum. Forest survey conducted by Rayong provincial forest office in 2004 shows that Rayong has remaining forest area of 130,625 rais or about 5.88% of Royong province's area. Most forests in this province are dry</p>	<p>on the information in the approved EIA report and also revises some information to be consistent with the current condition.</p> <p>- Biological resources is living organisms in an ecosystem in each area. They can be divided into producers, consumers, and decomposers. Producers are those that can utilize energy from sunlight by photosynthesis to make their own food from minerals and materials available in the nature. They are green plants, phytoplankton, and some bacteria. The producers play significant role in the nature by playing the starting part and the connecting part between non-living components of the ecosystems. Consumers are those that cannot synthesize their own food and must eat other living organisms as food to obtain energy in from of organic matter. There are four types of consumers: herbivores</p>	<p>reduce the loss of plankton, which mostly stay at 30 cm to 2 meter in depth.</p> <p>- Coordinate with local communities and related academic institutes to set up a proper procedure/plan to supplement economic marine species at sea. At first, the project plan to release as many as 1 million per year of the culture marine juveniles for the first three years during operation.</p> <p>- Follow up the supplemental plan implementing results through various means including interviewing the local fishermen on the total catch and income, and so on. The results will be analyzed for further improvement of the plan, while the plan improvement is to be undertaken in every 2-3 years.</p> <p>- Follow up the changes in numbers of early-stage marine animals at the project's seawater intake station in</p>	<p>meters from 500-meter canal outfall</p> <p>Frequency : 3 times a year</p> <p>Parameters : Type, quantity, diversity and density of early-stage marine animals</p> <p>Sampling stations : 2 stations</p> <p>* Station I, near the seawater intake station</p> <p>* Station B, 1,000 meters from 500-meter canal outfall</p> <p>Frequency : 3 times a year</p>

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>evergreen forest. Mangrove forest, mixed deciduous forest, and grove are also found in this area. Forest resources found in this study area are not designated as protected forest. Most areas have been developed for agricultural area, industrial area, residential area, and commercial area.</p> <p>(2) Wildlife Animals: at present, Rayong province's ecological system has changed from wildlife habitat to urban ecosystems, agricultural area, and industrial area. Consequently, in most of Rayong area there is no evidence of rare or endangered species, except those areas in the boundary of wildlife sanctuary or that of research watershed station where there might be some wildlife present. Most wildlife lives in Khao Ang Rue Nai Wildlife Sanctuary. Most commonly found wildlife are both big and small animals such as birds, squirrel, gibbon,</p>	<p>(1st) are animals that eat plants, carnivores (2nd) are animals that eat herbivores and sometimes other carnivores, omnivores (3rd) are animals that eat plants and other animals, and 4th consumers are those that are not eaten by other living organisms. Decomposers are those that cannot make their own food but will break down dead plants and animals, by using their enzymes, into organic materials for absorption and then release the rest into the ecosystem which the producers can use it. The decomposers therefore are a significant component of the ecosystem to allow minerals and nutrients to be circulated in the food cycle.</p> <p>- Ecosystem is a structural relationship between living organisms or biological resources in an area. The ecosystem connects with physical resources such as soil, water, air, etc.</p>	<p>order to evaluate for appropriate number of marine lives to be released.</p> <ul style="list-style-type: none"> - Support the local fishermen to create "crab bank" in order to hatch crab eggs from crab parents to increase crab numbers in the natural sea. - Interview and survey the opinions of local fishery villagers on pros, cons, obstacles and achievements owing to the restoration and supplemental measures. The results will be used for improving the measures to be most effective. - Evaluate the achievements and obstacles of the restoring and supplemental measures by coordinating with experts and academic institutes in order to improve the measures to be most effective and suitable for the project location. 	

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>munthjac, elephant, gaur, Sambar deer, tiger, panther, Asian wild dog, bear, thick -billed pigeon, serow, etc. Most commonly found reptiles in this area are skink, Bengal monitor, and snakes. At present, the study area has been developed into agricultural area and industrial area. Consequently, in most of the study area there is no evidence of rare or endangered species. Most wildlife found in this area is birds, certain mammals, reptiles, and amphibians.</p> <p>3.2 Biological resources and aquatic ecosystems Water reservoirs in this study area mostly are small reservoirs. Large amount of water is expected during rainy season while water is scarce during dry season. Important water reservoir in this area is therefore seawater source. This study puts main emphasis on aquatic biological resources in seawater by gathering the</p>	<p>of which involves limiting factors such as temperature, light, vibration, pH, salinity, or humidity.</p> <p>Such mentioned relationship inevitably makes living organisms or biological resources in the ecosystem to interact with other environments. Consequently, what affects the ecosystem also affects living organisms in it. Assessment of impact herewith is therefore carried out to evaluate overall impact on biological resources and ecosystems.</p> <p>5.3.1 Assessment of impact on Biological resources and terrestrial ecosystems</p> <p>(1) Construction period the project is located in the industrial estate area which is allocated specifically for industrial purpose. The project is also located in a vacated land of the 640-MW power plant facility without expansion of industrial land in the study</p>	<ul style="list-style-type: none"> - Interview the local communities in 5-km radius around the power plant, especially those practicing aquaculture on the production statistics and water quality since the past to present times. - <u>Support a research study on monitoring of heavy metal contamination in marine aquatic animals.</u> - <u>Support and coordinate with related agencies such as the Fishery Department, the Department of Marine and Coastal Resources, relevant research institute, etc. in rehabilitating or conserving coral reef in the Rayong Province area such as supporting coral reef plantation activity or artificial coral reef plantation by considering what appropriate for the area.</u> 	

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>monitoring results of aquatic biological resources in seawater (plankton, marine benthos, number of eggs and larvae) from the report on environmental quality monitoring of Map Ta Phut Industrial Estate and the report on performance of environmental measures of the 640-MW power plant facility during 2007-2009. The monitoring was conducted at 11 stations for 3 times a year. In addition, information on coral reef in the study area is also collected from the data of Department of Marine and Coastal Resources.</p> <p>The collected monitoring results of biological resources in seawater as mentioned above can be summarized as follows.</p> <p>1) Phytoplankton: density of phytoplankton in this area is 1,652-1,229,484 cells/liter which most commonly found phytoplankton were</p>	<p>area. According to the pollution control measures during the construction period and environmental impact prevention and mitigation measures during the construction period, the project requires a contractor to construct temporary toilet/bathroom with septic tanks in adequate number or to adequately provide mobile toilet, and to collect this wastewater and send to a licensed waste processor for disposal in order to prevent impact on water reservoir in the area. In addition, wastes generated from construction workers and construction activities are collected to send to Map Ta Phut District Municipality or a licensed waste processor. It can be seen that the project construction will pose an impact on biological resources and terrestrial ecosystems at low level.</p> <p>(2) Implementation period activities that may pose an impact on biological</p>		

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>of Phylum Chromophyta of which most commonly found species is <i>Skeletonema</i> sp., followed by <i>Chaetoceros</i> sp. Biodiversity index is in the range of 0.2513-2.5414. Most biodiversity index values are higher than 1.0 (only some biodiversity index values that are less than 1.0).</p> <p>2) Zooplankton: Density of zooplankton in this area is 55-365,956 individual/liter which most commonly found zooplankton were of Phylum Arthropoda of which most commonly found species is Copepod nauplii, followed by Nauplii. Biodiversity index is in the range of 0.3466-1.8892. Most biodiversity index values are higher than 1.0 (only some biodiversity index values at some period and some stations that are less than 1.0).</p> <p>3) Marine Benthos or living organisms that lives on seabed or</p>	<p>resources and terrestrial ecosystems are air pollutants that are NO_x and SO₂ being emitted from the project's boiler. High concentration of these gases can pose direct impact or indirect impact by reacting with water vapor resulting in acid rain. Nonetheless, according to information on air pollution control measures and air quality modeling, it is found that the project has operated based on the principle that no increase of overall air pollutant emission in the area. In addition, the result of air quality modeling shows that the project operation has not resulted in an increase of concentration at the most affected area. The estimation of NO_x and SO₂ concentrations in ambient that may be changed after the project operation (comparing to the actual measurement) shows the concentrations lower than the standard limit. Consequently, it can be concluded that</p>		

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>immerses in seabed: Its density is 45-2,313 individual/m² which most commonly found benthos is คือ Onuphidae, followed by <i>Meretrix meretrix</i>. Biodiversity index is in the range of 0.4759-2.5369. Most biodiversity index values are higher than 1.0 (only some biodiversity index values at some period and some stations that are less than 1.0).</p> <p>4) Number of eggs and larvae: Number of eggs and larvae found is in a range of 222-88,472 individual/liter which most commonly found eggs and larvae is Plecypod larvae, followed by Atlanta larvae.</p> <p>Considering biodiversity index of the measurements at these mentioned stations for phytoplankton, zooplankton, and marine benthos or living organisms that lives on seabed or immerses in seabed, it is found that most biodiversity index values are</p>	<p>the project's air pollution control system will not pose any more impact on biological resources and terrestrial ecosystems in the area.</p> <p>5.3.2 Assessment of impact on Biological resources and freshwater aquatic ecosystems</p> <p>(1) Construction period no structure is constructed in waterways since the project uses the existing 500-m draining canal together with the 640-MW power plant facility of GLOW SPP3 Co., Ltd. to drain its cooling system's effluent to the sea. Most wastewater generated from domestic consumption of construction workers. The project requires a contractor to construct temporary toilet/bathroom with septic tanks in adequate number or to adequately provide mobile toilet, and to collect this wastewater and send to a licensed waste processor for disposal. Consequently, the project's construction</p>		

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>higher than 1.0. Consequently, it is indicated that the seawater in this area still has moderate quality according to the study of Wilhm and Dorris (1968).</p> <p>The study of coral reef data in the study area is conducted by gathering information from Department of Marine and Coastal Resources and a journal article of Ronawon Boonprakob and Piyachok Sinanun from the 38th Technical conference of Kasetsart University. The study shows that there is coral reef around Saked Island which is a small island of 5 kilometers away in the south-east of the project area. It is stand-alone island without protection from wave and wind during the monsoon; the coral reef therefore has not been developed intensely. Better growth of coral reef is evident in the east of the island in form of</p>	<p>activities will pose an impact on biological resources and freshwater aquatic ecosystems at low level.</p> <p>(2) Implementation period during the implementation period, the project has prepared adequate and appropriate wastewater/effluent treatment system for each pollutant generated at each generating source. The treated effluent is directly discharged into the sea. No discharge of wastewater into public canal. Consequently, the project operation will not pose an impact on biological resources and freshwater aquatic ecosystems in the study area.</p> <p>5.3.3 Assessment of impact on Biological resources and marine aquatic ecosystems</p> <p>(1) Construction period no structure is constructed in waterways or in the sea during the construction period. Moreover, the project requires a contractor to construct temporary</p>		

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>Patch reef being distributed around the coast until 100-m distance from the coast by ending at 1-2 meter depth. Mostly found coral reef is <i>Porites lutea</i> that has small size distributed on the sand surface. There is coral reef formulated around the nearby rocks in the north-east of the island as wide as 50 meters and as deep as 2 meters. Majority coral reef is <i>Acropora spp.</i> In addition, <i>P. lutea</i> and <i>Pocillopora damicomis</i> are also evident. The coral reef at Saked Island is considered to be in moderately good condition at elevated zone with living and death coral of 20% (± 7), 25% (± 20), respectively.</p>	<p>toilet/bathroom with septic tanks in adequate number or to adequately provide mobile toilet, and to collect this wastewater and send to a licensed waste processor for disposal. Consequently, the project's construction activities will pose an impact on biological resources and marine aquatic ecosystems at low level.</p> <p>(2) Implementation period major aspects of impact posed by the project operation are as follows.</p> <p>* Sodium hypochlorite must be added to seawater that is used in the project's cooling system to disinfect microorganisms in seawater before use and to prevent clogging of piping system and equipments. This chemical addition may result in a loss of marine biological resources such as phytoplankton and zooplankton, and aquatic animals' eggs and larvae. This can be described as follows.</p>		

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
	<p>- phytoplankton: estimation of plankton loss is based on information of average density of plankton that is measured at seawater pumping location (for cooling purpose) and seawater pumping rate. It is found that loss of phytoplankton and zooplankton are about $23,195.77 \times 10^6$ cells/sec and 72.43×10^6 zooplankton/sec, respectively. Considering overall loss of plankton after the simultaneous operation of the existing plant, this project, and the cogeneration and steam plant of Glow Energy Public Company Limited that has overall seawater pumping rate of $82 \text{ m}^3/\text{sec}$, it is found that loss of phytoplankton and zooplankton will be about $45,286.98 \times 10^6$ cells/sec and 141.41×10^6 zooplankton/sec, respectively. Although seawater pumping for cooling purpose may lead to a loss of plankton, plankton can be regenerated at very fast rate specifically in the climate</p>		

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
	<p>condition of Thailand being in tropical zone with continual sunshine throughout the year and continual water tide. On the other hand, these planktons naturally have short life-cycle, about 3-4 days. Consequently, the impact will be at acceptable level. Nonetheless, rehabilitation measures for aquatic animal resources, mitigation measure for fishery in the area, and impact monitoring measures must be established.</p> <p>- Aquatic animals' eggs and larvae are different from plankton. Aquatic animals and their larvae can relocate therefore they can move to the new area that is suitable for their living and breeding. The area suitable for living and breeding of larvae is the area with plenty of food nutrients such. These areas are mangrove forest and river delta areas since they are the place that food nutrients are</p>		

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
	<p>accumulated. Moreover, these areas have brackish water. Tree roots also act as hiding place for these animals. Considering the coast's physical condition around the project area (located in a vacated land of the existing plant), it is found that its condition is different from natural coastal area since the area is a result of land reclamation for industrial purpose and port construction. Based on this face, this area is therefore not suitable for living and breeding of larvae. The measurement result of eggs and larvae in seawater at seawater pumping location of the 640-MW power plant facility shows that mostly found eggs and larvae are larvae of Copepod nauplii, eggs of Miscellaneous egg, Pelecypod larvae, Polychaete larvae, and Miscellaneous egg, respectively. Consequently, use of seawater for cooling purpose after the</p>		

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
	<p>project operation will pose impact at acceptable level. Nonetheless, rehabilitation measures for aquatic animal resources and impact monitoring measures must be established.</p> <p>* Discharge of the cooling system's effluent into the sea can pose an impact on biological resources since it may increase the temperature of seawater. Considering the management and control of effluent temperature and prediction of temperature of water at the project's effluent receiving water after the simultaneous operation of the existing plant, this project, and the cogeneration and steam plant of Glow Energy Public Company Limited, it is found that after the simultaneous operation of these 3 projects in the future the temperature of seawater at 1,000-meter distance from effluent discharging point canal is increased</p>		

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
	<p>by 1.1 ± 0.32 degree Celsius at maximum which is not exceeding the control standard at 2 degree Celsius (according to Notification of National Environment Board No.27 B.E.2549). Consequently, the project operation will result in a temperature change that may lead to an impact on biological resources and marine aquatic ecosystems at acceptable level. Nonetheless, impact prevention and monitoring measures must be established.</p> <p>5.3.4 Assessment of heavy metal contamination in sediment or food chain</p> <p>Heavy metal contamination may be a result of the project activity that utilizes seawater to remove SO₂ from air emission at boiler stack (at SW-FGD). Extent of contamination depends on heavy metal constituents found in coal. The component analysis</p>		

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
	<p>of coal shows that concentrations of Cd, Hg, and Pb are undetectable since they are lower than detection limits of the instrument. According to prediction of heavy metal contamination in seawater used in this project, it can be concluded that the project activity may result in an increase of As, Cd, Hg, and Pb concentrations by $0.0132 \mu\text{g}/\text{m}^3$, $0.0341 \mu\text{g}/\text{m}^3$, $0.0248 \mu\text{g}/\text{m}^3$, and $0.1240 \mu\text{g}/\text{m}^3$, respectively. Combining these increased concentrations with the existing concentrations of heavy metals in seawater before use, the concentrations of As, Cd, Hg, and Pb in seawater before being discharged will be $1.7132 \mu\text{g}/\text{m}^3$, $0.0341 \mu\text{g}/\text{m}^3$, $0.0748 \mu\text{g}/\text{m}^3$, and $7.112 \mu\text{g}/\text{m}^3$, respectively. These concentrations are lower than the standard limits of $250 \mu\text{g}/\text{m}^3$ As, $30 \mu\text{g}/\text{m}^3$ Cd, $5 \mu\text{g}/\text{m}^3$ Hg, and $200 \mu\text{g}/\text{m}^3$ Pb). In addition, the concentrations are lower than the</p>		

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
	<p>seawater quality standard limit.</p> <p>These mentioned heavy metals are quite stable and cannot be naturally degraded. When these heavy metals contaminate into the seawater reservoir, some of them are accumulated in soil sediment and some may be biochemically transformed and accumulated into tissue of living organisms and transferred through the food chain. Nonetheless, prediction of heavy metal contamination, as a result of the project operation, that may be accumulated in food chain has several limitations especially factors related to pathway of each heavy metal from the beginning when being discharged into the sea until get accumulated throughout the food chain. Hopefully, these factors will be investigated by future research study to allow prediction of heavy mental contamination that is suitable for the environmental condition</p>		

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
	<p>of the area. However, it can be seen that the project operation has not resulted in a significant change of heavy metal concentrations in seawater and the concentrations are also lower than the standard limit. Consequently, the study on existing heavy metal contamination in aquatic animals' tissue in the study area relies on literature review which can be concluded that the existing heavy metal contamination in aquatic animals' tissue in Map Ta Phut area is at safe level.</p>		
<p>4. Human Use Values</p> <p>4.1 Land use</p> <p>- Land use pattern in the study area in the 5-kilometer radius of the project site, land use can be classified into 4 types. They are sea area, industrial area, agricultural area and other area, and community area and commercial area. Most area is sea area (44.68%), followed</p>	<p>Construction and implementation periods</p> <p>The project is located in Mueang Rayong District, Rayong Province. Reviewing the land use pattern of the project area shows consistency with the relevant development plan as follows.</p> <p>(1) The project operation is corresponding to the land use master plan on industrial purpose according to</p>	-	-

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>by the industrial area (32.93%).</p> <p>- City plan within the study area:</p> <p>The project area and the study area are mostly in the boundary of city plan for major industrial area and Ban Chang Commune, Rayong Province. This city plan specifies land use purpose for the project area to be industrial land and cargo. Currently, Maptaphut District Municipality has appointed the consultant to study and formulate a new city plan. The progress so far is in the process of analyzing data and public hearing which is expected to complete by 2010. However, while waiting for such city plan to be finished, related regulations have to be followed. At present, municipalities in this area have announced their notifications to specify prohibited area for construction and modification of certain types of building. Most of</p>	<p>Eastern Seaboard Development Plan: Phase 2 as approved by the Cabinet's resolution relating to the promotion of industrial development in central area.</p> <p>(2) The project site is not located in the environmental protection area. Reviewing the information in the public manual, it is found that ONEP has announced the environmental protection area for the basin area of Nong Palai reservoir, Dok Krai reservoir, and Klong Yai reservoir. The project area is not included in these above mentioned environmental protection areas.</p> <p>(3) The project is located in Map Ta Phut Industrial Estate area that is a result of land reclamation specifically for industrial development purpose. The industrial estate project and the land reclamation project have prepared the EIA reports and prescribed the environmental impact prevention measures and impact monitoring</p>		

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>study area is located in the boundary of city plan of 2003 for major industrial area and Ban Chang Commune which has just been expired. This city plan specifies land use purpose for the project area to be industrial land and cargo.</p> <p>According to the results of public hearing events conducted for environmental and health impact assessment in the study area, stakeholders have suggested related agencies about criteria for buffer zone between community and industrial area, and criteria for protection strip of factories located outside industrial estate zone. So far, the Resolving Committee for compliance of Section 67 paragraph 2 of the Constitution of the Kingdom of Thailand B.E.2550 has already proposed mitigation measures for pollution problems in Map Ta Phut area and surroundings to Prime</p>	<p>measures for each environmental aspect before proceeding with the operation.</p> <p>In addition, although the project is located in the pollution control zone (refer to the Notification of National Environment Board No.32 B.E.2552), the project has realized the importance of the environmental impact prevention and mitigation measures for each environmental aspect to ensure that its operation will not significantly change the environmental condition of the area. The project has operated in according to the resolution of National Environment Board by reducing the overall air pollutant emission (NO_x and SO₂) of the existing plant before the project operation and designing the control of overall air pollutant emission from the new project at not exceeding 80% of the amount reduced. As a result, the overall air pollutant emission</p>		

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>Minister for consideration.</p> <p>- Pollution control zone in the study area: The project area and the study area are located in pollution control zone according to Notification of Environment Board No.32 (2009), which requires Rayong province to establish its environmental management action plan at provincial level. This action plan must include an action plan for pollution minimization and elimination established by local authority in the pollution control zone. At present, it is in the process of writing up the project description to be consistent with related regulation and considering the budget allocation for the implementation and reporting to National Environment Board.</p>	<p>in the area is not increased. Moreover, the project has clearly established the measures to be carried out which is consistent with the pollution prevention and mitigation action plan for pollution control zone, Rayong province.</p>		
<p>4.2 Transportation</p> <p>(1) Land transportation Major roads that pass Mueang Rayong District are National Highway no.3 and National</p>	<p>Construction and implementation periods</p> <p>Evaluation of existing traffic condition (prior to the project development) and</p>	<p>Construction periods</p> <p>- Provide training to the truck/bus drivers to strictly pursue the traffic rules and regulations.</p>	<p>Construction periods</p> <p>- In and out traffic record of the preobject's area at the preject's gate, classify a type of vehicles every day</p>

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>Highway No.3191. National Highway no.3 is an important route for transportation of raw materials and products from other regions into Rayong province area. The survey result of traffic volume during 2006-2010 shows that National Highway No.3 at Km.206+753 had traffic volume of 37,443-52,086 vehicles/day while National Highway No.3191 at Km.0+500 had traffic volume of 25,688-31,960 vehicles/day. Four-wheel small truck is mostly found vehicle type in both routes.</p> <p>(2) Marine transportation Map Ta Phut Industrial Port consists of 12 berths divided into 10 specific berths and 2 public berths. Currently, there is an increasing demand for the use of port or port area with the frequency as high as 2,000-4,000 ships/year. Consequently, there will be the expansion project for this port to</p>	<p>evaluation of changing traffic condition as a result of the project operation during both construction and implementation periods are conducted on National Highway no.3 and National Highway No.3191. National Highway no.3 and National Highway No.3191 during 2 periods that are non-rush hour period and rush hour period. The evaluation result of traffic condition can be described as follows.</p> <ul style="list-style-type: none"> - Existing traffic condition during non-rush hour period (prior to the project development) of National Highway No.3 is good while that of National Highway No.3191 is very good. The evaluation of traffic condition after the project operation shows that traffic condition of both National Highway no.3 and National Highway No.3191 are slightly changed but still in good and very good condition, respectively. - Existing traffic condition during rush 	<ul style="list-style-type: none"> - Limit the vehicle speed in the construction area to not exceeding 40 km/hour. - <u>Limit truck speed in community area according to the legal limit.</u> - Inspect and maintain the vehicles and machines used for construction to be in good condition and in accordance with the instruction manual of each unit. - Avoid transportation during rush hours (07.00-08.00 and 17.00-18.00 hrs.). - Limit the vehicle weight to be under the related standard and law in order to avoid the damage of the road surface. - Manage the road traffic within the construction site by assigning responsible persons to facilitate the incoming and outgoing of vehicles. <p>Implementation period</p>	<p>and report every 6 months throughout the construction period.</p> <ul style="list-style-type: none"> - The numbers and causes of accident at the project's gate are operated every day and report every 6 months throughout the construction period.

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>support the increasing demand.</p> <p>(3) U-Tapao Airport : It is commercial airport which is 30 kilometers away from Rayong downtown area. Currently, most goods transported via air cargos are those with small size with high value per unit.</p> <p>(4) Train: Rayong province has train route from Bangkok to Map Ta Phut Industrial Estate. Train is mainly used for transporting raw materials, products, and goods of factories in Map Ta Phut Industrial Estate.</p>	<p>hour period (prior to the project development) of National Highway No.3 is congested while that of National Highway No.3191 is good. The evaluation of traffic condition after the project operation shows that traffic condition of both National Highway no.3 and National Highway No.3191 are slightly changed but still in congested and good condition, respectively.</p> <p>The project's marine transportation of coal employs deep-water channels of Map Ta Phut Industrial Estate and the existing plant's port. According to the capacity of these deep-water channels, they are designed to support as many as 17,520 ships/year. Information from Map Ta Phut Industrial Port Office indicates that during 2005-2007 there was about 7,844 ships/year using these channels which was about 44.77% of their capacity. If number of ship is</p>	<ul style="list-style-type: none"> - Coordinate with Map Ta Put Industrial Estate to educate the road users and drivers to strictly pursue the traffic rules and regulations to prevent accident. - During the rush hours (07.00-08.00 and 17.00-18.00 hrs.), assign responsible persons to facilitate the traffic at the plant entrance. - Avoid transportation of chemicals during rush hours. - Control the weight of truck carrying chemical compounds and waste to be under the related standard to avoid the damage on the road surface. - <u>Provide adequate number of bus for transportation of employee in order to reduce traffic volume on the road and specify pick-up locations by avoiding traffic congested area.</u> - <u>Provide information on chemical management in case of accident such</u> 	

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
	<p>increased to 33 trips as a result of the project operation in the future, the maximum traffic volume in the future will be 7,877 trips/year which is about 45% of the capacity. Consequently, these channels can adequately support the increasing traffic volume as a result of the project operation.</p> <p>In addition, the company has coordinated with Marine Office 6 (Rayong), Marine Department which is responsible for safety control (specifically in case of emergency). It is found that an increase of coal transporting trips from 19 trips to 52 trips a year is still under the capacity of safe operation.</p>	<p><u>as MSDSs, emergency response procedure, first-aid procedure, or “incident prevention manual” published by Department of Industrial Works by putting these information separately from packaging of toxic goods.</u></p> <ul style="list-style-type: none"> - <u>Specify in the contract that requires a chemical transporter to prepare an emergency response plan in case a chemical transporting vehicle gets into an accident.</u> - <u>Chemical transporting vehicle must pose a sign showing potential risk on the body according to related regulation, and its driver must have driver license type 4.</u> - <u>Limit truck speed in community area according to the legal limit.</u> - Ensure the coal ships to follow the Map Ta Phut Industrial Estate’s regulations regarding the marine traffic in the estate’s waterway and anchoring at Glow SPP3’s sea port. 	

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
		<ul style="list-style-type: none"> - Coordinate with the existing power plant's port officers every time the ship is to anchor or unload the coal. - <u>Prepare the coal stockyard with the capacity to reserve coal for use at least 45 days.</u> - <u>Strictly control coal transporting ship and coal transporting company to aware of impact controlling measures, to prohibit illegal dumping of wastewater and ballast water into the sea in the area of deep-water channel and internal waters, and to prohibit illegal dumping of wastes from the ship using the deep-water channel.</u> 	
4.3 Water Consumption (1) Raw water sources Water used in various activities in the study area mostly comes from the same source that is Klong Yai basin. Royal Irrigation Department has developed 3 important reservoirs in Klong Yai basin. They are	Construction and implementation periods The project receives water from the 640-MW power plant facility of Glow SPP3 Co., Ltd. (the existing plant) for utilization during the construction and implementation periods. The existing	Implementation period <ul style="list-style-type: none"> - <u>Issue water recycle policy</u> - <u>establish an action plan to ensure that the project has adequate water for consumption during water shortage condition.</u> - <u>Submit data on the project's water</u> 	-

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>Dok Krai reservoir, Nong Palai reservoir, and Klong Yai reservoir. These reservoirs collect large amount of runoff occurring during rainy season so that it can be used as a source of supply during dry season. Klong Yai basin provides runoff entering all 3 basins that can be used for consumption averagely about 320-350 million cubic meters per year. To prevent drought condition, Royal Irrigation Department and East Water have planned to construct water distribution system to enhance efficiency of raw water management system which currently is in the process of construction.</p> <p>(2) Raw water allocation Royal Irrigation Department is mainly responsible for allocation of raw water. According to information of Rayong irrigation project in 2009, water was allocated for various activities that are</p>	<p>plant has received raw water from Eastern Water Resources Development and Management Public Company Limited (East Water) and treated before using at the power plant facility and selling some portion to other facilities in the area. The existing plant also supplies water from this project and the 401-MW cogeneration and steam plant of Glow Energy Public Company Limited which are both located in the vacated area of the existing plant and expected to commence their operations by the end of 2011. It can be concluded that water supply source of the project and the 401-MW cogeneration and steam plant project is the same source used for various activities in the study area and mostly is from surface water of Klong Yai basin (that is from are Dok Krai reservoir, Nong Palai reservoir, and Klong Yai reservoir). Consequently, evaluation of</p>	<p><u>demand to government agencies or private agencies that are responsible for water allocation to use in formulating overall water management plan for this area.</u></p>	

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>consumption (water supply), agricultural use, industrial use, and ecosystem. Total water consumption is about 304 million cubic meters per year. Royal Irrigation Department has policy to give priority to those using water for consumption and agricultural purpose.</p> <p>(3) Water supply water supply service provider in the study area is Ban Chang Regional Water Works Authority with the production capacity of 1,000 m³/hr by acquiring raw water from Klong Bang Phai reservoir and East Water. Its service area covers Ban Chang and Map Ta Phut area that have overall water demand of 23,500 m³/day. Since 2004-2010, another filtration plant has been constructed with the capacity to produce water supply of 24,000 m³/day by acquiring raw water from East Water and has service area covering Map Kha area and Mueang Mai Map Ta Phut area.</p>	<p>availability of water resources herewith involves evaluation of current overall water demand in the area (prior to the project development) and overall water demand by these two projects that will be operated in the future. The result can be described below.</p> <p>(1) Water demand of this project and the 401-MW cogeneration and steam plant project</p> <p>Considering the project's water consumption data, it is found that the project's freshwater water demand during the construction and implementation periods is about 145 m³/day and 1,062 m³/day, respectively, or maximum water demand of 0.4x10⁶ m³/year. While the 401-MW cogeneration and steam plant project of Glow Energy Public Company Limited has maximum freshwater water demand about 2,105 m³/day or about m³/day 0.7x10⁶</p>		

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
	<p>m³/day m³/year (according to the EIA report of the cogeneration and steam plant project approved by ONEP in June 2008). Consequently, the simultaneous operation of these 2 projects in the future will result in an overall freshwater water demand of about 1.1x10⁶ m³/year.</p> <p>(2) Capacity of natural water in the area currently Klong Yai basin has 3 important reservoirs that are Dok Krai reservoir, Nong Palai reservoir, and Klong Yai reservoir (there is allocation system from Dok Krai reservoir and Klong Yai reservoir to Nong Palai reservoir to enhance efficiency of runoff collection at the basin area). In addition, Ban Khai side way is constructed at downstream of the reservoir. Currently, raw water from Klong Yai basin is allocated for use in various purposes that are consumption (water supply), agricultural use,</p>		

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
	<p>industrial use, and ecosystem by covering the area with irrigation system at present. These areas are the study area (Map Ta Phut area), Nikhom Pattana District, Sattahip District, Muaeng Rayong District, Ban Khai District, Pluak Daeng District, Sri Racha District, and Bang La Mung District. According to data from Rayong irrigation project (Irrigation Office 9), normally Klong Yai basin has average runoff flowing into the reservoirs each year about 320-350 million cubic meters per year and has runoff flowing into Ban Khai side way of about 40 million cubic meters. Currently, Eastern Water Resources Development and Management Public Company Limited (East Water) has constructed raw water allocation system from Rayong River, by linking with the existing pipeline from the reservoirs, to Map Ta Phut area, and constructed raw water allocation</p>		

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
	<p>system from Bang Pa Kong River to Bang Pra reservoir in order to distribute water to Sri Racha District and Bang La Mung District in Chonburi Province. These two systems can allocate additional water of $50 \times 10^6 \text{ m}^3/\text{year}$ and $25 \times 10^6 \text{ m}^3/\text{year}$, respectively. In other words, Klong Yai basin can normally provide average runoff for utilization of about 360-390 million cubic meters per year. Combining with raw water allocated from Bang Pa Kong River and Rayong River, capacity of raw water sources supplying to the service area at present is increased to 435-465 million cubic meters per year.</p> <p>(3) Existing water demand in the area (prior to the project operation) after reviewing the information of Rayong irrigation project (Irrigation Office 9), it is found that in 2009 (prior to the project development) about 304 million cubic meters per year of raw water was</p>		

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
	<p>allocated for various activities in the area.</p> <p>(4) Water demand in the area after the project operation after the operation of this project and the cogeneration and steam plant project of Glow Energy Public Company Limited, water demand will be increased by $1.1 \times 10^6 \text{ m}^3/\text{year}$ making the overall raw water demand in the area to be 305.1 million cubic meters per year. According to average capacity of natural water in Klong Yai basin as mentioned in (2), quantity of runoff water in the area is still adequate to meet this demand after the project operation. Nonetheless, if drought crisis occurs that results in a decrease of runoff water being collected in the reservoirs and a possibility of shortage for the demand in each year, the government and Royal Irrigation Department have policy to give priority to allocate raw water for domestic</p>		

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
	<p>consumption and agricultural purposes, while the rest of water can be allocated for industrial purpose. Lesson learnt from drought crisis in the eastern region during 2004-2005 has encouraged the government to appoint Royal Irrigation Department to develop additional projects on enhancement of natural water capacity so that additional raw water from other sources can be allocated for utilization in the area in the future.</p>		
<p>4.4 Electricity consumption (1) Domestic electricity consumption according to data collection, it is found that Rayong Province has received electricity from EGAT's sub-station via high voltage distribution line of network system at Ao Phai Station, Chonburi province, from Sattahip Sub-station 1 to Rayong Station 3 via 115-kwatt distribution line. In the study area, there are several sub-stations such as</p>	<p>Construction period The project construction activities use electricity from the company's existing plant. Since electricity demand during the construction period is not as much and only temporary, the impact on community's electricity consumption is expected to be at low level.</p>	<p>-</p>	<p>-</p>

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>Map Ta Phut Station 1, Rayong Station 2, Rayong Station 3, Map Ta Phut Station 3, and Ban Chang Station. Additionally, Ban Chang Regional Electricity Authority has planned to improve and expand distribution systems for both high voltage and low voltage electric current.</p> <p>(2) Industrial electricity consumption for factories located both inside and outside the industrial estate area (Map Ta Phut Industrial Estate, Hemaraj Eastern Industrial Estate (Map Ta Phut), Asia Industrial Estate, and Pa Daeng Industrial Estate) within the study area, they can purchase electricity from EGAT, PEA, or small producers within Map Ta Phut area.</p>	<p>Implementation period</p> <p>After the project operation, the project has gross power output of 700 MW and has net power output of 660 MW to be sold to EGAT through high voltage distribution line system. The rest of 40 MW is for utilization within the project. Consequently, it poses a positive impact such that the project can supply electricity to EGAT by not affecting community's electricity consumption.</p>	-	-
<p>4.5 Drainage system Most of the study area is seawater area while land area mostly is within the boundary of Map Ta Phut District Municipality and some area is also within Ban Chang</p>	<p>Construction and implementation periods</p> <p>Assessment of impact on drainage system can be considered into 2 major aspects that are the impact on</p>	-	-

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>Sub-District Municipality. Drainage system in this area is managed similarly to what being done in other areas of the country. In community or residential area with extensive development, drainage system is normally constructed to collect rainwater into public waterways, while drainage system in less developed area or non-developed area relies on natural drainage into public waterways. Aims of drainage system are to prevent or alleviate damages caused by flooding condition in the community area. Considering public waterways in the study area that are Nueng Canal, Song Cancal, Sam Cancal, Bang Krprun Canal, Chak Mak Canal, Lhod Canal, Nam Cha Canal, Nam Hu Canal, and Bang Bird Canal (draining ditch adjacent to Pa Daeng Industrial Estate), various waterways flow into the sea. In addition, certain community area within</p>	<p>rainwater drainage in the study area that may lead to flood condition, and the impact from contamination of toxic substance in rainwater drained from the project area. The project area is located in a vacated land of the existing 640-MW power plant facility of Glow SPP3 Co., Ltd. (in operation since 1999) which is sited on the land reclamation area of Map Ta Phut Industrial Estate. This area has been developed and adjusted for quite sometimes ling before the project development. In addition, the project is located near the sea and drains its rainwater and treated effluent into the draining canal for cooling system's effluent of Glow SPP3 Co., Ltd. for direct draining to the sea eventually. Consequently, the project operation will not pose any more burdens on the drainage system in the study area or on the community's drainage</p>		

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>Map Ta Phut District Municipality uses rainwater draining ditch to collect wastewater into wastewater holding pond (combined sewer overflow structure; CSOs), interceptor sewer, and finally into central wastewater treatment system of Map Ta Phut District Municipality (also known as combined system). Wastewater ditch or interceptor sewer is laid along Sukhumvit Road from the west end of Municipality border to the east end. At present, only 2,000-3,000 m³/day of wastewater is entering into wastewater treatment system, while carrying capacity of wastewater treatment system of Map Ta Phut District Municipality is 15,000 m³/day.</p>	<p>system; the impact is expected to be at low level.</p> <p>To prevent drainage of contaminated rainwater to outside environment, during the construction period the project has constructed drainage system to drain rainwater into the existing drainage system of the 640-MW power plant facility. Bar screen is also installed to remove garbage in rainwater before draining into the outside environment. During the implementation period, the areas with potential to generate contaminated rainwater are recognized. They are coal stockyard area, transformer area, pump locations. Separate drainage system is setup for these areas to allow treatment of toxic substances that may be contaminated in rainwater before discharging into the outside environment.</p>		

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
4.6 Waste management (1) Domestic waste management 1) Maptaphut District Municipality: Currently, it collects about 75 tons/day of wastes. Solid wastes are collected and sent for disposal at Municipality's sanitary landfill which is located at Ban Neon Phayom. Moreover, Rayong Provincial Administration Organization has coordinated with local administrative organizations in the provincial area about the construction project of an integrated solid waste management center. These local authorities consist of 19 municipalities and 48 tambon administration organizations. These authorities have been aware of the waste-related problems occurring in their area including in municipalities locating in pollution control zone, Rayong province. This integrated solid waste management center applies Integrated	Construction period Considering the performance of the prevention and mitigation measures for impact posed by the project construction activity in the past (according to the EIA report approved by ONEP in May 2008) detailed in a summary report submitted to related agencies every 6 months, it is found that the project has carried out these prescribed measures regularly by providing adequate number of waste collection bins to collect oil contaminated cloth, sorting for recyclable wastes, and appointing responsible personnel for waste collection in the construction area and contact with a licensed waste processor for disposal service. Implementation period Considering the project description, it is found that waste generating sources, types, and quantity being generated is not different from what indicated in the	Construction period <ul style="list-style-type: none"> - Provide sufficient numbers of garbage bags and bins to store waste from the worker. - Provide sufficient numbers of closed containers to store oily cloth. - Prohibit littering of waste into the sewers. - Appoint responsible persons for waste management during construction period. - Sort out recyclable waste for further selling to recycling companies. - Contact the government licensed agencies to transport the waste out of the project for disposal. Implementation period Domestic waste <ul style="list-style-type: none"> - Provide 3 different types of waste containers for different types of waste, including degradable waste, 	Construction period <ul style="list-style-type: none"> - Record the information of waste from the project in terms of type, quantity, transportation method and types of disposal, for every month. Implementation period <ul style="list-style-type: none"> - Record the information of waste from the project in terms of type, quantity, transportation method and types of disposal, for every month.

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>Solid Waste Management system with highest efficiency for solid waste management in Rayong province. This center is designed with capacity of at least 20 years. The center is located in Tambon Nam Kok, Mueang District, Rayong province with the area of 430 rais. It serves all local authorities located in Rayon province and pollution control zone, as well. Waste collection and transfer station is then constructed in the remote area. At present, the project is in the process of conducting public hearing and communicating with the local public.</p> <p>2) Ban Chang District Municipality: About 15 tons/day of wastes is collected. So far, the municipality has no disposal site within its area. Collected solid wastes will be landfilled at the land that the municipality has requested approval from Royal Forest Department to use the area with Pala</p>	<p>EIA report approved by ONEP in May 2008. These generated wastes can be classified into 2 types that are hazardous wastes and non-hazardous wastes. The project operation has 2 waste generating sources that are production process and employees' activities which have been managed as follows.</p> <p>1) Waste generated from production process and auxiliary system the project has collected these wastes into appropriate containers separately according to their types before contacting a licensed waste processor for disposal service. Significant waste generated in considerable quantity in this project is ash generated from coal combustion in boiler. The project has issued its recycling policy to reuse this ash as substitute raw material for cement production. However, in case that cement industry has some</p>	<p>recyclable waste and hazardous waste.</p> <ul style="list-style-type: none"> - Collect the degradable waste in a proper waste container with a lid, and contact Map Ta Phut Municipality to remove such waste. - Collect the recyclable waste to be recycled within the project, or sold to the recycling companies. - Provide a waste storage building with roof covered to temporarily store the waste, before being removed out of the project site for disposal by the government licensed agencies. - Promote 3R principles for the project waste management; these include reduce, reuse and recycling of waste. - Collect the hazardous waste in proper containers with lids, and contact the DIW licensed agencies to remove such waste. <p>Process waste</p>	<p>- <u>Keep records on statistics of accidents associated with transportation of raw material, chemicals, and wastes generated from the project's production process every year</u></p>

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>Tambon Administrative Organization. This area is at Neon Sam Rhe - Khao Phu Don, which has area of 15 rai. It is expected to be in operation within 10 years.</p> <p>(2) Industrial waste management</p> <p>Industrial waste management in industrial estates located in the study area is supervised and controlled by IEAT and Department of Industrial Works (DIW). Moreover, there are many licensed recycling facilities that provide sorting and recycling service of hazardous wastes. These companies directly contact a factory and provide service in collecting, sorting, transporting, and recycling wastes which helps to eliminate contamination caused by transportation activity. Prior to sending waste off-site, a factory must apply for a waste permit from DIW for off-site disposal which manifest sheet is also required.</p>	<p>limitations regarding the project's ash, the project will send its ash to a licensed waste processor instead. Both fly ash and bottom ash generated from this type of power plant has recycling potential. Fly ash can be mixed with cement to make concrete thereby reducing capital cost of concrete production. In addition, it also helps in improving concrete property by providing strong adhesion, increasing concrete strength and density thereby better preventing water or chemical permeation. Bottom ash can be used as substitute raw material for cement production. Consequently, first alternative for ash management is selling or supplying to cement industry which promotes the efficient use of resources. In the past, the company has coordinated with cement industry such as SCG Trading Co., Ltd. and Siam City Cement PCL to receive fly</p>	<ul style="list-style-type: none"> - <u>strictly supervise the project's waste management in accordance with the Notification of Ministry of Industry on industrial waste disposal B.E.2548 by sending generated wastes to licensed waste processor for disposal service.</u> - The used catalyst from the SCR, consisted of vanadium and tungsten, used resins, used batteries, insulator and lubricant shall be removed by the DIW licensed agencies. - Seek for the possibility in regenerating the used catalyst from the SCR for further reuse. - Provide a silo to collect fly ashes from ESP system, and use a closed conveyer to transport the ashes to the silo. - Provide a silo to collect the bottom ashes from the combustion chamber, and use a proper conveyer to transport the ashes to the silo. 	

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
	<p>ash and bottom ash for further use. Nonetheless, the project will also coordinate with other companies in cement industry to increase possibility for ash recycling. In case there is an economic crisis that puts limitations on cement industry to receive these ashes, the project will send some portion of these ashes to licensed waste processor for disposal service. Considering the analysis results of Total Threshold Limit Concentration (TTLC) and Soluble Threshold Limit Concentration (STLC) for toxic inorganics (according to the Notification of Ministry of Industry on industrial waste disposal B.E.2548) of ash generated from the 640-MW power plant facility of Glow SPP3 Co., Ltd. that uses bituminous coal from the same source, it is found that heavy metal concentrations in ash are not exceeding the regulatory limit.</p>	<ul style="list-style-type: none"> - Set a policy to use both the fly ashes and bottom ashes as substituting raw materials in the cement companies, or for other reuse purposes. - In case that the ashes cannot be reused, the ashes shall be removed by the DIW licensed agencies for further disposal. - Enhance capacities of the local communities to utilize the project's waste, especially the use of ashes from coal-fired power plant as raw material for brick production, etc. - Fly ashes from the silo shall be transported out of the project site by the trucks specifically for ash transport. - Create a preventive maintenance plan for the machines and equipment that are used in the ash processing. - <u>Strictly supervise licensed waste processor to install GPS system to</u> 	

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
	<p>Therefore, these fly ash and bottom ash can be considered as non-hazardous waste which can then be disposed in sanitary landfill. However, cement industry normally has planned its operation in advance. If they have problem to receive ash from the project, they will notify the project in advance thereby providing flexibility and enough time to contact waste processor for disposal service.</p> <p>2) Wastes generated from employee wastes generated from various activities such as office building and food canteen. General solid waste can be divided into 3 types that are general wastes, recyclable wastes, and hazardous wastes. For recyclable wastes, the project has policy to sort and maximize its recycling capacity. Wastes remained after sorting which cannot be used for any purpose are collected and sent to</p>	<p><u>allow appropriate tracking of waste movement.</u></p> <ul style="list-style-type: none"> - <u>Require selection of waste processor to be based on efficiency and capacity.</u> - <u>Contractor must clearly pose its name and contact number on the body of chemical or hazardous waste transporting vehicle.</u> 	

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
	licensed waste processor for disposal service.		
<p>4.7 Disaster prevention and mitigation</p> <p>(1) Emergency response plan for chemicals and toxic substances for Rayong province Since in Rayong province there are many industrial estates, industrial zones, and factories situated in many districts, to prevent disaster or emergency that may occur the emergency response plan at provincial level is established. This is to ensure that the situation can be controlled without delay to minimize danger and damages to public's lives and properties. Rayong province has classified emergency level into 3 levels that are an emergency at factory level, an emergency level 1 (assistance from outside agencies is needed) and an emergency level 2 (assistance from provincial level is needed).</p>	<p>Hazard assessment</p> <p>After reviewing the project description in Chapter 2, it is found that no aspect of the project that is changed and may result in an impact posed by a hazard as already mentioned in the approved EIA report. Consequently, the result of hazard assessment presented herewith is the same as that proposed in the approved EIA report. Activity having risk of generating hazard is associated with the operation of power production equipment that is risk of boiler explosion. Risk assessment is conducted in accordance with the Regulation of Department of Industrial Works on criteria for hazard identification, risk assessment, and establishment of risk management plan B.E.2543 which can be described below.</p> <p>(1) Boiler description</p>	<p>Construction period</p> <ul style="list-style-type: none"> - Ensure that there is occupational health and safety management indicated in contract which covers the occupational health and safety for the employees. - Comply with occupational health and safety regulations, such as Labor Protection Act B.E. 2541, Ministry of Interior Notification concerning work safety in the construction, etc. - The area with machine installation must be isolated, and the equipment and machinery must be placed tidily. - Post warning signs in the area which is at risk to accident, for example "machine being installed", "do not turn on the switch", "construction zone", "helmet wearing zone", etc. - Assign security officers to facilitate the traffic and generally inspect within 	<p>Construction period</p> <ul style="list-style-type: none"> - Record the type, area, severity, cause and solution of all accidents within the project.

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>(2) Emergency response plan of industrial estates in the area emphasis is given to awareness and promptness for emergency response in case of an emergency in industrial estates located in Map Ta Phut area, Hemaraj Eastern Industrial Estate (Map Ta Phut), and Pha Daeng Industrial Estate. Industrial estates' emergency response action has been integrated to ensure consistency with Rayong's emergency response plan. IEAT has also established Environmental Monitoring & Control Center (EMCC) to conduct routine monitoring of environmental quality and to systemically prevent environmental problems.</p> <p>(3) Disaster prevention and mitigation task of local authorities in the study area and surroundings they are Map Ta Phut District Municipality and Ban Chang Sub-District Municipality which provide service covering the above</p>	<p>The project has installed 1 set of boiler that can produce steam at pressure of 242 bar gauge with temperature of 566 degree Celsius. Hazard associated with boiler is explosion caused by various factors such as overheated combustion chamber; heat cannot be transferred to boiler, etc.</p> <p>(2) Risk assessment</p> <p>1) Classification of incident occurrence level potential for explosion of the project's boiler is at level 1 (hardly occurring, i.e., not occur in 10-year period). This is due to the face that the GLOW affiliates are the companies with expertise in energy business and have been in operation for more than 10 years, and the parent company, Suez, has been recognized as one of the well-known company in energy business that operates more than 100 power plants worldwide. For</p>	<p>the construction areas throughout 24 hours everyday.</p> <ul style="list-style-type: none"> - Arrange orientation and training for the construction workers concerning safety rules and equipment usage. - Provide personal protective equipment for the construction workers and enforce the usage of such equipment. - Designate the supervisor to inspect and ensure the compliance with the safety regulations. <p>Implementation period</p> <p>Safety policy and plan</p> <ul style="list-style-type: none"> - Designate a safety policy to be followed by all employees. - Establish the safety committee to create the plan and procedures on safety action. The committee shall report the results of safety plan implementation to the executive board, and set up the safety meeting 	<p>Implementation period</p> <ul style="list-style-type: none"> - Monitor the safety parameters as follows. <p>Parameters : Heat stress index (WBGT)</p> <p>Sampling stations : 2 stations</p> <ul style="list-style-type: none"> * Boiler building * Steam turbine <p>Frequency : Every 6 months</p>

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>mentioned area. They are responsible for controlling and supervising on safety issue associated with disaster and for supporting a control of incident in factory groups and coordinating with other agencies in case the situation cannot be kept under control.</p> <p>(4) Statistics on accident and incident</p> <p>1) Statistics on typical accident:</p> <p>according to statistics data of accident-related injury and injury from other causes collected from Rayong Provincial Public Health Office, Public Health Service Center of Map Ta Phut District Municipality, and Ban Chang Hospital during 2006-2008, top three causes of accident-related injury and injury from other causes are transportation-related accident, accident caused by contacting with mechanical force of object, accident caused by contacting with mechanical force of</p>	<p>the past 10 years, no explosion of boiler type used in the project is evident. In addition, the project has designed installations of equipments and boilers in accordance with relevant standards such as ASME (The American Society of Mechanical Engineering) which also helps in minimizing the risk of explosion.</p> <p>2) Consideration of severity of incidents can be described as follows.</p> <p>(a) Classification of level of severity of incidents posing impact on individual the area for installation of boiler and related production units is area that does not require many employees in operation (most employees works in the control room). The project's boiler has also been designed with prevention method for potential hazard. Consequently, in case of broken boiler the impact</p>	<p>at least once a month.</p> <ul style="list-style-type: none"> - Prepare safety plan to prevent accident by eliminating or reducing conditions that may cause accidents from employees, machine, or work environments. - Practice the safety management plan by implementing various safety activities to achieve the objectives of accident prevention. - Establish risk assessment between the contractor and project at detail designing stage. This is to analyze, study and review the assessment in order to identify potential circumstance and unsafe condition that may lead to major hazard, and to find solutions. - The PC boiler must be certified by an international standard body such as ASME (the American Society of Mechanical Engineering), BS (British Standard), DIN (Deutsches 	<p>Parameters : Brightness</p> <p>Sampling stations : 2 stations</p> <ul style="list-style-type: none"> * Production areas * Maintenance building <p>Frequency : Every 6 months</p> <p>Parameters : Noise (Leq-8 hrs.)</p> <p>Sampling stations : Within the noise contour area (above 85 dB(A))</p> <p>Frequency : Every 3 months, 5 consecutive days each time</p> <p>Parameters : Dust</p> <p>Sampling stations : 2 stations to the north and south of the coal yard</p> <p>Frequency : Every 4 months</p> <ul style="list-style-type: none"> - Conduct employee annual check-up as follows: <ul style="list-style-type: none"> * General physical and lung check-up for all employees * Hearing ability inspection for the employees working in the area

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>animal/human, and accident from falling down.</p> <p>2) Statistics of accident and incident in factory: according to statistics of accident and incident in various factories in Rayong province during 2007-2009, most accidents were caused by fire and chemical leakage which often occurred in Mueang District, Rayong province. Statistics data collected from Social Welfare Office during 2007-2009 show that number of self-insured people was increased as same as number of services required due to illness. Number of work-related injury and illness (within Workmen's Compensation Fund) comparing to number of self-insured people is found to increase in 2008 and decrease in 2009.</p>	<p>posed on individual is expected to be not very severe which can be classified into moderate level or level 2 (has injury that requires medical treatment).</p> <p>(b) Classification of level of severity of incidents posing impact on community the project is located within Map Ta Phut Industrial Estate area which is quite distant from the community area. The closest community is Nong Fab commune which is about 2,000 meters distant. The project has established prevention plan and emergency mitigation plan to control the hazard at low level as possible. In addition, Map Ta Phut Industrial Estate has also established its emergency mitigation plan. It is therefore expected that at such distance explosion effect will pose impact on community at low level (level 1).</p> <p>(c) Classification of level of</p>	<p>Institute Fur Normung), and JIS (Japanese Industrial Standard).</p> <ul style="list-style-type: none"> - Assign particular operators to operate the boiler in accordance with the related regulations, such as Ministerial Regulation, Vol. 2 (B.E. 2535) under the Factory Act B.E. 2535. - Provide 24-hour security officers equipped with communication devices to inspect the project area. Such security officers shall be trained and involved in fire fighting rehearsal. - Arrange various forms of safety activities within the project, such as safety announcement, poster and exhibition. - Arrange an orientation for new employees before starting work to understand and realize the importance of work safety. The training shall be held periodically. - Prepare a safety manual for the 	<p>of noise level above 85 dB(A).</p> <ul style="list-style-type: none"> * Visual ability and lung condition inspections for the employees working as welders or associated with heat. - Collect accident and damage statistics related to the project operation. - Collect statistics on illness and annual physical check-up. - Report the emergency drill results - <u>Conduct a survey on utilization rate of personal protective equipment by employees in the project area every 6 months.</u> - <u>Report on statistics of accidents occurrence and implementation of emergency response plan including equipments used in corrective action in case of chemical spill or leakage in the project area every year.</u>

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
	<p>severity of incidents posing impact on environment since the project's boiler is a type that does not have boiler drum, in case of breakage or leakage there will be only water and steam, which is not toxic, released to the environment. Consequently, the impact posed on environment is expected to be at level 1 that is very low impact which can be controlled and corrected.</p> <p>(d) Classification of level of severity of incidents posing impact on property breakage of pipe inside the boiler is expected to cause some damage on nearby property since steam pressure can result in scattering of boiler parts and high temperature steam can be released to the surrounding area leading to physical damage. A boiler is considered as principal production equipment of the project. If broken, the production</p>	<p>employees to better understand about safety regulations.</p> <ul style="list-style-type: none"> - Provide medical check-up for the new employees prior to starting work, and for all the employees annually. - Provide first-aid facility, including the referral system, within the project. <p>Management of working environment</p> <ul style="list-style-type: none"> - Design the work environment within the project in accordance with the ministerial rules on Management and Administration of Safety, Occupation Health and Working Environment related to heat, brightness, and noise B.E. 2549, as follows: <p><u>Noise</u></p> <ul style="list-style-type: none"> * Create noise contour to determine the area where noise level is higher than 85 dB(A) and personal protective equipment is to be used. * Provide a control room with air-conditioned system for the employees to prevent a direct noise 	

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
	<p>process must be ceased. Consequently, the level of severity is at high level (level 4).</p> <p>(e) Classification of risk level it is a result of multiplication between potential level and severity level posing on individual, community, environment, and property. If risk levels posing on individual, community, environment, and property are different, the highest risk level is chosen as a result of risk assessment. Risk can be classified into 4 levels. The result of risk levels posing on individual, community, environment, and property are 2, 1, 1, and 4, respectively. Considering the highest value (level 4), it is found that this level is acceptable level.</p> <p>In addition, the consultant has evaluated hazard associated with the use of SCR system in controlling NO_x. This system uses ammonia to trap NO_x and transforms it into nitrogen gas.</p>	<p>exposure.</p> <p><u>Brightness</u></p> <p>* Ensure sufficient brightness in the workplace and traffic routes.</p> <p><u>Heat</u></p> <p>* Ensure the workplace is at appropriate temperature.</p> <p>* Designate the employees who work in high temperature areas to wear personal protective suits.</p> <p>Safety systems/ equipment</p> <ul style="list-style-type: none"> - Provide a sufficient amount of personal protective equipment such as helmets, safety shoes, earmuffs or earplugs, etc. - Provide emergency showers in the process area and chemical storage building sufficiently and appropriately. - Provide sufficient and proper fire extinguishing systems, consisting of sprinkle system, deluge water system, 	

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
	<p>Ammonia anhydrous consumption rate is about 1,183 tons/yr. It is stored in one 100-m³ storage tank at storage building in the SCR area. The tank has net storage capacity of about 80 m³).</p> <p>The consultant has assessed the impact caused by various concentrations of this chemical leaked from ammonia anhydrous storage tank in case of 1-ince leaked hole which is most likely to occur. The result shows that in case of 1-ince leaked hole there will be concentrations at levels ERPG-1, ERPG-2, ERPG-3 at distance of 9.50 km, 2.73 km, and 0.92 km, respectively.</p>	<p>CO₂ system, fire hydrants, mobile foam unit, fire extinguishers and fire detector, to be in accordance with the National Fire Protection Association (NPPA) standard. The project's fire water storage tank and fire water pumps are isolated from those of the existing power plant.</p> <ul style="list-style-type: none"> - Install various measuring devices to inspect the boiler performance such as pressure, temperature, flow rate, water level, etc. These devices must be linked to control room to report the results and warnings. - Install the safety or protective equipment at the boiler, including the installation of 2 safety valves at minimum in order to safely release the steam when the pressure level is higher than the limit. - <u>Establish preventive maintenance plan for NO_x removal system (SCR system) and related equipment during</u> 	

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
		<p><u>the project operation.</u></p> <ul style="list-style-type: none"> - <u>Install ammonia detector in the storage area which can send signal to control room in case of leakage.</u> - <u>Install expansion valve to prevent damage of ammonia tank in case the pressure level inside the tank gets higher than normal.</u> - <u>Provide information of chemical to responsible government agencies other than Map Ta Phut Industrial Estate Office such as local authorities, public healthcare facility in the area.</u> - <u>Establish communication plan for an emergency level 1 which at minimum must consist of notification, rehearsal, and evacuation.</u> - <u>Conduct rehearsal of emergency plan with the community by considering this rehearsal with the community.</u> - Provide emergency responding plans 1-3. - Arrange an emergency drill for 	

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
		<p>the 1st level emergency plan, together with those from the existing power plant and the 401 MW power plant project, at least once a year, and cooperate with the industrial estate for the 2nd and 3rd level emergency plan drills.</p> <ul style="list-style-type: none"> - Daily inspect and seek for unsafe conditions by security officers. If found, they shall correct and improve such conditions immediately. - Set up a plan for inspection of the fire control systems/equipment. - Set up a preventive maintenance plan for the boiler equipment/systems. - Test boiler's safety equipment /systems at least once a year or as indicated in the related Ministry of Industry notifications, the Notification Vol. 26 (B.E. 2534). - <u>be responsible for proposing the budget to support disaster prevention and mitigation works and first-aid</u> 	

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
		<p><u>works via the power plant fund</u></p> <p>Working with chemicals</p> <ul style="list-style-type: none"> - Prepare a safety document of each chemical substance, and post it at the working area. - Educate the employees about the chemical hazard in case it leaks and spills, and solution guidelines. - Set up an inspection plan for the leakage of ammonia used in the SCR system, for example at the joint, valve and pump. - Ammonia transportation from its tank to SCR system must be a closed system. 	
<p>4.8 Agriculture/ fishery and livestock/ industry</p> <p>- Agriculture: Rayong province has agricultural area of 1,409,840 rais, or about 64% of province area (Rayong province area is about 2,220,000 rais). There are agricultural farmers 47,283</p>	<p>Implementation period</p> <p>Impact on agriculture is concerned most by the public and stakeholders at various public hearing events conducted at various stages of the study. The study team has considered the project description specifically on</p>	-	-

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>households. Important economic crops of the province are pararubber, tapioca, pineapple, sugarcane, rice, various fruits such as durian, rambutan, and mangosteen.</p> <p>- Fishery and livestock: both freshwater fishery and brackish water fishery are found in Rayong Province. The area for marine fishery is about 1.5 million rai, while that for freshwater fishery (swamp, pond, canal, and lagoon) is 63,080 rai. There are 5,020 fishery households, 2,603 fishing boats, 6 fishing associations, 36 groups of fishermen, 2 fishing cooperatives, 45 fishing ports. In 2008, top three freshwater animals caught in Rayong province area is tilapia, mango fish, and silver barb. Freshwater fishery is mostly found in Pluak Daeng District, Klang District, Khao Chamao District, and Ban Khai District. According to</p>	<p>the issues of the project's effluent, is evident that no potential of impact on agriculture caused by the project's effluent since the project drains its effluent directly to the sea. The effluent from cooling system therefore has no chance to be used for agricultural purpose. Major pollutants that may pose an impact on agriculture are air emissions from the project's boiler stack. They are NO_x and SO₂ which can pose both direct and indirect impact. High ambient concentration of these gases with considerable exposure time can pose direct impact on plant. In addition, they may react with water vapor in atmosphere resulting in acid rain which can also pose an effect on plant.</p> <p>Considering air quality assessment or the prediction of NO₂ and SO₂ ambient concentrations that are changed as a result of the</p>		

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<p>Rayong Provincial Livestock Office, top three livestock farming is swine, beef cattle, and buffalo. Area with most livestock farms is in Pluak Daeng District and Mueang Rayong District. For poultry, top three poultry farming is native chicken, meat chicken, and layer chicken, which is found mostly in Pluak Daeng District, Mueang Rayong District, and Klang District.</p> <p>- Industry: Certain area of Rayong province has been designated as industrial zone since 1981 as a result of the national policy in promoting eastern seaboard development project. At present, Rayong province has industrial estates, private industrial estates, industrial zones, industrial communities or industrial parks in total of 19 sites and 2,141 factories scattering in districts of Rayong province. For industry in the study area and</p>	<p>simultaneous operation of this project and the 401-MW cogeneration and steam plant of Glow Energy Public Company Limited, it is found that maximum 1-hr average concentration of NO₂ and 1-yr average concentration of SO₂ in atmosphere are 219 µg/m³ and 43.3 µg/m³, respectively. Reviewing the related research study shows that these above mentioned concentrations will not pose significant effect on plant. According to "Pranee Pantumsinchai and colleagues, Basic Principle in Environmental Engineering B.E.2550", it is indicated that the experiment shows ambient NO₂ concentration in the range of 0.25-1.0 ppm (or 470-1,880 µg/m³) can reduce agricultural product yield. Additionally, when some plants such as bean or tomato exposed to NO₂ concentration of 0.5 ppm or 940 µg/m³ for 10-12 days, their growth was inhibited. Effect on plant is also evident</p>		

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
surroundings, it consists of 4 industrial estates that are Map Ta Phut Industrial Estate, Hemaraj Eastern Industrial Estate (Map Ta Phut), Pha Daeng Industrial Estate, and Asia Industrial Estate.	<p>at 1-yr average SO₂ concentration of 78.5 µg/m³.</p> <p>Moreover, the project has operated its air pollution control system in according to the resolution of National Environment Board by reducing the overall air pollutant emission (NO_x and SO₂) of the existing 640-MW power plant facility of Glow SPP3 Co., Ltd. before the project operation and designing the control of overall air pollutant emission from the new project at not exceeding 80% of the amount reduced. As a result, the overall emission of NO_x and SO₂ in Map Ta Phut area is decreased. Consequently, the air pollution control management as previously mentioned can pose positive impact on rainwater quality.</p>		
<p>5 Quality of Life Value</p> <p>5.1 Aesthetics and tourism In the 5 kilometers radius of the study area, no interesting tourist destination or</p>	<p>Construction and implementation period</p> <p>Considering information on tourist destination and aesthetics in the</p>	<p>Implementation period</p> <p>- <u>Specify the green area of about 7,000 m² or about 5.15% of the project area.</u></p>	-

Table 3-1 (continued)

Environmental components and values	Significant environmental impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
historically significant area is found. However, only natural tourist destination found in this area is Nam Rin Beach.	project area and the study area, no significant national or regional historical site is found. Only 1 local tourist destination found is Nam Rin Beach where currently there are several food shops although not many recreational activities and beach swimming is evident.	<ul style="list-style-type: none"> - <u>Plant evergreen trees around the coal stockyard by choosing type that has height consistent with height of coal pile such as grevillea, asoke tree by planting in 3 zigzag rows.</u> - <u>Support a program that increase green area for the communities.</u> 	

Table 3-2

Environmental and health impact, Environmental Impact Prevention and Mitigation Measures and Environmental Impact Monitoring Measure

Environmental components and values	Significant health impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
<u>Construction periods</u>			
Social group formation	Has positive impact on communities in the area. Social groups are formed to conduct community development activities.	Attend/ organize various activities with surrounding communities to develop community and strengthen good relationship (community relationship).	Report on community relations activities.
Job creation/ employment	Has positive impact on communities in the area by increasing job/ employment rate.	Give priority to local employment.	Report on local employment.
Air quality (TSP and PM-10)	May cause respiratory tract disease.	<ul style="list-style-type: none"> - To have/provide mitigation measures for community residents as follows. <ul style="list-style-type: none"> * Limit vehicle speed at not exceeding 40 km/hr in community zone. * Cleaning truck tires to minimize soil and sand attached to the tires. - To have/provide mitigation measures for construction workers as follows. <ul style="list-style-type: none"> * Spraying water in the area with dust dispersion. * Prohibit open burning of material scrap or solid wastes in the construction area. * Provide adequate number of protective equipment and strictly supervise its use. * Truck transporting construction material should be covered. 	Collect statistics on illness caused by respiratory tract disease from public healthcare service facility.

Table 3-2 (continued)

Environmental components and values	Significant health impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
Noise level	May pose an impact on hearing ability of construction workers and pose nuisance on community.	<ul style="list-style-type: none"> - Inspect and maintain machinery and equipment used in construction as scheduled. - Provide adequate number of protective equipment and strictly supervise its use. - Cease noise generating construction activity during 19.00-07.00. 	Survey on use of personal protective equipment.
Transportation	May lead to injury/accident of community residents caused by traffic.	<ul style="list-style-type: none"> - Limit vehicle speed at not exceeding 40 km/hr in community zone. - Supervise all drivers to strictly follow traffic rules. - Avoid transportation during rush hours. - Require motor cyclist to wear safety helmet, car users to wear safety belt, and all drivers to strictly follow traffic rules. - Train drivers responsible for transportation of construction material or construction workers to strictly follow traffic rules. 	Collect statistics on accident occurrence associated with transportation of the project's construction equipment/material.

Table 3-2 (continued)

Environmental components and values	Significant health impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
Wastewater, wastes, and manure	May induce diseases of the digestive system in construction workers due to inappropriate management of wastewater, wastes, and manure in workers housing camp.	<ul style="list-style-type: none"> - Provide adequate number of waste collection bins with lid. - Manage solid wastes according to sanitation principle. - Contact licensed waste processors for waste disposal service. - Construct drainage ditch to prevent wastewater or runoff in the project area or worker housing camp draining into public reservoir. - Prepare hygienic toilet and bathroom adequately for numbers of construction workers. 	<ul style="list-style-type: none"> - Collect statistics on illness caused by diseases of the digestive system from public healthcare servicing facility. - Conduct a survey on adequacy of toilet/bathroom and waste collection bins, and management method as specified in the measures.
Communicable disease	May induce respiratory tract disease, diseases of the digestive system, and sexual transmitted diseases in construction workers as a result of insanitation practice.	<ul style="list-style-type: none"> - Conduct health examination and collect health data of construction workers. - Provide clean water for construction workers' consumption. - Maintain workers' housing camp and bathrooms/toilet in hygienic condition. - Eliminate breeding places and disease carriers such as mouse, mosquito, fly, and cockroach. - Educate workers on food sanitation/hygiene and prevention of communicable diseases of digestive system, respiratory tract system, and sexual transmitted diseases. 	<ul style="list-style-type: none"> - Collect statistics on illness caused by communicable diseases from public healthcare servicing facility. - Collect data on destruction of breeding places and disease carriers.

Table 3-2 (continued)

Environmental components and values	Significant health impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
Public service and public health	May lead to over demand for public utility services such as school, water supply, electricity, etc. and affect the accessibility to medical and public health service.	<ul style="list-style-type: none"> - Organize a first-aid unit and adequately provide basic medical supplies in the construction area, including an ambulance for transfer patients to a hospital in case of emergency or accident. - Organize a mobile medical unit to regularly provide healthcare service for workers and their family members, including communities. 	<ul style="list-style-type: none"> - Record statistics on services provided by a first-aid unit. - Report on health examinations by a mobile medical unit.
Disaster mitigation	May affect readiness and servicing capability for disaster mitigation.	<ul style="list-style-type: none"> - Consider the details of safety management issue specified in the contractor's servicing contract. - Strengthen capacity of volunteer and network of disaster prevention and mitigation in the area such as supporting communication instrument, vehicles, and life-saving tools. - Train and refresh knowledge of disaster mitigation volunteer on first-aid and patient transfer. 	Report on supporting for disaster mitigation unit.

Table 3-2 (continued)

Environmental components and values	Significant health impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
Population growth in the area and non-registered population	May lead to unsafe condition for life and property, drug problem, and street fight for both community residents and construction workers.	<ul style="list-style-type: none"> - The project and communities cooperate in inspecting and guarding the community for illegal conduct such as burglary, drugs, gambling, etc by prescribing rules and penalty. - Establish personnel records of construction workers. - Establish channel to receive complaint on nuisance caused by construction workers. - Do not support employment of illegal foreign labor. - Support an establishment of police volunteers to safe guard the communities in the project surroundings. - Support activities promoting safety for the community such as providing lighting in risky area. 	<ul style="list-style-type: none"> - Keep record on complaints received at complaint receiving unit. - Report on summary of complaint and corrective action. - Report on supporting of safe guard volunteer establishment in the community.
<u>Implementation period</u>			
Social group formation	Have a positive impact with a community around the project's area. Have a group establishment for activities for community development.	<ul style="list-style-type: none"> - Such as participating or organizing activities with the nearby communities to develop the community and strengthen good relationship (community relations). - Organize community relations activities to cover various plans on improvement of quality of life and well-being, community health, educational development, and career development. 	Report on community relations activities.

Table 3-2 (continued)

Environmental components and values	Significant health impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
Occupation/employment	Pose positive impact on communities in the area by creating more jobs and employment rate.	<ul style="list-style-type: none"> - Consider employment of qualified local laborers for the project's employees by setting as first priority and trying to hire as many as possible. - Organize vocational training on product promotion. - Develop capacity building for local labor such as organizing training to strengthen knowledge and skill. 	<ul style="list-style-type: none"> - Report on local employment. - Report on training of capacity building and vocational promotion.
Air quality TSP and PM-10, SO ₂ , NO _x	May lead to the respiratory tract disease and asthma in the community residents and employees caused by air pollutants.	<ul style="list-style-type: none"> - Provide particulate matter protection equipments for employees and supervise them to use these equipments. - Install water nozzle for spraying water around the area to prevent dispersion of coal dust. - Install wind shield in the coal stockyard area. - Plant tall trees around the fence of the power plant as a shield for dust distribution. - Implement the air quality action plan to ensure that air pollutant emission is complied with the standard limit. 	<ul style="list-style-type: none"> - Conduct a survey on utilization rate of employees' personal protective equipment. - Report on performance of environmental management measures. - Collect statistics data on illness of respiratory tract disease from public healthcare servicing facility. - Report on educational training and disseminating document regarding danger of environmental pollutants that is provided to employees and communities.

Table 3-2 (continued)

Environmental components and values	Significant health impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
Noise level	May induce a hearing impact on employees and communities surrounding the project area.	<ul style="list-style-type: none"> - Specify operating period of employees who are exposed to loud noise in accordance with the standard prescribed by Ministry of Labor. - Provide noise protection equipment for employees and supervise them to use such equipment. - Plant tall trees around the fence of the power plant as a noise barrier to reduce disturbing noise level on nearby communities. - <u>Conduct educational training for employees on danger of noise and prevention method.</u> 	<ul style="list-style-type: none"> - Report on hearing examination. - Survey on utilization rate of personal protective equipment.
Transportation related accidents	May lead to injury caused by transportation-related accident and illness caused by exposure to leaked chemicals.	<ul style="list-style-type: none"> - Limit vehicle speed not to exceed 40km/hr in the community area. - Strictly supervise a licensed waste processor to install GPS system to allow tracking of waste transportation and to ensure appropriate waste management. - Supervise drivers to strictly follow traffic regulation. 	<ul style="list-style-type: none"> - Collect statistics on occurrence of accidents associated with transportation of raw materials, chemicals, and wastes from production process.

Table 3-2 (continued)

Environmental components and values	Significant health impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
Fly ash and bottom ash	May induce the respiratory tract disease on employees.	<ul style="list-style-type: none"> - Carry out the waste management action plan. - Strictly supervise on the use of prevention to equipment during transfer of fly ash and bottom ash. 	<ul style="list-style-type: none"> - Collect statistics on illness related to the respiratory tract disease of employees. - Collect statistics on occurrence of accidents associated with transportation of wastes generated from production process.
Heavy metal such as mercury	May lead to illness related to heavy metal toxicity such as effect on nervous system caused by mercury exposure	<ul style="list-style-type: none"> - Control coal quality to ensure low level of heavy metal contamination and properly manage wastewater generated from the coal stockyard to minimize contamination of heavy metal in public reservoir 	<ul style="list-style-type: none"> - Monitor heavy metal concentration in run-off pond receiving run-off from the coal stockyard 3 times/yr
Acid rain	May induce the respiratory tract disease-rainwater quality that cannot be used for consumption.	<ul style="list-style-type: none"> - Control emission of SO₂ and NO_x, which are the cause of acid rain formation, within the standard limit. - Maintain operation of particulate matter control system at high efficiency at all times. 	<ul style="list-style-type: none"> - Monitor concentrations of NO_x, SO₂, TSP, and PM-10.

Table 3-2 (continued)

Environmental components and values	Significant health impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
Chemicals * sulfuric acid * sodium hydroxide * coagulant * Sodium hypochlorite * ammonia/ammonium anhydrous	Employees or communities may be exposed to chemicals in case of accident that chemicals are leaked which can cause irritation to skin, conjunctiva, and respiratory tract. Exposure to high concentration of chemicals may damage tissue and lead to respiratory failure.	- Provide eyewash and shower in the area of chemical transfer or chemical storage. - Install equipment to wash out leaked chemicals such as water dispensing system - Establish an emergency response plan level 1. - Organize a rehearsal for an emergency response plan level 1 at least once a year and participate in a rehearsal for an emergency response plan level 2-3. - Organize a rehearsal plan with communities by coordinating with the community in establishing the plan. - Educate the employees and communities on danger of chemical exposure and prevention method.	- Collect statistics on accidents and related damages generated in the project. - Report on statistics of accident occurrence associated with leaked chemicals. - Report on educational training and disseminating document regarding chemical danger provided to employees and communities.

Table 3-2 (continued)

Environmental components and values	Significant health impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
Occupational health and working safety	May lead to injury/handicap/death of employees caused by work-related accident.	<ul style="list-style-type: none"> - Establish safety manual for employees. - Establish safety rules and criteria. - Provide standard protective equipment such as safety helmet, safety glasses, safety shoes, noise protective equipment and dust prevention equipment, and supervise the employees to use them appropriately. - Set up working environment appropriately and lay out working equipment according to Ergonomics such as lighting, ventilation, desk, chair, shelf, etc. - Organize educational training for employees on use of protective equipment and working ergonomics. 	<ul style="list-style-type: none"> - Report on organizing educational activities for employees such as use of protective equipment, working environment, and ergonomics for working equipment. - Survey on protective equipment utilization rate of employees in the risk group.
Traffic related accident	Congested traffic may lead to an accident of employees and communities while traveling to work.	Request motor cyclers to wear safety helmet, drivers to wear safety belt, and strictly follow the traffic regulation.	Collect statistics on accident occurrence associated with commuting of employees.

Table 3-2 (continued)

Environmental components and values	Significant health impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
Population growth in the area and non-registered population	May lead to unsafe condition for life and property, drug problem, and street fight for both community residents and construction workers.	<ul style="list-style-type: none"> - The project and communities cooperate in inspecting and guarding the community for illegal conduct such as burglary, drugs, gambling, etc by prescribing rules and penalty. - Establish channel to receive complaint on nuisance caused by construction workers. - Do not support employment of illegal foreign labor. - Support an establishment of police volunteers to safe guard the communities in the project surroundings. - Support activities promoting safety for the community such as providing lighting in risky area. 	<ul style="list-style-type: none"> - Keep record on receiving complaints, corrective actions, and outcome. - Report on supporting of safe guard volunteer establishment in the community.

Table 3-2 (continued)

Environmental components and values	Significant health impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
Public service and public health	May lead to over demand for public utility services such as school, water supply, electricity, etc. and affect the accessibility to medical and public health service.	<ul style="list-style-type: none"> - Organize a first-aid unit and adequately provide basic medical supplies in the project area, including an ambulance for transfer patients to a hospital in case of emergency or accident. - Prepare data on use and MSDSs of chemicals used in the project and distribute to related agencies. Organize training on chemical danger, pollution, prevention and first-aid for public health officials and public health volunteer in the project surrounding area. - Organize an annual health examination for employees and a mobile medical unit for communities. Collect health data of community residents in the project surrounding area. - Support public healthcare facility in the area in terms of readiness of facility and capacity building of their officials. 	<ul style="list-style-type: none"> - Record statistics on services provided by a first-aid unit. - Report on employees' annual health examination. - Report on education training and disseminating document on the project's chemical use and MSDSs provided to related agencies and communities. - Report on organizing of a mobile medical unit. - Report on community relations activities regarding medial and public health support.

Table 3-2 (continued)

Environmental components and values	Significant health impacts	Environmental Impact Prevention and Mitigation Measures	Environmental Quality Monitoring Measures
Disaster mitigation	May affect readiness and servicing capability for disaster mitigation	<ul style="list-style-type: none"> - Establish communication plan during an emergency level. - Establish a rehearsal of emergency plan with the communities. - Strengthen capacity of volunteer and network of disaster prevention and mitigation in the area such as supporting communication instrument, vehicles, and life-saving tools. 	<ul style="list-style-type: none"> - Report on supporting for disaster mitigation unit. - Report on rehearsal of emergency response plan.