



Glow SPP 11 Co., Ltd.

**Summary Report  
of  
Environmental Impact Assessment**

**Gas-Fired Combined Cycle Power Plant  
(Expansion) Project**

Located at Siam Eastern Industrial Park

Pluak Daeng, Rayong



**Envi Work Co., Ltd.**

4/524 Moo 4 Serithai Rd, Klongkum, Buengkum, Bangkok 10240

TEL: 02-736-4536 FAX: 02-736-4537 E-mail: [enviwork@hotmail.co.th](mailto:enviwork@hotmail.co.th)



September 2013

Executive summary of  
Environmental Impact Assessment  
Gas-Fired Combined Cycle Power Plant (Expansion) Project  
Glow SPP11 Co., Ltd.

## 1. Preface

### 1.1 The company background and status

Gas-Fired Combined Cycle Power Plant (Expansion) Project of Glow SPP11 Co., Ltd. (Formerly Thai National Power Co., Ltd.(TNP)), which has area approximately 29.2 rai, is located in Siam Eastern Industrial Park, Map-Yang-Phon sub-district, Pluak Deang district, Rayong province. The plant started operation since 2000 to produce electricity that is sold to EGAT under the Small Power Producer (SPP) program by using natural gas as fuel. Background in the Preparation of the Environmental Impact Assessment (EIA) Report of the Project can be summarizing as Table 1.1-1. The latest report indicated that the total capacity 155.5 MW. with 2 types of generators as follows; 1) 1 set of Gas Turbine Generator (GTG)/Steam Turbine Generator (STG) with a capacity of 121 MW. And 2) 6 sets of Gas Engine Generator (GEG) with total capacity 34.5 MW. (Each with a capacity of 5.75 MW.) Despite the fact that the current installed generators nearly every set, as stated in the EIA report, except 2 sets of Gas Engine Generator (GEG). The economic crisis of the past (2007), had delayed the installation of 2 set of Gas Engine Generator (GEG) to meet electricity demand at that time. Therefore, the actual operation of the project are now generating capacity by 144 MW, which is less than what is stated in the Environmental Impact Assessment (EIA) Report.

Since Thailand's economy started to grow, the company plans to install the remaining two sets of Gas Engine Generator (GEG) (GEG5-6). However, the review and survey on demand for electricity in the area has shown the need to install Gas Engine Generator (GEG), with the capacity of 10.0 MW for each set instead of 5.75 MW. Resulting to an increase in the overall capacity stated in the reports 8.5 MW (from 155.5 MW to 164 MW). When compared to the current capacity of the power plant that has a capacity increase of 20 MW (from 144 MW to 164 MW). In summary that the expansion project has resulted to the installation of 2 types of generators as follows; 1) 1 set of Gas Turbine Generator (GTG)/Steam Turbine Generator (STG) with a capacity of 121 MW., which has been implemented already. And 2) 6 sets of Gas Engine Generator (GEG) with a capacity of 43 MW (4 sets has been implemented already, and 2 remaining sets (GEG5-6) are being installed) . (Each with a capacity of 5.75 MW.)

**Table 1.1-1****. Background in the Preparation of the Environmental Impact Assessment (EIA) Report of the Project**

No.	Year	Description	Remark
1.	1998	- The Environmental Impact Assessment (EIA) report of Gas-Fired Combined Cycle Power Plant of Thai National Power Co.,Ltd. was submitted with set of gas turbine generator and steam turbine at 114.24 megawatts (MW) capacity. For transfer some electricity to Electricity Generating Authority of Thailand (EGAT) and some to industrial factory in Siam Eastern Seaboard Industrial Park and nearby.	- Refer to the letter no. WW.0408/11483 Date 21 August 1998
2.	2000	- Operated the Gas-Fired Combined Cycle Power Plant with set of gas turbine generator and steam turbine at 114.24 MW capacity.	-
3.	2004	- The Environmental Impact Assessment (EIA) report of Gas-Fired Combined Cycle Power Plant (Expansion) was submitted, then the overall electricity capacity increase from 114.24 to 151.5 MW. For details of the project are as follows. <ul style="list-style-type: none"> <li>* There are plans to install a nozzle or fogging system for spray water to mix with air before transfer to Combustion chamber of Gas Turbine Generators (GTGs). The following results was currently Gas Turbine and Steam Turbine Generators capacity increase from 114.24 to 117 MW</li> <li>* There are plans to expand the factory in the industrial park. So that, each of Gas Turbine Generators has a 5.75 MW capacity. And overall Gas Turbine Generators capacity is 34.5 MW</li> </ul>	- Refer to the letter no. TS.1009/7293 Date 15 July 2004

**Table 1.1-1 (cont'd)**

No.	Year	Description	Remark
4.	2005	- The Environmental Impact Assessment (EIA) report was submitted. There are plan to increase the efficiency and improve some part of Gas Turbine Generators. The following results were Gas Turbine and Steam Turbine Generators capacity increase from 117 to 121 MW. Then the overall electricity capacity increased from 151.5 to 155.5 MW	- Refer to the letter no. TS.1009/7293 Date 24 March 2005
5.	2006	- Operated the Gas Engine Generators (GEGs) no. 1-4. So the GEGs no. 5- 6 was slowed down from the economic situation of the country at that time.	-
6.	2010	- The modify request of diameter and height of stacks was submitted. And the additional conditions were "if the company does not construct the GEGs no. 5 and 6 in 2 years, then have to revise the impacts and measurement."	- Refer to the letter no. TS.1009/74347 Date 19 October 2000
7.	2011	- The changing of project description was submitted. The project is about the increase of Diesel Tank bund wall size and volume. And improve the wastewater treatment method by drain overall into central wastewater treatment plant of the Industrial park.	- Refer to the letter no. TS.1009.7/1687 Date 15 February 2011
8.	2012	- Change the company name from Thai National Power Co.,Ltd. to Glow SPP 11 Co.,Ltd.	- Refer to the letter no. TS.1009.7/2957 Date 28 March 2012

In addition, this project will improve the existing utilities as follows 1) to improve the demineralized water treatment unit by installing Reverse Osmosis unit to improve water quality before it is added to the resin tank, resulting to the decreasing of resin cleaning frequency. As a result, the amount of wastewater generated from the demineralized water system will be decreased 2) plans to produce more clarify water / demineralized water to serve nearby factories. Also construct an additional demineralized water reserve tank.

Terms of Office of Natural Resources and Environmental Policy and Planning (ONEP ) has stated that " if the project is has not begun the construction of GEG 5 and 6 within two years, the project is required to review the data of impact and measures in accordance with the changes of existing environmental, and then present to ONEP for consideration. Therefore, Glow SPP11 Co., Ltd. has assigned Envi Work Co., Ltd. (environmental consultant) to study and review of the environmental impact assessment of the (expansion) project. To review and improve prevention and mitigation measures and environmental impact monitoring measures to be appropriate and consistent with the current situation before applying for the business license of this (expansion) project.

## 1.2 Objectives

- 1) To study the project description of existing plant/expansion project and existing environmental. Also identify, classify and predict the potential impact of the expansion project.
- 2) Provide for the participation of the public and stakeholders in the process of environmental impact assessment of the expansion project. Gathering comments on the public participation process into account of environmental impact assessment process, and review prevention and mitigation measures and environmental impact monitoring measures.
- 3) To review prevention and mitigation measures and environmental impact monitoring measures.
- 4) Present environment impact assessment report to authorizer as documentation to obtain a business license.

## 1.3 Work Plan

Work plan of Gas-Fired Combined Cycle Power Plant (Expansion) Project of Glow SPP11 Co., Ltd. is shown as Table 1.3-1. The construction of the expansion project will take approximately 13 months and is expected to be launched by the year 2014. The expansion project is expected to have the highest number of construction workers in a period of about 80 people.

#### 1.4 Study area

Term of study area of consulting company is inner 5 km circle around plant according to current policy of Office of Natural Resources and Environmental Policy and Planning (ONEP) (Figure 1.4-1) Defined in the initial study area for the EIA, the project covers an area within a radius of five kilometers. However, if there are impacts which tend to occur outer 5 km circle around plant. It will be included in the study area as well. Scoping area of air quality impact assessment covers an area of 20 x 20 square kilometers.

Table 1.3-1

GEGs No. 5 and 6 Expansion Project Construction plan

Construction Activities	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Design Purchasing and Hiring												
2. Structural foundations												
3. Building												
4. Machine installation												
5. Piping installation and control system												
6. Instruments and System Testing												
7. Machines test Run												
8. Operating												

Φ

source : Glow SPP 11 Co.,Ltd., 2013

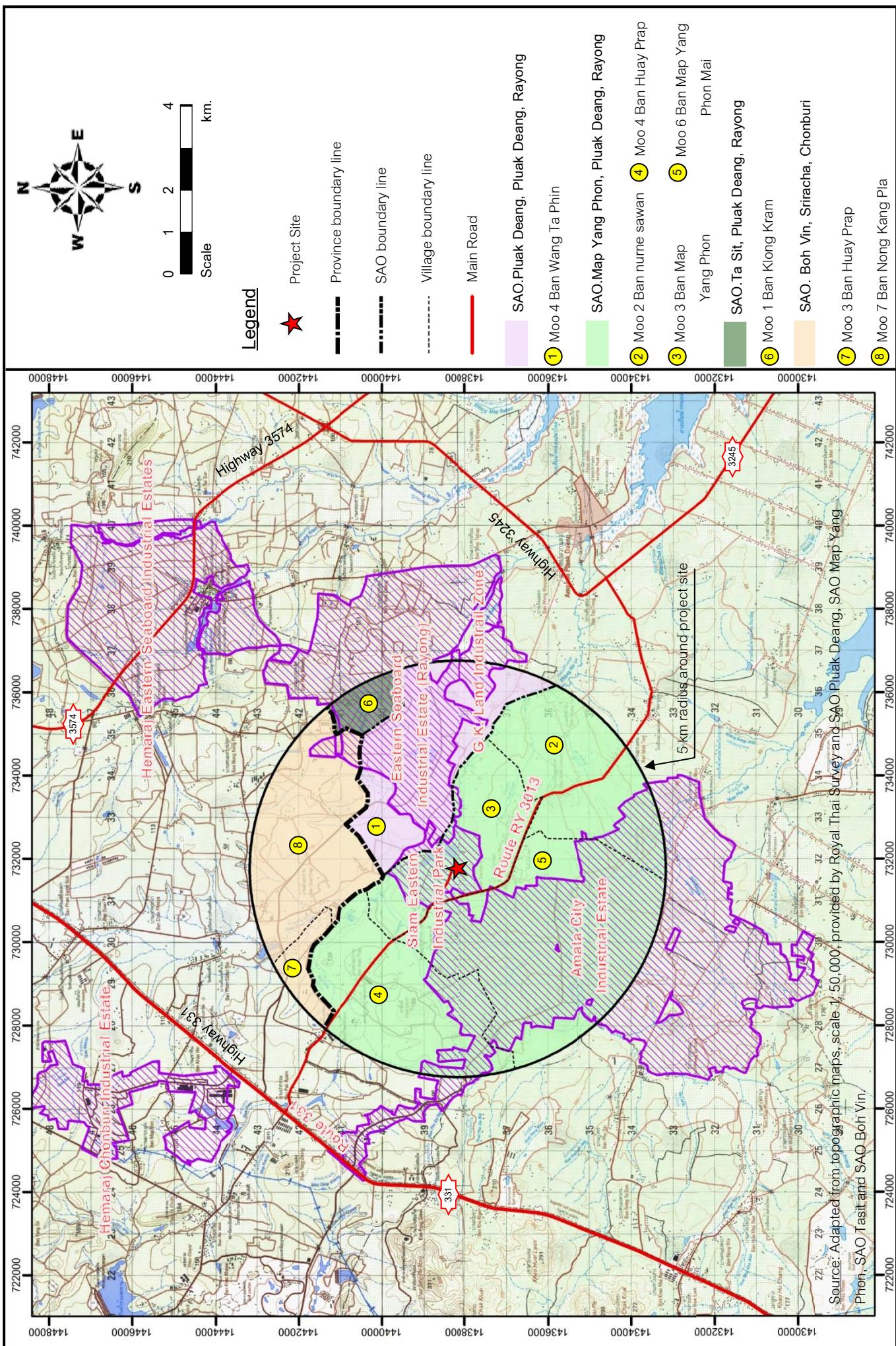


Figure 1-4-1 Project location and study area.

## 2. Project description

### 2.1 Comparison on the details of current project and after the expansion

The comparison on the details of current project and after project expansion can be summarized as shown in Table 2.1-1.

### 2.2 Project location and Land use

The current project and the expanded project are located in the area of 29.2 rai in the operational area of Siam Eastern Industrial Park, Map Yang Phon Sub-district, Plauk daeng district, Rayong province (as shown from 2.2-1 to 2.2-4). The details about the landuse in the areas surrounding the project location are as shown in Figure 2.2-5. The sensitive areas near the project area are Ban Saphan See School and Ratassadaram Temple (located 1.3 km far from the west of project location) and Ban Map Yang Phon School / Map Yang Phon Temple (located 1.5 km far from the south of project location)

### 2.3 Consideration on the choices of project location and project operation

2.3.1 Regarding the consideration on the choices of project location, several factors are considered as follows:

1) **Suitability for the environment management:** The project is located in the operational area of Siam Eastern Industrial Park which is the area particularly allocated for serving the industries. There is the preparation of infrastructures for serving the established plants as well as studying and regulating the scope of pollution emission in accordance with the potential of area.

2) **Accordance with target group in the area:** The main objective of the project development is to deliver the power to neighboring plants. Therefore, the development of expanded project in this area positively affects the communities as it is the enhancement of security in electricity power of the area.

3) **Readiness of area:** As the current power plant does not have area sufficiently for serving the development of expanded project and the expanded project is also located in the unoccupied area of the current power plant, some parts of infrastructure can be used mutually with the current project. As a result, the resources are used worthily.

4) **Readiness of system to release natural gas:** Metering and Regulating Station (*MRS*) of the current power plant is sufficient for releasing natural gas to the expanded project. As a result, the establishment of the expanded project does not need the installation of system of pipelines to carry natural gas from outside more.

**Table 2.1-1****Detailed comparison between existing plant and after the project implementation**

Content	Description		Remarks
	Before expansion	After expansion	
1. Project name	- Gas-Fired Combined Cycle Power Plant Project.	- Gas-Fired Combined Cycle Power Plant (Expansion) Project.	-
2. The owner company	- Glow SPP 11 Co.,Ltd.	- Not different.	- In 2012, Change the company name from Thai National Power Co.,Ltd. to Glow SPP 11 Co.,Ltd.
3. Size and Location	- The project area is 29.2 rai, in Siam Eastern Industrial in Map Yang Phon Sub-district, Pluak Daeng District, Rayong Province.	- Not different.	- Size of project not different from before because the generator that plan to install was set in the useless space of current project.
4. Electricity capacity and Main Equipment	- The max electricity capacity is 144 megawatts with 2 part of generator as, (1) Gas and Steam Turbine Generator (1 set) overall capacity is 121 megawatts (including 2 sets Gas Turbine Generator, 2 sets of Steam produced from the rest heat 2 , 1 set of and Steam Turbine Generator) (2) Gas Engine Generators (4 sets as GEG 1-4) the total capacity is 23 megawatts. (each set of GEG 1-4 have 5.75 megawatts capacity φ)	- The max electricity capacity is 164 megawatts with 2 part of generator as, (1) Gas and Steam Turbine Generator (1 set) overall capacity is 121 megawatts (including 2 sets Gas Turbine Generator, 2 sets of Steam produced from the rest heat 2 , 1 set of and Steam Turbine Generator) (2) The Gas Engine Generators (GEGs) (6 sets as GEG 1-6) the total capacity is 43 megawatts. (GEG 1-4 have 5.75 megawatts per set and GEG 5-6 have 10.0 megawatts per set)	- The capacity was increased 20 megawatts. Because of the installation of 2 sets Gas Engine Generators (GEGs) (10 megawatts per set). Then the generators of current project not different from before.

Table 2.1-1 (continued)

Content	Description		Remarks								
	Before Expansion	After Expansion									
5. Fuels	<ul style="list-style-type: none"> <li>- The natural gas consumption is 12.5 Million Cubic Feet per Day. By receive the natural gas from PTT public company limited by piping system.</li> </ul>	<ul style="list-style-type: none"> <li>- When the expansion project was operated, the total natural gas consumption will increase to <u>14.26 Million Cubic Feet per Day</u>. By receive the natural gas from PTT public company limited by piping system.</li> </ul>	<ul style="list-style-type: none"> <li>- The currently Environmental Impact Assessment (EIA) report detailed that the Gas Turbine Generator and Steam Turbine was installed with reserve diesel tank to using when the main transportation system was fail. But the normal operation of the project was not reserve the diesel for the Gas Turbine and Steam Turbine Generator, then the Gas and Steam Turbine Generator of the current project was use only natural gas.</li> </ul>								
6. Chemicals	<ul style="list-style-type: none"> <li>- the chemical usage objective of current project is for improve water quality that use in any activities as producing water, demineralization water resin regeneration, scale prevention, and pH pretreatment in cooling water and steam generators, and to prevent the growth of microorganisms in cooling system, details are as follows,</li> </ul>	<ul style="list-style-type: none"> <li>- The chemical usage after the project expansion as follows,</li> </ul>	<p>The expansion project have to install SCR system for control air pollution from generator. This system need an ammonia and others catalyst to support. For transform NO<sub>x</sub> from the combustion in 2 sets of Gas Engine Generators (GEG 5-6) into nitrogen before vent to the atmosphere.</p> <p>In addition, They have the a improvements of demineralized water system by install the Reverse Osmosis (RO) water system for</p> <table border="1" style="margin-top: 10px;"> <tr> <td>* Hydrochloric acid solution (35 %)</td> <td>34 t/y</td> </tr> <tr> <td>* Sulfuric acid solution (50%)</td> <td>54 t/y</td> </tr> <tr> <td>* Sodium Hydroxide solution (50%)</td> <td>24 t/y</td> </tr> <tr> <td>* Sodium Hypochlorite</td> <td>133 t/y</td> </tr> </table>	* Hydrochloric acid solution (35 %)	34 t/y	* Sulfuric acid solution (50%)	54 t/y	* Sodium Hydroxide solution (50%)	24 t/y	* Sodium Hypochlorite	133 t/y
* Hydrochloric acid solution (35 %)	34 t/y										
* Sulfuric acid solution (50%)	54 t/y										
* Sodium Hydroxide solution (50%)	24 t/y										
* Sodium Hypochlorite	133 t/y										

Table 2.1-1 (continued)

Content	Description		Remarks	
	Before Expansion	After Expansion		
* Dispersant Solution (Nalco 7348) * Amine (TriAct1800) * PAC * Polymer * 3D Transat (R) 3DT 129) * Corrosion Prevention solution * Oxygen Scavenger (Eliminox) * Non-Oxidizing Biocide (N-7330)	6.5 t/y 12 t/y 57 t/y 2.6 t/y 54 t/y 7.7 t/y 1.2 t/y 1.4 t/y	* Dispersant Solution (Nalco 7348) * Amine (TriAct1800) * PAC * Polymer * 3D Transat (R) 3DT 129) * Corrosion Prevention solution * Oxygen Scavenger (Eliminox) * Non-Oxidizing Biocide (N-7330) * Ammonia * SCR catalyst	6.5 t/y 12 t/y <u>78 t/y</u> <u>3.6 t/y</u> 54 t/y 7.7 t/y 1.2 t/y 1.4 t/y 302.4 t/y <u>10.0 t/y</u>	improve the water quality before transfer into current system (Resin Tank). The frequency of cleaning and restoring vinyl compounds decreased from 1 to 7 day per time that make the wastewater from demineralized water system decrease. Then the chemical consumption that used for regeneration a resin (Hydrochloric and Sodium Hydroxide) decrease from before and current project plan to produce water and demineralized for sale to nearby factory. Which makes the use of chemicals in the production of water (PAC and Polymer) increased.
7. Power grid system	- The current project feed the electricity into power grid of Provincial Electricity Authority (PEA) in Pluak Daeng station at the north of project (in Industrial Park area) through the 115 kilovolt (KV) power transmission line that connected from generator in project area with Pluak Daeng station.	- Not different.	-	-

Table 2.1-1 (continued)

Content	Description		Remarks
	Before Expansion	After Expansion	
8. Water use	<ul style="list-style-type: none"> <li>- Current project receive water supply from water supply system of industrial park for using in office and employees activity. Water that use in the process and utility is receive a raw water from East Water Public Company Limited to improve product quality with clear water and demineralized water system before. The total consumption is <u>5,257.8 m<sup>3</sup>/day</u> as follows,</li> <li>* Compensate water in cooling system of Gas and Steam Turbine <u>3,120 m<sup>3</sup>/day</u></li> <li>* Compensate water in cooling system of Gas Engine Generators <u>600 m<sup>3</sup>/day</u></li> <li>* Compensate water in cooling system of cool water system <u>720 m<sup>3</sup>/day</u></li> <li>* Water use in fogging system of Gas and Steam Turbine <u>288 m<sup>3</sup>/day</u></li> <li>* Compensate water in steam produce system of Gas and Steam Turbine <u>480 m<sup>3</sup>/day</u></li> <li>* Resins wash water in demineralized system <u>48 m<sup>3</sup>/day</u></li> <li>* Water used in office and employees <u>1.8 m<sup>3</sup>/day</u></li> </ul>	<ul style="list-style-type: none"> <li>- When the expansion project was operated, water and demineralized water planed to selling for other company. Then a consumption was shows in 2 case as follows,           <ul style="list-style-type: none"> <li>(1) <b>In case of no sales water and demineralized water to other company.</b> A water usage was decrease <u>to 5,216.8 m<sup>3</sup>/day</u> (increased <u>41 m<sup>3</sup>/day</u>) as</li> <li>* Compensate water in cooling system of Gas and Steam Turbine <u>2,806 m<sup>3</sup>/day</u></li> <li>* Compensate water in cooling system of Gas Engine Generators <u>600 m<sup>3</sup>/day</u></li> <li>* Compensate water in cooling system of cool water system <u>720 m<sup>3</sup>/day</u></li> <li>* Water use in fogging system of Gas and Steam Turbine <u>288 m<sup>3</sup>/day</u></li> <li>* Compensate water in steam produce system of Gas and Steam Turbine <u>480 m<sup>3</sup>/day</u></li> <li>* Resins washing water in demineralized system <u>2 m<sup>3</sup>/day</u></li> <li>* Water used in office and employees <u>1.8 m<sup>3</sup>/day</u></li> </ul> </li> </ul>	<p>The project plans to improve the demineralized water system of the current project. By install the RO system for improve water quality before send into resin tank. The frequency of cleaning and regeneration resin of demineralized water was reduced. As a result, the volume of water used for regeneration of resin compounds was decreased.</p>

Table 2.1-1 (continued)

Content	Before Expansion	Description		Remarks
			After Expansion	
		<p>* Water used in RO system <u>314 m<sup>3</sup>/day</u></p> <p>(2) In case of sales water and demineralized water to other company. A water usage was increase <u>to 7,201.8 m<sup>3</sup>/day</u> as</p> <ul style="list-style-type: none"> <li>* Compensate water in cooling system of Gas and Steam Turbine <u>2,604 m<sup>3</sup>/day</u></li> <li>* Compensate water in cooling system of Gas Engine Generators <u>600 m<sup>3</sup>/day</u></li> <li>* Compensate water in cooling system of cool water system <u>720 m<sup>3</sup>/day</u></li> <li>* Water use in fogging system of Gas and Steam Turbine <u>288 m<sup>3</sup>/day</u></li> <li>* Compensate water in steam produce system of Gas and Steam Turbine <u>480 m<sup>3</sup>/day</u></li> <li>* Resins washing water in demineralized system <u>7 m<sup>3</sup>/day</u></li> <li>* Water used in office and employees <u>1.8 m<sup>3</sup>/day</u></li> <li>* Water used in RO system <u>480 m<sup>3</sup>/day</u></li> <li>* Water supplied to the plants within the industrial park <u>1,320 m<sup>3</sup>/day</u></li> <li>* Mineralized water supplied to the plants within the industrial park <u>665 m<sup>3</sup>/day</u></li> </ul>		

Table 2.1-1 (continued)

Content	Description		Remarks
	Before Expansion	After Expansion	
9. Drainage system	<p>- The current project design drainage area that divided into 2 parts as general storm water drainage system and contaminated water drainage system that managed as follows,</p> <p>(1) <b>General storm water drainage system</b> Rainwater that falls on the current project area and chances to contaminated are collected into gutters within the project area prior to the drainage channel adjacent to the area to the east of the project area, which is collect water into the pond of the industrial park.</p> <p>(2) <b>Contaminated water drainage system</b> Rainwater that falls on the area that may have been contaminated with oil as transformer area and air compressor. So the management of rainfall that fell in the area to provide a separate sewer system is separated from the other parts. to collect rainwater into oil Separator in each area. The rain water that has been treated with oil separator is collected into the gutter within the project area prior to the storm water drainage channel adjacent to the trunk area to the east of the current project area.</p>	<p>- Not different.</p>	<p>- The 2 sets of Gas Engine Generators was installed on the space of the current projects already developed drainage systems from the start of project construction. Thus the concept of expanding the capacity of the drainage system is not different from the existing.</p>

Table 2.1-1 (continued)

Content	Description		Remarks
	Before Expansion	After Expansion	
10. Air pollution and control	<p>- The project consists of 2 part of generators with 6 stack as follows,</p> <p>(1) <b>Gas Turbine Generator and Steam Turbine using a natural gas as fuel (1 set)</b> The 2 stack that vents hot gases from the combustion of gas turbines or GTG from the heat utilized to produce steam in HRSG. The technology that used to control the temperature in the combustion chamber is steam injection and installation of continuous emissions monitors (CEMs).</p> <p>(2) <b>Gas Engine Generators (GEG) (4 sets)</b> Which 4 stacks that producing power gas engines, each set will have 1 stack is used to control the rate of mixing between the gas and air before burned with intensity less than normal (lean burn gas engine).</p>	<p>- The project consists of 2 part of generators with 8 stack as follows,</p> <p>(1) <b>Gas Turbine Generator and Steam Turbine using a natural gas as fuel (1 set)</b> The 2 stack that vents hot gases from the combustion of gas turbines or GTG from the heat utilized to produce steam in HRSG. The technology that used to control the temperature in the combustion chamber is steam injection and installation of continuous emissions monitors (CEMs).</p> <p>(2) <b>Gas Engine Generators (GEG) (6 sets)</b> Which 4 stacks (no. 1-4) that producing power gas engines, each set will have 1 stack is used to control the rate of mixing between the gas and air before burned with intensity less than normal (lean burn gas engine).</p> <p>So, the no. 5-6 has installed selective catalytic reduction (SCR) with ammonia into the gas reacts with the nitrogen oxides to nitrogen gas, which does not change the impact on air quality. And they have installed Continuous Emission Monitoring System (CEMs) that can send a result to the relevant government agencies.</p>	-

Table 2.1-1 (continued)

Content	Before Expansion	Description	After Expansion			Remarks
- Control air pollution emission from GTG & HRSG and GEG stack as follows,		- Control air pollution emission from GTG & HRSG and GEG stack as follows,				
● <b>HRSG stack</b>		● <b>HRSG stack</b>				
* NO <sub>x</sub> not over	108 ppm	* NO <sub>x</sub> not over	108 ppm			
* SO <sub>2</sub> not detailed		* SO <sub>2</sub> not over	5 ppm			
* TSP not detailed		* TSP not over	7 ppm			
● <b>GEG stack no. 1-4</b>		● <b>GEG stack no. 1-4</b>				
* NO <sub>x</sub> not over	108 ppm	* NO <sub>x</sub> not over	105 ppm			
* SO <sub>2</sub> not detailed		* SO <sub>2</sub> not over	5 ppm			
* TSP not detailed		* TSP not over	15 ppm			
● <b>GEG stack no. 5-6</b>		● <b>GEG stack no. 5-6</b>				
		* NO <sub>x</sub> not over	35 ppm			
		* SO <sub>2</sub> not over	5 ppm			
		* TSP not over	24 ppm			
- Control air pollution emission from GTG & HRSG and GEG stack as follows,		- Control air pollution emission from GTG & HRSG and GEG stack as follows,				
● <b>HRSG stack</b>		● <b>HRSG stack</b>				
* NO <sub>x</sub> not over	24.22 g/s	* NO <sub>x</sub> not over	12.86 g/s			
* SO <sub>2</sub> not detailed		* SO <sub>2</sub> not over	0.83 g/s			
* TSP not detailed		* TSP not over	0.44 g/s			

Table 2.1-1 (continued)

Content	Before Expansion	Description		Remarks
		After Expansion		
● GEG stack no. 1-4 * NO <sub>x</sub> not over 1.91 g/s * SO <sub>2</sub> not detailed * TSP not detailed	● GEG stack no. 1-4 * NO <sub>x</sub> not over 1.19 g/s * SO <sub>2</sub> not over 0.08 g/s * TSP not over 0.09 g/s  ● GEG stack no. 5-6 * NO <sub>x</sub> not over 0.5 g/s * SO <sub>2</sub> not over 0.1 g/s * TSP not over 0.18 g/s			
11. Wastewater and Management	- The volume of waste water occurs by 1261.8 cubic meters / day. It contains a collection of wastewater all the clarifier effluent before discharge into the central wastewater treatment of industrial park. For the source and amount of wastewater, as detailed below.  * Wastewater from cooling tower of Gas Turbine Generators and Steam Turbine 720 m <sup>3</sup> /day * Wastewater from cooling tower of Gas Engine Generators 180 m <sup>3</sup> /day * Wastewater from cooling tower of cold water system 216 m <sup>3</sup> /day	- The volume of waste water occurs by 1220.8 cubic meters / day. It contains a collection of wastewater all the clarifier effluent before discharge into the central wastewater treatment of industrial park. For the source and amount of wastewater, as detailed below.  * Wastewater from cooling tower of Gas Turbine Generators and Steam Turbine 720 m <sup>3</sup> /day * Wastewater from cooling tower of Gas Engine Generators 180 m <sup>3</sup> /day * Wastewater from cooling tower of cold water system 216 m <sup>3</sup> /day	- The project plan to improve the demineralized water system by installed the RO system to improve water quality before it is added to the resin tank. The frequency of cleaning and regenerate resin of demineralized water was reduced.  As a result, water consumption and waste water to restore the resin material decreased as well. And 2 sets of Gas Engine Generators are used air cooling that does not use water and wastewater due to the cooling of machinery.	

Table 2.1-1 (continued)

Content	Description		Remarks
	Before Expansion	After Expansion	
	<ul style="list-style-type: none"> <li>* Wastewater from steam system 96 <math>m^3/day</math></li> <li>* Wastewater from demineralized water system 48 <math>m^3/day</math></li> <li>* Wastewater from office 1.8 <math>m^3/day</math></li> </ul>	<ul style="list-style-type: none"> <li>* Wastewater from steam system 96 <math>m^3/day</math></li> <li>* Wastewater from demineralized water system 7 <math>m^3/day</math></li> <li>* Wastewater from office 1.8 <math>m^3/day</math></li> </ul>	
12. Noise pollution and control	<ul style="list-style-type: none"> <li>- The main source of noise that may arise from the implementation of the project is machinery or equipment used in the manufacturing process, manufacturing and utility includes a Gas Turbine Generators, Steam Turbine Generators, Gas Engine Generators , air compressor, and cooling tower. The project has volume control along fence in accordance with the Ministry of Industry which provides 24-hour average noise level caused by the operator not more than 70 dB. Around the factory fence. From the general sound level measurements at the fence of the existing plant found that the noise levels are in the range of 54.8 to 67.0 dB.</li> </ul>	<ul style="list-style-type: none"> <li>- The expansion are not significantly different from the original manufacturer. It is expected that the noise level in the building is not different from the original.</li> </ul>	

Table 2.1-1 (continued)

Content	Description		Remarks
	Before Expansion	After Expansion	
13. Waste	<ul style="list-style-type: none"> <li>- The current project have a waste arising from the following sources           <ul style="list-style-type: none"> <li>* Waste of employees 1.5 t/yr</li> <li>* Metal 10 t/yr</li> <li>* Used oil 40 t/yr</li> <li>* Sludge 70 t/yr</li> <li>* Degraded resin 2 t/yr</li> <li>* Air filter 3 t/yr</li> <li>* Insulation rock wool 4 t/yr</li> <li>* Used chemical 0.5 t/yr</li> <li>* Contaminated materials 0.5 t/yr</li> <li>* Used battery 0.1 t/yr</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>- After expansion, the volume of waste was increased. Details are as follows.           <ul style="list-style-type: none"> <li>* Waste of employees 1.5 t/yr</li> <li>* Metal 10 t/yr</li> <li>* Used oil <u>50 t/yr</u></li> <li>* Sludge 70 t/yr</li> <li>* Degraded resin 2 t/yr</li> <li>* Air filter <u>3.5 t/yr</u></li> <li>* Insulation rock wool 4 t/yr</li> <li>* Used chemical 0.5 t/yr</li> <li>* Contaminated materials 0.5 t/yr</li> <li>* Used battery 0.1 t/yr</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>-</li> </ul>
14. Transportation	<ul style="list-style-type: none"> <li>- The transportation of chemicals, garbage and waste includes employee travel has the highest overall volume of transport 311 units/day, divided into 21 cars trucks / day, private car 6 car /day and shuttle van 4 cars / day.</li> </ul>	<ul style="list-style-type: none"> <li>- The highest transport volume increased to 35 units / day, divided into 25 cars trucks / day private car 6 car /day and shuttle van 4 cars / day.</li> </ul>	<p>The expansion resulted in the transport of some increased activity is the transportation of chemicals and transportation of waste. Transportation for employees does not change because the number of employees not increased.</p>
15. Workers and Employers	<ul style="list-style-type: none"> <li>- The project currently employs 40 people</li> </ul>	<ul style="list-style-type: none"> <li>- Not different.</li> <li>- The construction is expected to be approximately <u>80</u> construction workers</li> </ul>	<ul style="list-style-type: none"> <li>-</li> </ul>

Table 2.1-1 (continued)

Content	Description		Remarks
	Before Expansion	After Expansion	
16 Fire Protection and Control	<ul style="list-style-type: none"> <li>- The current project is design a fire fighting systems and fire extinguishing equipment to cover the project area include fire sprinkler systems, fire sprinklers and fire hose cabinets, mobile fire extinguishers, fire suppression system with carbon dioxide, and fire detection systems.</li> <li>- Current project have a fire pump within areas of the project included Electric Fire Pump size 227 cubic meters / hour, Diesel Pump size 227 cubic meters / hour, and Jockey Fire Pump 2 PCS Size 22.7 cubic meters. /hour.</li> <li>- Considering the maximum demand in transformer area that have 2 wys sprinklers, the demand for water is 195 cubic meters / hour. The project will use water fire of Treated Water Tank with a capacity of 2,500 cubic meters, designed to reserve water for use in firefighting anytime at 1,250 cubic meters , accounting for 50 percent of the volume of the tank storage service. Thus , the volume of water up to a storage area for firefighters to use water for a maximum of 6.4 hours.</li> </ul>	<ul style="list-style-type: none"> <li>- The expansion of this project to install fire protection equipment in Gas Engine Generators building includes sprinkler, fire sprinklers and fire hose cabinets, mobile fire extinguishers, fire detection system. The design of such devices or systems in accordance with NFPA standards and other laws.</li> <li>- The project expansion was not change the maximum fire water pumps and fire water reserve capacity of the plant.</li> </ul>	<ul style="list-style-type: none"> <li>-</li> </ul>

Table 2.1-1 (continued)

Content	Description		Remarks
	Before Expansion	After Expansion	
17. Green Area	<ul style="list-style-type: none"> <li>- Current project provided green area within the project area of 1.512 rais or 5.18 percent of project area by 3 rows staggered at the fence of project. By designated as a indigenous trees and trees that are deciduous.</li> </ul>	<ul style="list-style-type: none"> <li>- Not different.</li> </ul>	<ul style="list-style-type: none"> <li>-</li> </ul>

RAYONG MAP

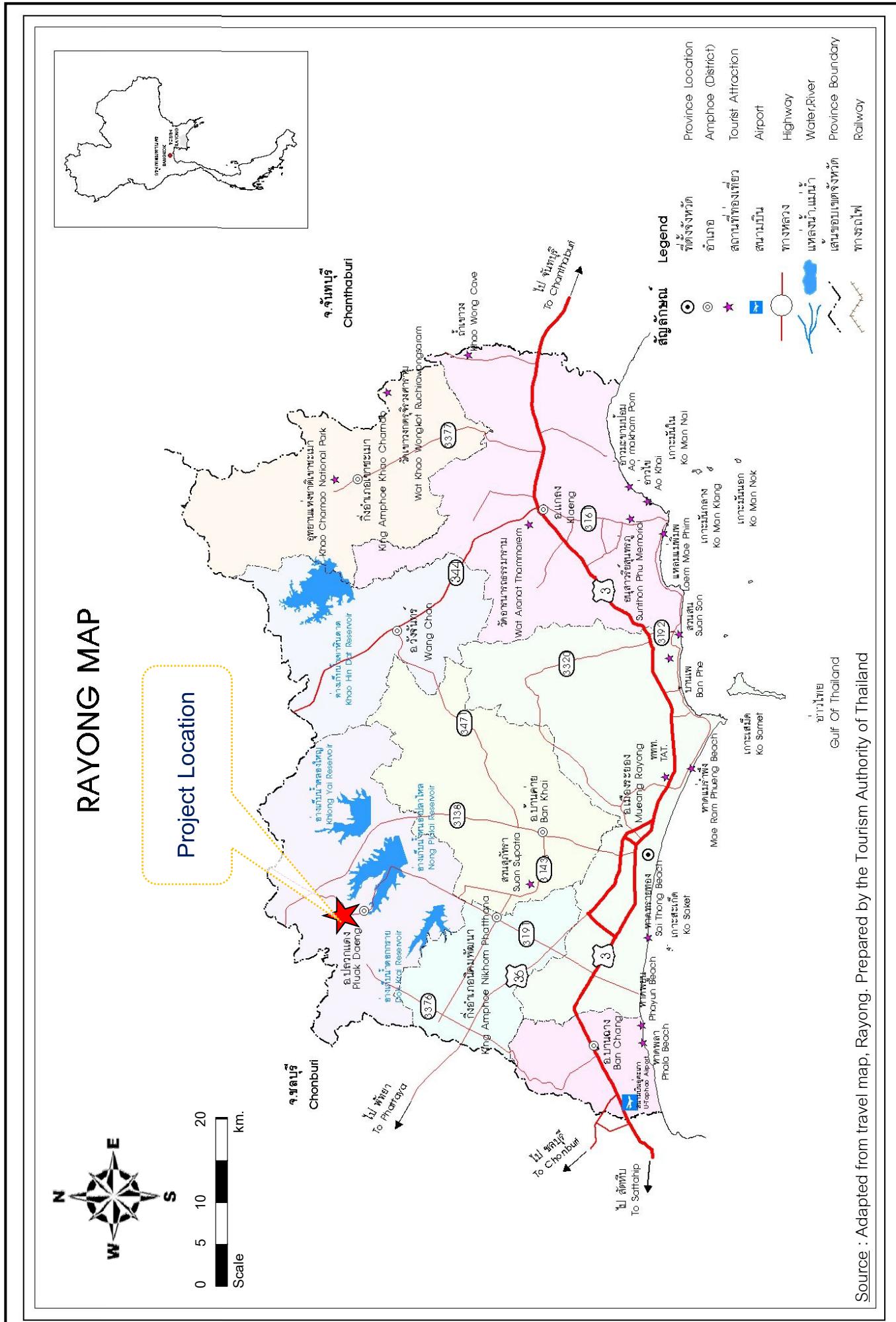
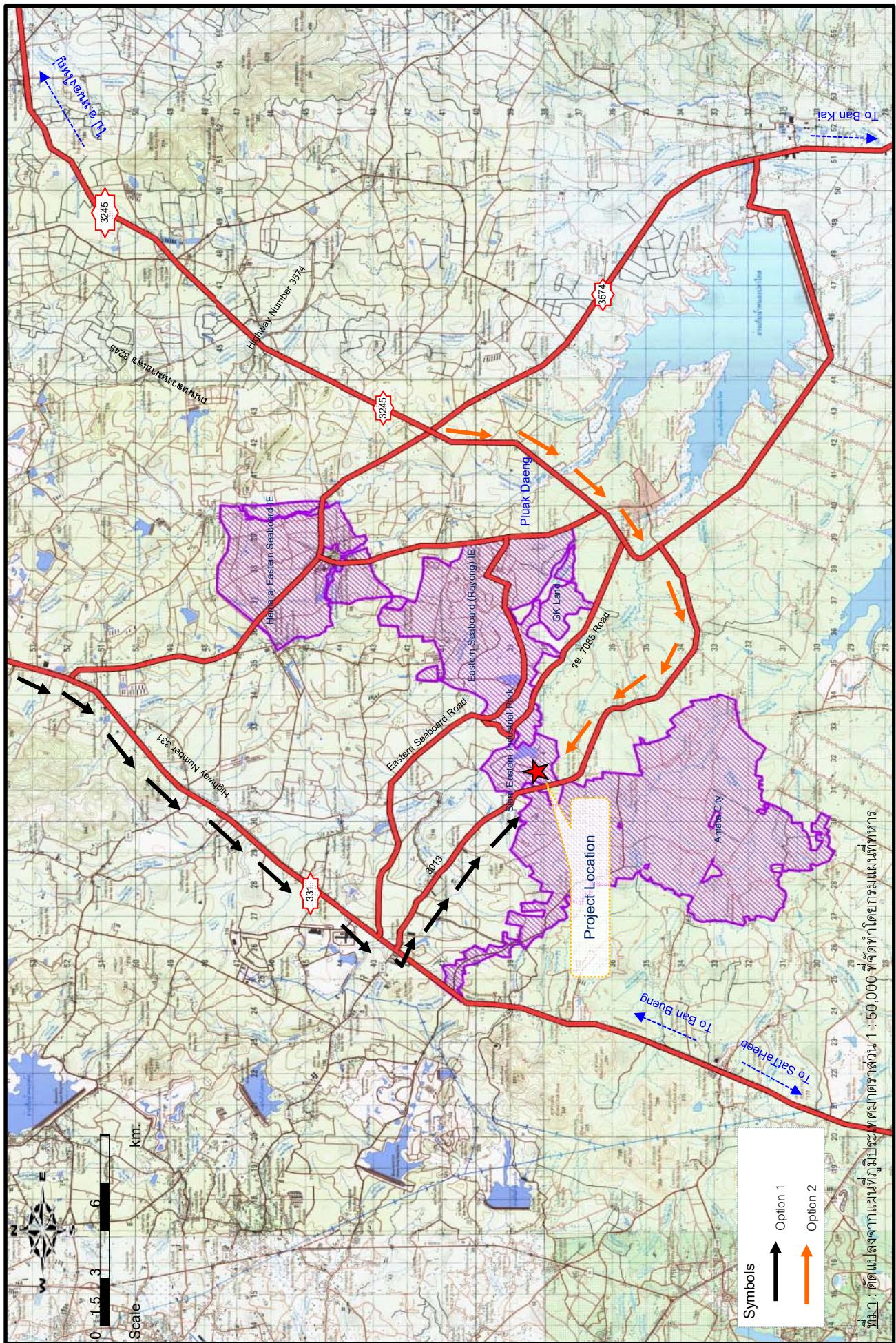


Figure 2.2-1 Project location in Rayong Province



**Figure 2.2-2** Project location and route

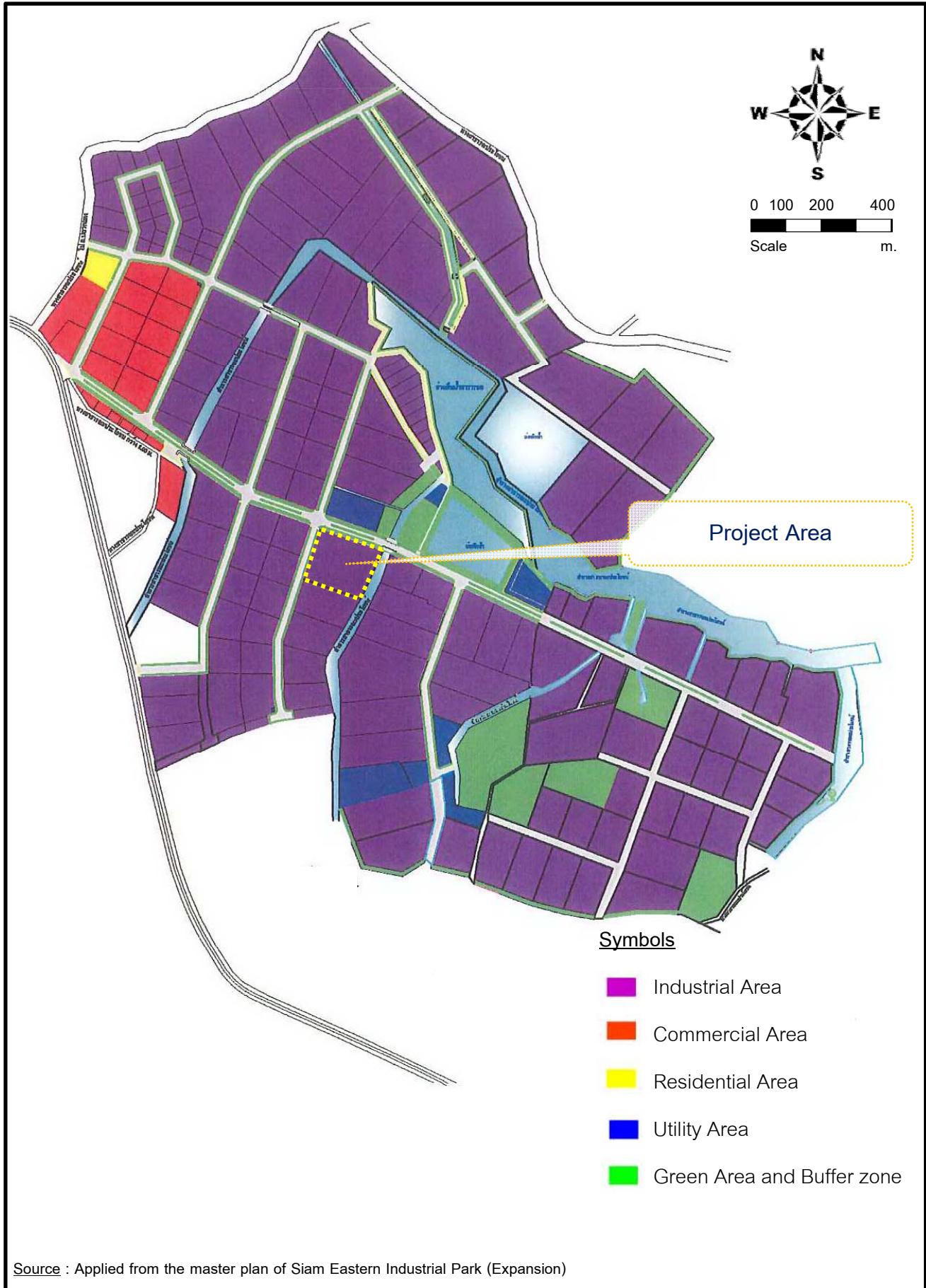
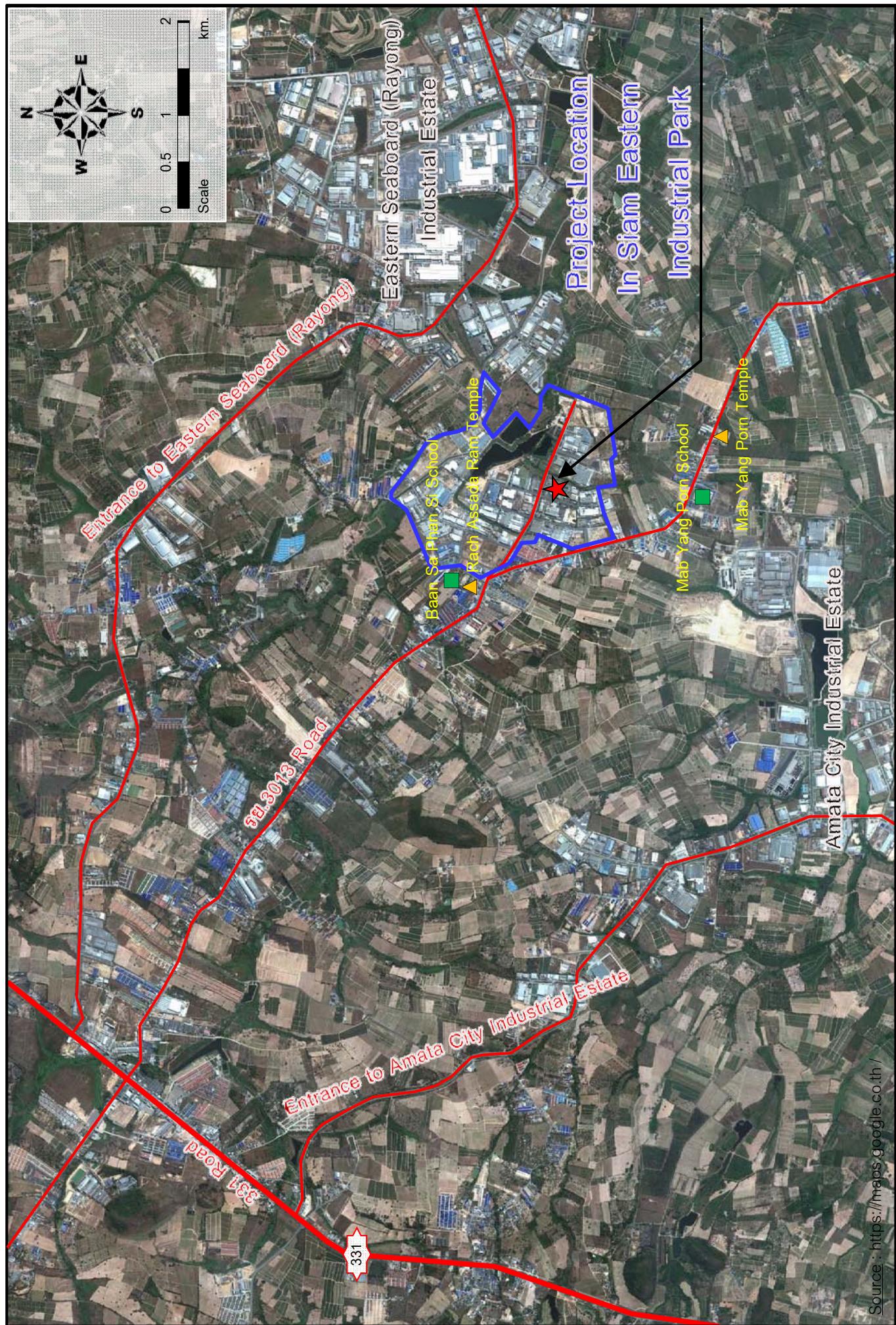


Figure 2.2-3 Project location in Siam Eastern Industrial Park



Source : <https://maps.google.co.th/>

Figure 2.2-4 Sensitive Areas



Figure 2.2-5 Landuse around the project area

### 2.3.2 Consideration on the choices for the project operation

**1) Suitability for the demand of power usage in the area:** The objective of the expanded project is to serve the demand of power usage of neighboring plants which is expected to have more demand of power of 20 megawatts. Therefore, the expanded project chooses to install the Gas Engine Generators as other technologies such as the Gas Turbine Generator and Steam Turbine is usually suitable for producing the power of 110-130 megawatts.

**2) Suitability for the control of air pollution:** The expanded project installs 2 sets of Gas Engine Generators using natural gas as fuel. As the main pollution is Nitrogen Dioxide, the system is installed to control the aforementioned pollution called Selective Catalytic Reduction (SCR) which is the Best Available Technology. It can control Nitrogen Dioxide for not over 35 ppm (the standard specifies of not over 120 ppm). Moreover, the control value of Nitrogen Dioxide emission from the previous plant is reduced following the Max Actual resulting in the entire reduction of control value of emission for around 47%.

**3) Suitability for the control of wastewater:** The project improves the previous demineralized water system by installing more RO systems for improving the quality of wastewater before entering the previous system which is the resin tank. This causes the frequency in recovering and cleaning resin to reduce from once a day to once in 7 days. Therefore, the amount of wastewater from the demineralized water reduces and the demand on using chemical in recovering and cleaning resin reduces.

### 2.4 Chart of project components

The current power plant covers the area of 29.2 rai. As the expanded project will install the machines in the unoccupied areas of the current power plant, the size of area in the entire picture does not change. However, the proportion of using some areas change a little as shown in Table 2.4-1 (chart of project components is as shown in Figures 2.4-1 and 2.4-2). Furthermore, the green area is allocated for 5.18% of the whole areas.

### 2.5 Fuel use

The current power plant requires the use of natural gas of 12.5 million ft<sup>2</sup>/day. When the Gas Engine Generators of the expanded project has been installed, the demand on the use of natural gas entirely increases to 14.26 million ft<sup>2</sup>/day. (Note – The previous report on the analysis states that the installation of diesel tanks to be used as reserved fuel for producing the Gas Turbine Generators and Steam Turbine. When the natural gas release system is out of order, the actual operation does not have the reserve of diesel).

Table 2.4-1

Proportion of Project landuse before and after project expansion.

Area/Activities of Project	Proportion of Project landuse			Proportion of area		
	Current power plant		After project expansion			
	sq.m.	rais	percent	sq.m.	rais	percent
1. Office/Maintenance /Storage buildings /Parking.	1,954	1.221	4.18	1,954	1.221	4.18
2. Gas Metering Station	1,162	0.726	2.49	1,162	0.726	2.49
3. Process Area <sup>2/</sup>	8,512	5.320	18.23	9,423	5.889	20.18
4. Utilities <sup>1/</sup>	6,702	4.189	14.35	6,702	4.189	14.35
5. Electricity Sub Station	4,340	2.713	9.30	4,599	2.874	9.85
6. Buffer Zone and Green Area	2,419	1.512	5.18	2,419	1.512	5.18
7. Road and Useless area <sup>2/</sup>	21,607	13.504	46.27	20,437	12.774	43.77
Total Area	46,696	29.185	100.0	46,696	29.185	100.0

Remark: <sup>1/</sup> Utilities included water quality improvement plant/Tank area/Water Pond/Cooling Tower. Then after project expansion the demineralized water tank and RO system were installed in space in utility area.

<sup>2/</sup> With the construction of the Gas Engine Generator no. 5 and 6 on the space of the existing plant. In this area, the ratio changes.

Source : Glow SPP 11 Co.,Ltd. ,2013

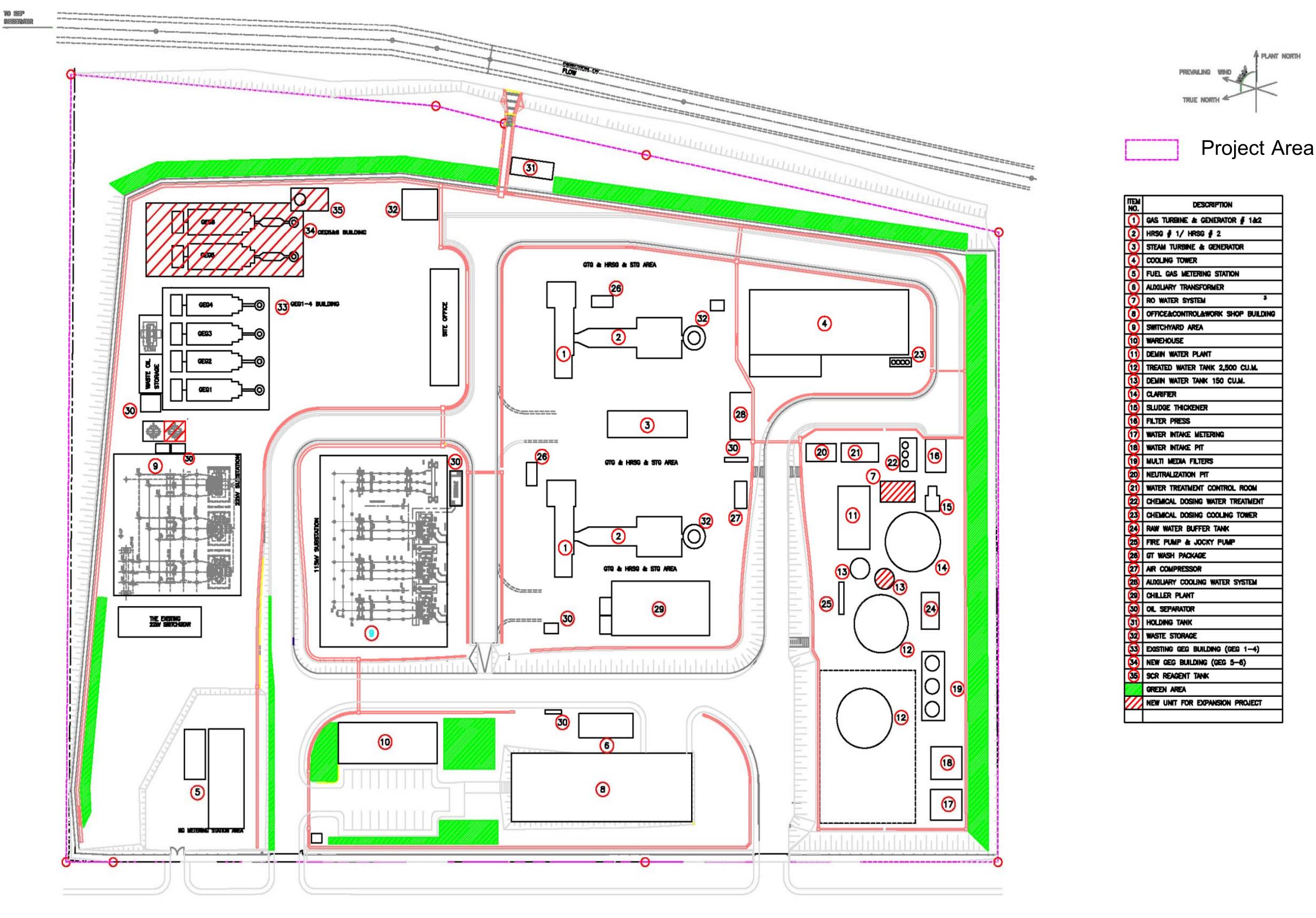


Figure 2.4-1 Project layout



## Gas Turbine Generator and Steam Turbine



Gas Engine Generators no. 1-4



Gas Engine Generators no. 5-6 area (Expansion Project)



Cooling Tower



Sub Station

Figure 2.4-2 Photos of current project and expansion area



Metering and Regulation Station : MRS



Demineralized system



Office building and Green Area



Waste Storage



Green Area



Figure 2.4-2 (continued) Photos of current project and expansion area

The current power plant obtains natural gas from the carrying pipes of PTT PCL which are 10 inches (as shown in Figure 2.5-1). As the system of natural gas pipes mentioned above is sufficient for the expanded project, there is no need to install more carrying pipes from outside. However, there will be the combination of pipes of the expanded project from the main pipe of the previous generator of gas engine to the generator of gas engine of the expanded project. The pipelines of natural gas are as shown in Figure 2.5-2 and the data of pipelines system of natural gas is as shown in Table 2.5-1. For the elements and properties of natural gas obtained from PTT PCL are as shown in Table 2.5-2.

## 2.6 Chemicals

The details of chemical usage compared between the current power plant and the expanded project are as shown in Table 2.6-1. The current power plant uses chemical in improving the quality of water used in several activities which are the production of clear water, recovery of resin condition of demineralized water system, scale prevention, adjustment of pH of cooling system and steam production system, and prevention of growth of microorganisms in the cooling system.

In the expanded project, 2 sets of Gas Engine Generators are additionally installed. They are the technology without the production of steam. The technology to be used is the cooling technology of machines with air. It will not cause the amount of chemical used in improving the quality of water in the cooling system and system to produce steam to change. However, the SCR system is installed for controlling air pollution from power generator additionally installed. Therefore, there is the demand on the additional use of ammonia solution and catalyst. Moreover, the previous demineralized water system is also improved by designing the RO system more for improving the quality of water before entering the previous system. This causes the frequency in recovering and cleaning resin to reduce from once a day to once in 7 days resulting in the reduction of demand of usage of hydrochloric acid and sodium hydroxide. There is also the plan to produce the clear water and demineralized water to sell to neighboring plants causing more use of chemical in the clear water production (PAC sediment substance and polymer sediment substance)

## 2.7 Production process

### 2.7.1 Productivity and guidelines for the operation

The data of electricity production compared between the current power plant and the expanded project can be summarized as shown in Table 2.7.1-1. The data of proportion of power distribution of each target group is as shown in Table 2.7.1-2. The total productivity of current power plant is 144 megawatts. When the expanded project has operated, the total productivity will increase from 144 to 164 megawatts (increase for 20 megawatts).

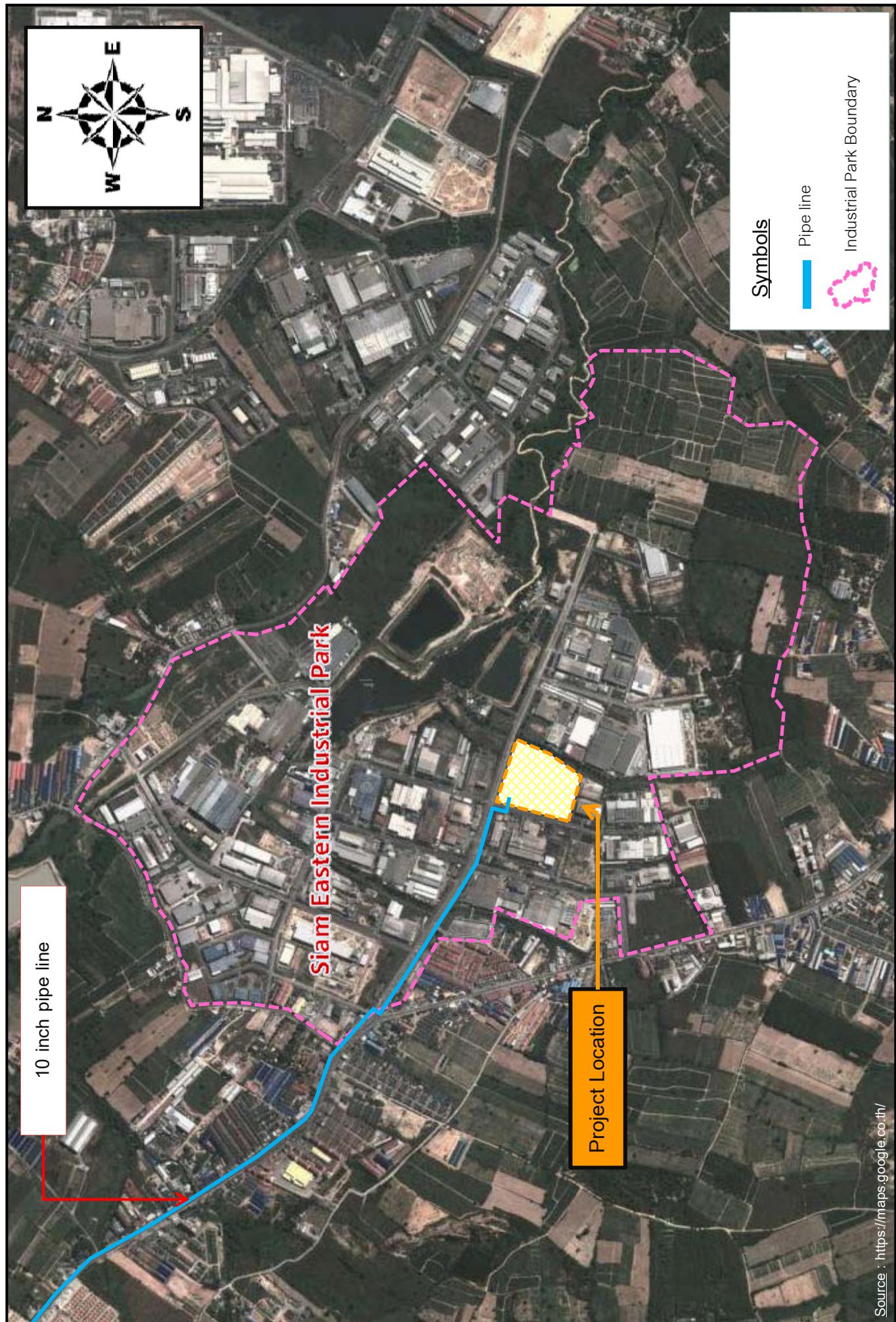


Figure 2.5-1 Natural Gas pipeline from PTT Public Company Limited

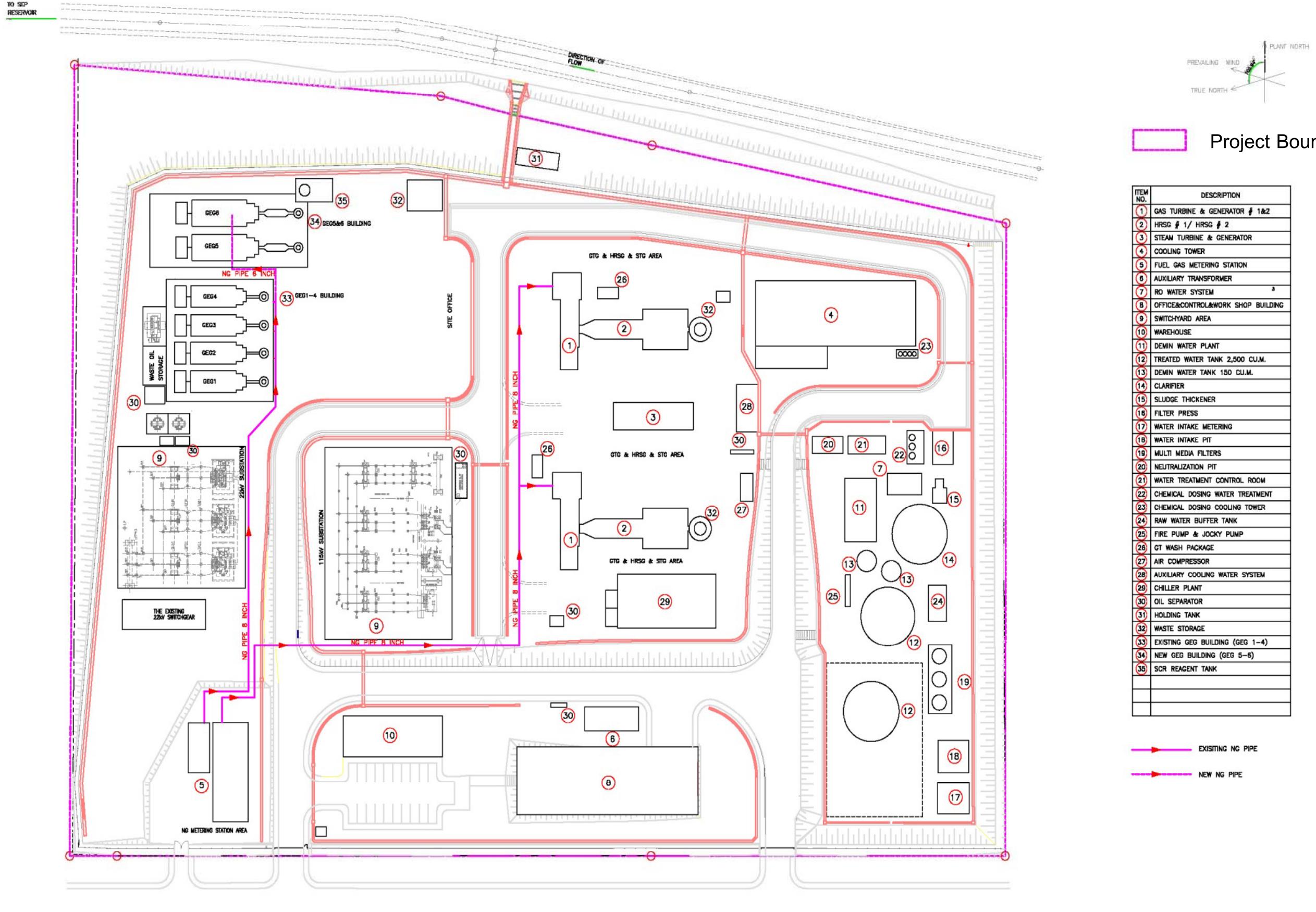


Figure 2.5-2 Natural gas pipeline within the project area

Table 2.5-1

The gas pipeline details of expansion and current project.

Natural gas pipe within project area	Initial Ending	Diameter of pipe (Inch)	Lenght of pipe (m)	Max operating condition Pressure (kg/cm <sup>2</sup> G)	Temperature (°F)
1. The Gas Turbine Generators and Steam Turbine of current project					
1.1 Main pipe and other connected into the process.	MRS	GTG 1-2	8	250	24
2. The Gas Engine Generators no. 1-4 of current project.					
2.1 Main pipe	MRS	GEG 1-4	8	130	9
2.2 Other pipe			3	10	9
3. The Gas Engine Generators no. 5-6 of expansion project.					
3.1 Main pipe	MRS	GEG 5-6	6	30	9
3.2 Other pipe			4	5	9
					60-120
					60-120

Source : Glow SPP 11 Co.,Ltd. ,2013

Table 2.5-2

Elements and Proportion of natural gas that used in project design

Elements		Proportion (%mol)
Cabon Dioxide	CO <sub>2</sub>	2.3-9.51
Nitrogen	N <sub>2</sub>	2.22-2.38
Methane	CH <sub>4</sub>	80.82-92.01
Ethane	C <sub>2</sub> H <sub>6</sub>	2.62-4.98
Propane	C <sub>3</sub> H <sub>8</sub>	0.5-1.68
Iso-Butane	iC <sub>4</sub> H <sub>10</sub>	0.09-0.35
n-Butane	nC <sub>4</sub> H <sub>10</sub>	0.07-0.30
Iso-Pentane	IC <sub>5</sub> H <sub>12</sub>	0.02-0.08
n-Pentane	nC <sub>5</sub> H <sub>12</sub>	0.01-0.04
Hexane	C <sub>6</sub> H <sub>14</sub>	0-0.02
Heptane	C <sub>7</sub> H <sub>16</sub>	0
Octane	C <sub>8</sub> H <sub>18</sub> <sup>+</sup>	0
Higher Heating Value (HHV SAT), BTU/SCF		959-980
Specific Gravity (SG)		0.6064-0.7076
WOBBE INDEX, BTU/SCF		1,160-1,280

Source : Glow SPP 11 Co.,Ltd. ,2013

Table 2.6-1

Chemical usage and details compare to current and expansion project

Materials / Chemicals / Products	Usage Description	Volume (ton/year)		transportation	Frequency of transportation (trips / year)		Storage
		current	after expansion		existing	after expansion	
1.Hydrochloric acid solution (35 %)	Regeneration of the resin in the demineralized water system	100	34	Trucks (with tank)	12	2	15 m <sup>3</sup> Tank
2.Sulfuric acid solution (50%)	Adjusting the pH of the cooling system	54	54	Trucks	144	144	1 m <sup>3</sup> Tank
3.Sodium Hydroxide solution (50%)	Regeneration of the resin in the demineralized water system	71	24	Trucks (with tank)	12	2	15 m <sup>3</sup> Tank
4.Sodium Hypochlorite	Microorganisms control in cooling system.	143	143	Trucks	144	144	1 m <sup>3</sup> Tank
5.Dispersant Solution (Nalco 7348)	Optimization control microorganisms in cooling system	2.3	2.3	Trucks	12	12	-
6.Trisodium phosphate	Adjusting the pH in steam system	4.2	4.2	Trucks	24	24	1 m <sup>3</sup> Tank
7.Amine (TriAct1800)	Adjusting the pH of the condensate water	1.2	1.2	Trucks	12	12	1 m <sup>3</sup> Tank
8.Polyaluminum Chloride	Disperse the precipitate particles used in water supply system	57	78	Trucks	24	33	5 m <sup>3</sup> Tank
9.Polymer	Disperse the precipitate particles used in water supply system.	2.6	3.6	Trucks	24	33	1 m <sup>3</sup> Tank
10.3D Trasar (R) 3DT 129	Prevent fouling in the cooling system	5.4	5.4	Trucks	24	24	1 m <sup>3</sup> Tank
11.Corrosion Prevention solution	Prevent fouling in the cooling system.	7.7	7.7	Trucks	24	24	0.5 m <sup>3</sup> Tank
12.Oxygen Scavenger (Eliminox)	Removal of oxygen in steam system	1.0	1.0	Trucks	12	12	1 m <sup>3</sup> Tank
13. Non-Oxidizing Biocide (N-7330)	Bacteria removal in the cooling system	1.4	1.4	Trucks	12	12	-
14.Ammonia	Used in SCR Air pollution control system	-	<u>302.4</u>	Trucks	-	24	35 m <sup>3</sup> Tank
15.SCR catalyst	Used in SCR Air pollution control system	-	<u>10.0</u>	Trucks	-	<u>0.34</u>	-

Source : Glow SPP 11 Co.,Ltd. ,2013

Table 2.7.1-1  
Electricity capacity of current and expansion project

Unit	Existing		Expansion Project	
	Quantity (set)	Capacity (megawatt)	Quantity (set)	Capacity (megawatt)
1. Current project				
1.1 Gas Turbine Generators and Steam turbine	1	121	1	121
1.2 Gas Engine Generators (GEG 1-4)	4	23	4	23
2. expansion project				
2.1 Gas Engine Generators (GEG 5-6)	-	-	2	20
Total	5	144	7	164

Source : Glow SPP 11 Co.,Ltd. ,2013

Table 2.7.1-2  
Tagget group of current and expansion project

Detail	Existing (megawatt)	expansion project (megawatt)
1. Used in project area	2.5	2.5
2. Sold to EGAT	90	90
3. Sold to other company	51.5	71.5
Total	144	164

Source : Glow SPP 11 Co.,Ltd. ,2013

## 2.7.2 Main equipment and production process

The details of main equipments of the current power plant and the expanded project can be summarized as shown in Table 2.7.2-1. The power generator of the current power plant consist of 2 parts; (1) 1 set of the Gas Turbine Generator and Steam Turbine with the productivity of 121 megawatts. The mass balance and heat are as shown in Figure 2.7.2-1 and (2) 4 sets of Gas Engine Generators (GEG 1-4) for 5.75 megawatts each. The mass balance and heat of each generator are as shown in Figure 2.7.2-2. For the expanded project, 2 sets of Gas Engine Generators (GEG 5-6) for 10 megawatts each will be additionally installed. The mass balance and heat of each generator are as shown in Figure 2.7.2-3.

The principles of operation of the equipments used in the production process of the current power plant and the expanded project are as follows:

1) The generator of Gas Turbine Generators and Steam Turbine of the current power plant consists of:

(1) **Gas Turbine Generators (GTGs)** consist of 4 parts; Compressor, Combustion chamber, Gas Turbine, and Generator. The operation starts from separating the air from the atmosphere being sprayed with demineralized water (called Fogging) by using the Compressor to be mixed with natural gas in the Combustion chamber. After the combustion occurs, the energy occurs by making the Gas turbine connected with Generator to move. The power is produced. Besides, the installation of Steam Injection is for injecting the steam into the combustion area of GTGs in order to control the occurrence of Nitrogen Dioxide.

(2) **Heat Recovery Steam Generators (HRSGs):** The principle of operation is to put the Exhaust gas from GTG into HRSGs which is the equipment exchanging the heat for transferring the heat from hot gas to demineralized water. This results in the occurrence of High Pressure Steam with the pressure of 58 bars at the temperature of 520 Celsius degree.

(3) **Steam Turbine Generator (STG)** consists of 2 main parts; Steam turbine and Generator. The operation starts from putting the steam gained from HRSGs into STG causing Steam turbine to be connected with Generator. The power is produced.

(4) **Condenser:** It makes the steam from the power production of STG condense by putting the steam from STG into the condenser. The condenser functions like the machine to exchange the heat by using the cooling water to reduce the heat of steam. Thus, the steam will be condensed to become water to be used in producing the steam again.

(5) **Coolant tower and cycling pump:** It pumps the cooling water from the cooling tower to cool the condenser and the cooling system of Gas Turbine Generators. The cooling water past the use of machine mentioned above will have higher temperature and will be brought into the cooling tower for lower the temperature to be normal and used as the cooling water again.

Table 2.7.2-1  
Detailed technical design of the main equipment of existing and expansion project

Equipment	Unit	Details
1. Gas Turbine Generator and Steam Turbine of current project		
1.1 Gas turbine generator (GTG)		
- Quantity	set	2
- Fuel input	-	natural gas
- Shaft speed	rpm	5,163
- Voltage	kV	11000
- Gross power out put (1 set)	MW	40
- Emission Control system	-	Steam injection
1.2 Steam turbine generator (STG)		
- Quantity	set	1
- Shaft speed	rpm	3,000
- Voltage	kV	10500
- Gross power out put	MW	41
1.3 Heat recovery steam generator (HRSG)		
- Quantity	set	2
- HP steam		
Steam temperature	°C	520
Steam input pressure	bar (g)	34-65
- LP steam		
Steam temperature	°C	250
Steam input pressure	bar (g)	6.5
2. Gas Engine Generators of current project		
- Quantity	set	4
- fuel input		natural gas
- Gross power out put (1 set)	MW	5.75
- Emission Control system	-	lean burn gas engine
3. Gas Engine Generators of expansion project		
- Quantity	set	2
- Fuel input		natural gas
- Gross power out put (1 set)	MW	10.0
- Emission Control system	-	SCR

Source : Glow SPP 11 Co.,Ltd. ,2013

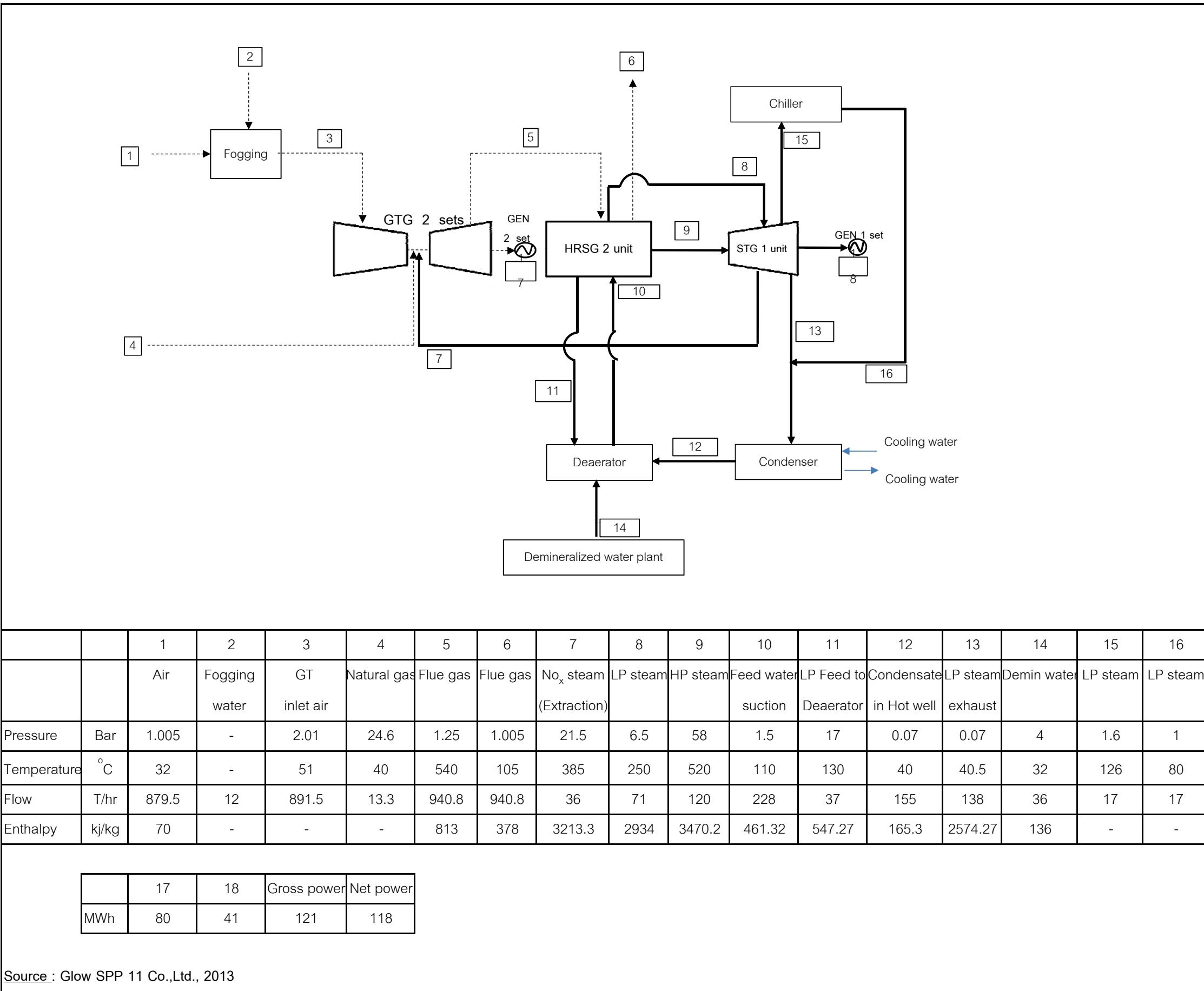


Figure 2.7.2-1 The current project heat balance of Gas Turbine Generators and Steam Turbine Generators

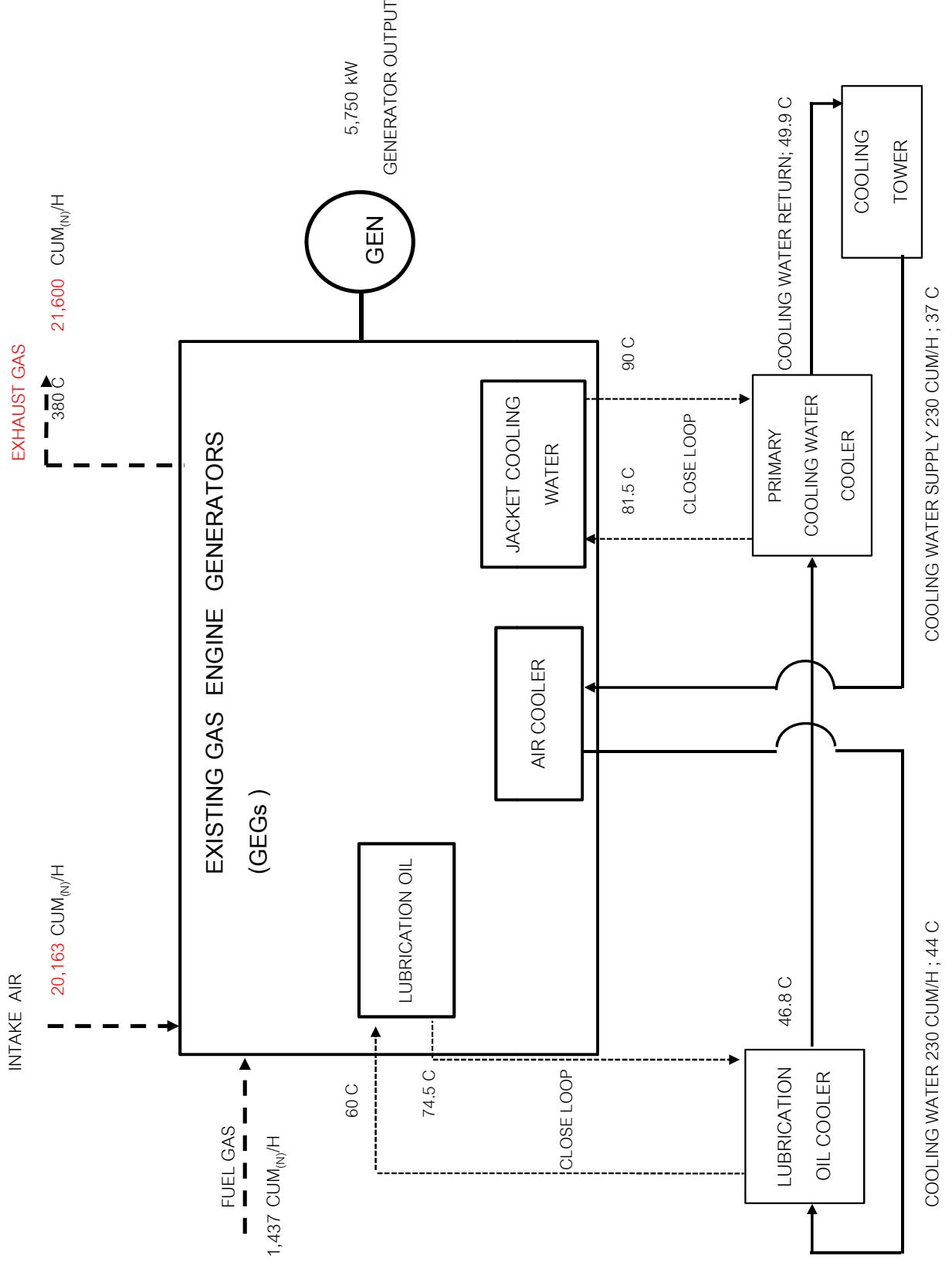
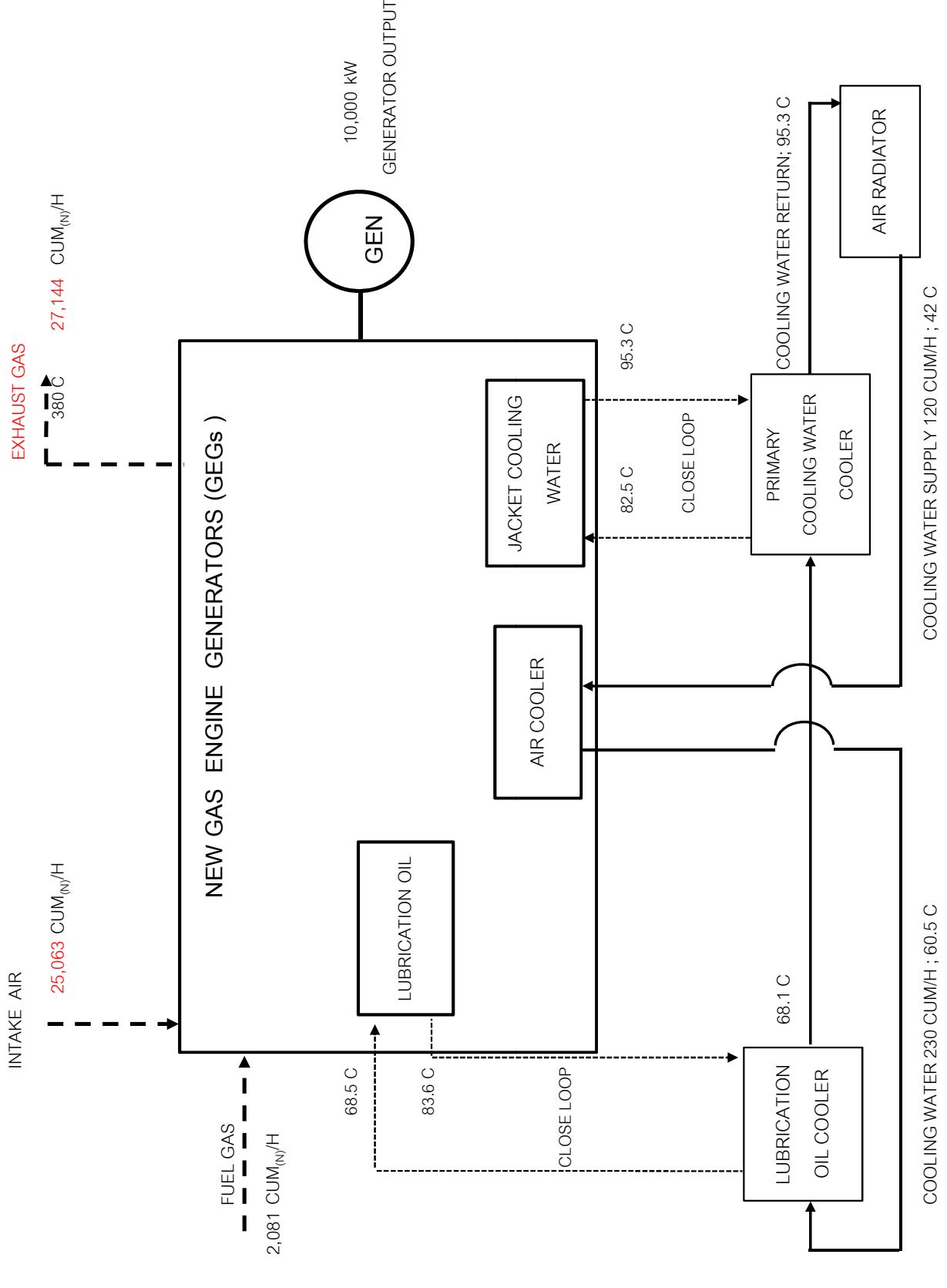


Figure 2.7.2-2 The expansion project heat balance of Gas Turbine Generators and Steam Turbine Generators (GEG1-4)



Source: Glow SPP 11 Co.,Ltd., 2013

Figure 2.7.2-3 The expansion project heat balance of Gas Turbine Generators and Steam Turbine Generators (GEG 5-6)

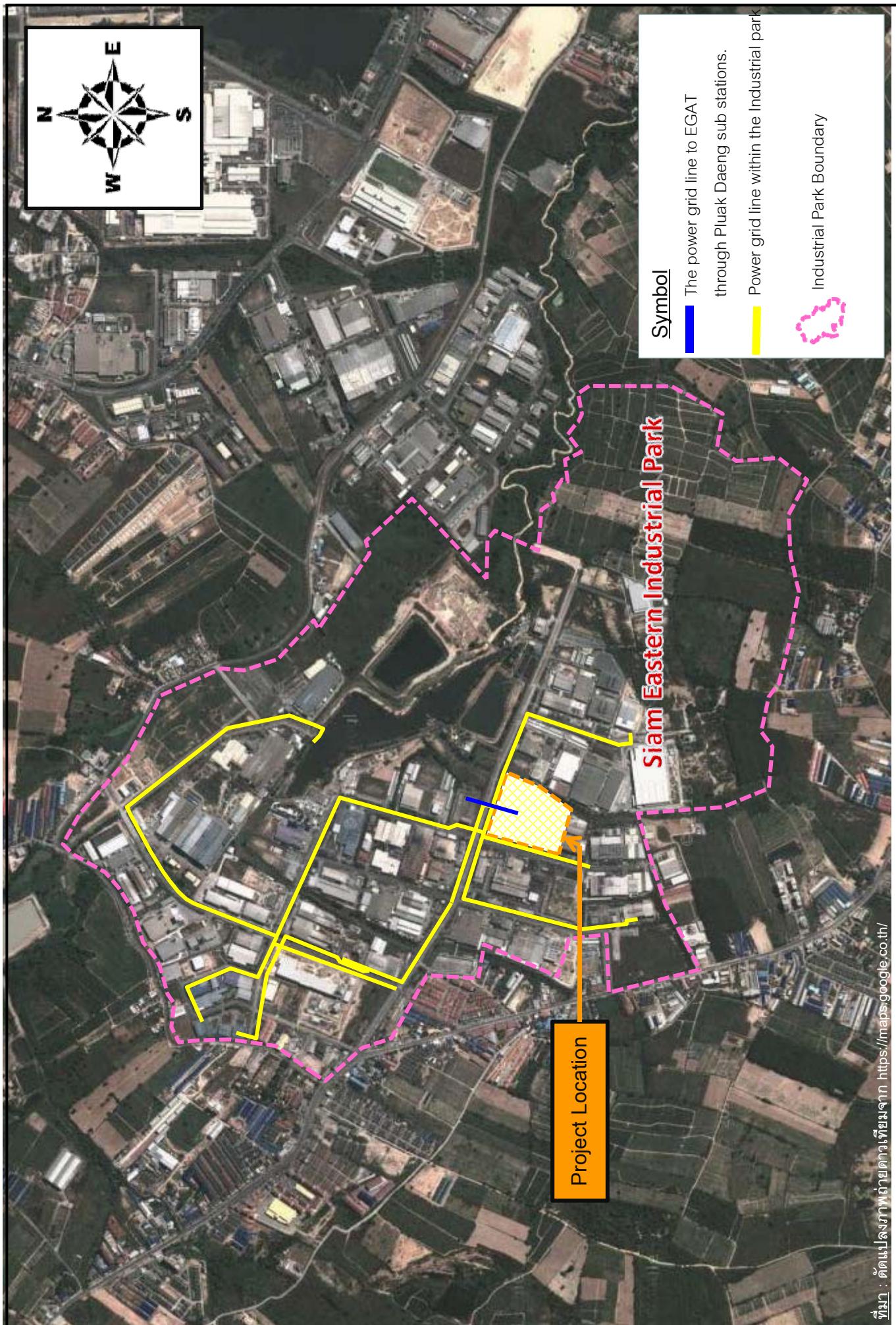
(6) Cold water producing machine: In the current power plant, the cold water producing machine is installed by using the heat from some parts of steam remaining from the production of power by STG as the source of energy for producing cold water. This system to produce cold water is called the Absorption Chiller.

2) Gas Engine Generator (GEG) of the current power plant: Now there are 4 sets of Gas Engine Generator (GEG 1-4) with the productivity of 5.75 megawatts each. Each set consists of the main equipments which are Engine, Generator and Cooling Tower. The engine is the Internal Combustion Engine using natural gas as fuel. The engine consists of piston and crankshaft connected with the generator. However, as the 4 sets do not use the spark plug, the system will be earlier operated by putting the diesel into the combustion area for helping in the ignition of engine. The cooling water system of engine will be the cooling tower and cycling pump.

3) Gas Engine Generator (GEG) of the expanded project: There is a plan to install 2 more sets of Gas Engine Generator (GEG 5-6) with the productivity of 20 megawatts each. The components and principle of operation are not significantly different from the previous engine generator. The different is only in 2 issues; (1) the gas engine of the expanded project has the spark plug so that it does not need the use of diesel in the ignition in the earlier state of system and (2) the cooling system will use the air instead of using the cooling tower.

## 2.8 Power Grid system

The current power plant partly distributes the power into the wire network of Electricity Generating Authority of Thailand (EGAT) at the Pluak Daeng Sub Station located in the north of the project. Moreover, some part of power is also distributed to the plants in the operational areas (the power grid distribution is as shown in Figure 2.8-1).



ที่มา : ดูแลแผนกวิศวกรรมศาสตร์เชิงนโยบาย https://maps.google.co.th/

Figure 2.8-1 The power grid line to industrial within industrial park and EGAT

## 2.9 Water Use System

### 2.9.1 Category and Consumption Quantity

In the extension construction period, the water will be provided by the contractor and the anticipated water consumption is 14.8 cubic meters/day. The Project uses water during operation period in two parts: water for employees and production processes and support systems. The tap water is provided by Industrial Estate and used in the office or employee activities. The raw water is adjusted before feeding to production processes and support systems which is provided by Eastern Water Resources Development and Management Public Company Limited

The water consumption in each case is shown in Table 2.9.1-1. The water balance of the current Project activities is shown in Figure 2.9.1-1 and the water balance of extension construction activities can be divided into two cases is shown in Figure no. 2.9.1-2 and 2.9.1-3 respectively and details are manifested below.

- (1) The treated and demineralised water are not available for sell to the outsider and
- (2) The treated and demineralised water are available for sell to the outsider.

Referring to table 2.9.1-1, when the Project is not sell the treated and demineralised water to the outsider, the water consumption during extension activities will be decreased from 5,257.8 cubic meters/day to 5,216.8 cubic meters/day or 41 cubic meters daily reduction.

The improvement plan for demineralised water production system by installing the RO systems at the Project site will be reduced the frequency of system cleaning and remedy that will be effective in reducing water consumption. However, when the Project sells the treated and demineralised water to the outsider, the water consumption will be increased to 7,201.8 cubic meters/day.

### 2.9.2 Water Purification System

The power plant has already installed and launched the water purification system with a capacity of 7,200 cubic meters/day (300 cubic meters/hour) and it is sufficient to use in the extension construction and Project activities.

### 2.9.3 Demineralised Water System

The power plant has installed the Ion Exchange process for producing demineralised water with a capacity of 1,440 cubic meters/day (60 cubic meters/hour) and this is enough to use in the Project activities. The Project is planning to install the RO systems in order to treat water before feed into demineralised water production system which can be reduced the frequency of system maintenance and chemical consumption (HCl and NaOH) and this will be effective in reducing of wastewater from the process.

Table 2.9.1-1

Water consumption of existing and after project expansion

Type of usage	Quantity (cu.m./day)		
	Existing	No water supply to the other plants	Expansion Project
- Compensation water for cooling system of Gas Turbine Generators and Steam Turbine	3,120	2,806	2,640
- Compensate water in cooling system of Gas Engine Generators	600	600	600
- Compensate water in cooling system of cool water system	720	720	720
- Water use in fogging system of Gas and Steam Turbine	288	288	288
- Compensate water in steam produce system of Gas and Steam Turbine	480	480	480
- Resins wash water in demineralized system	48	7	7
- Water used in RO system	-	314	480
- Water used in office and employees	1.8	1.8	1.8
- Water supplied to the plants within the industrial park	-	-	1,320
- Mineralized water supplied to the plants within the industrial park	-	-	665
<b>Total</b>	<b>5,257.8</b>	<b>5,216.8</b>	<b>7,201.8</b>

Source : Glow SPP 11 Co.,Ltd. ,2013

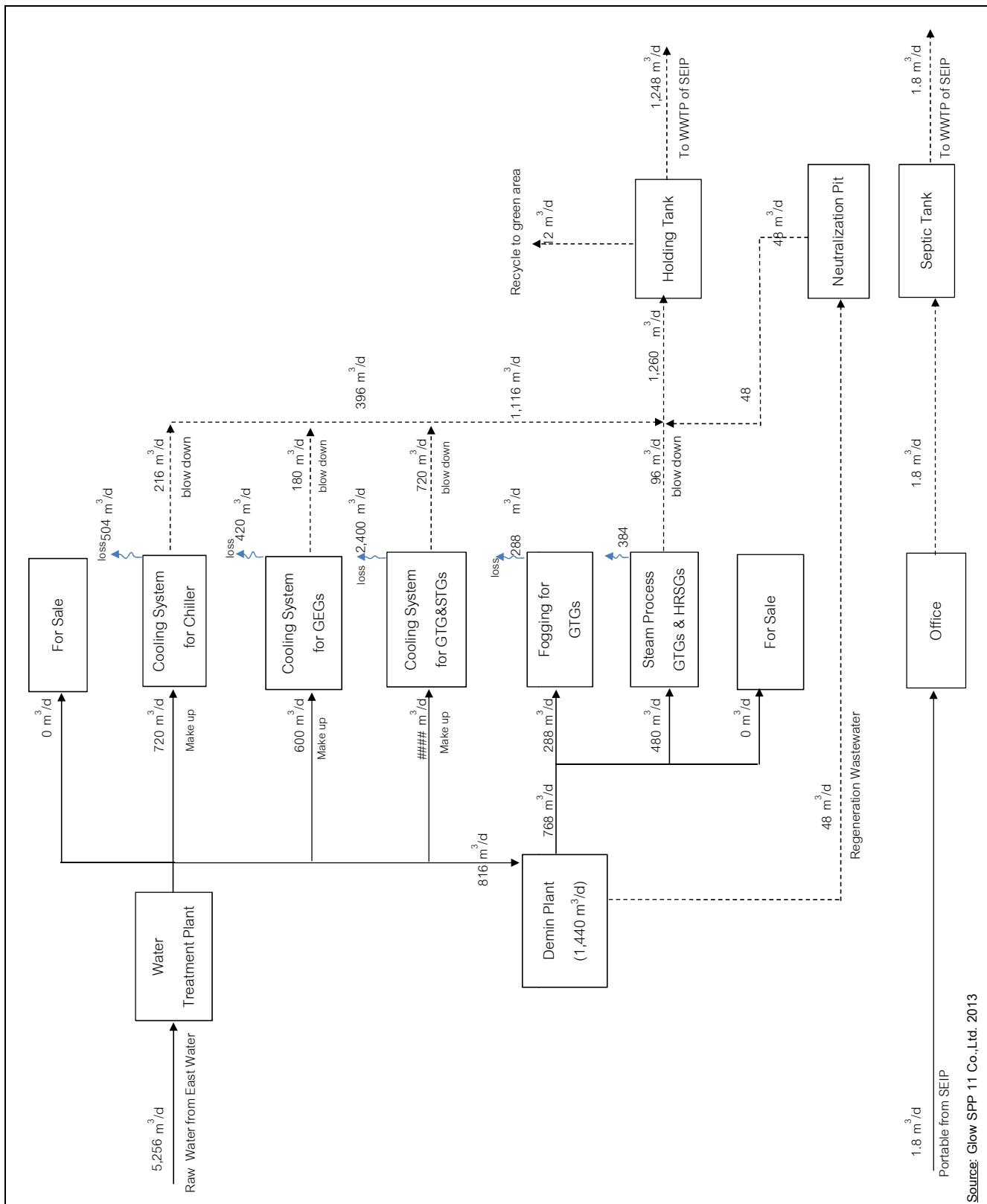


Figure 2.9.1-1 Water Balance

Source: Glow SPP 11 Co.,Ltd. 2013

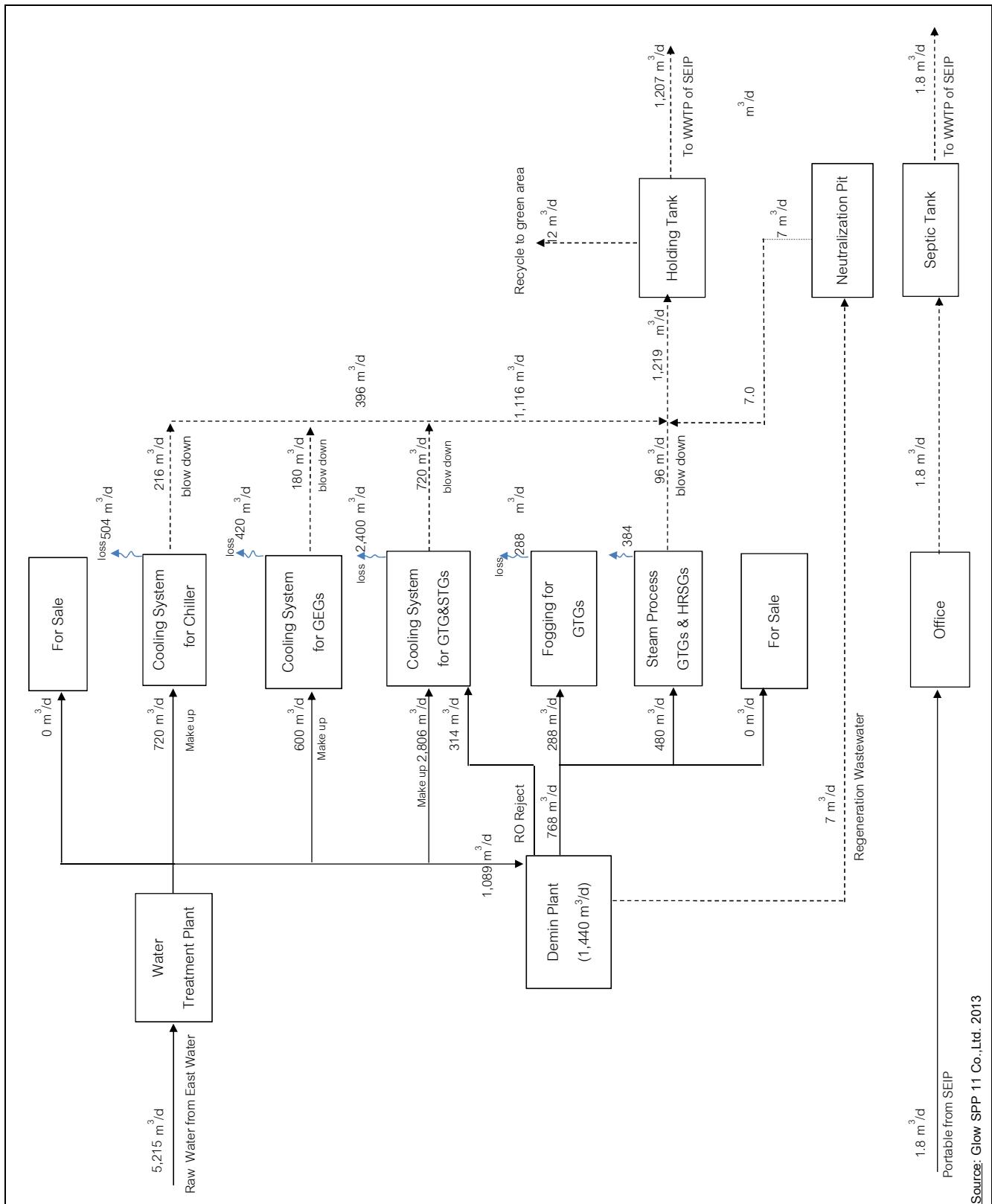


Figure 2.9.1-2 Water balance In case of no sales water and demineralized water to other company

Source: Glow SPP 11 Co.,Ltd. 2013

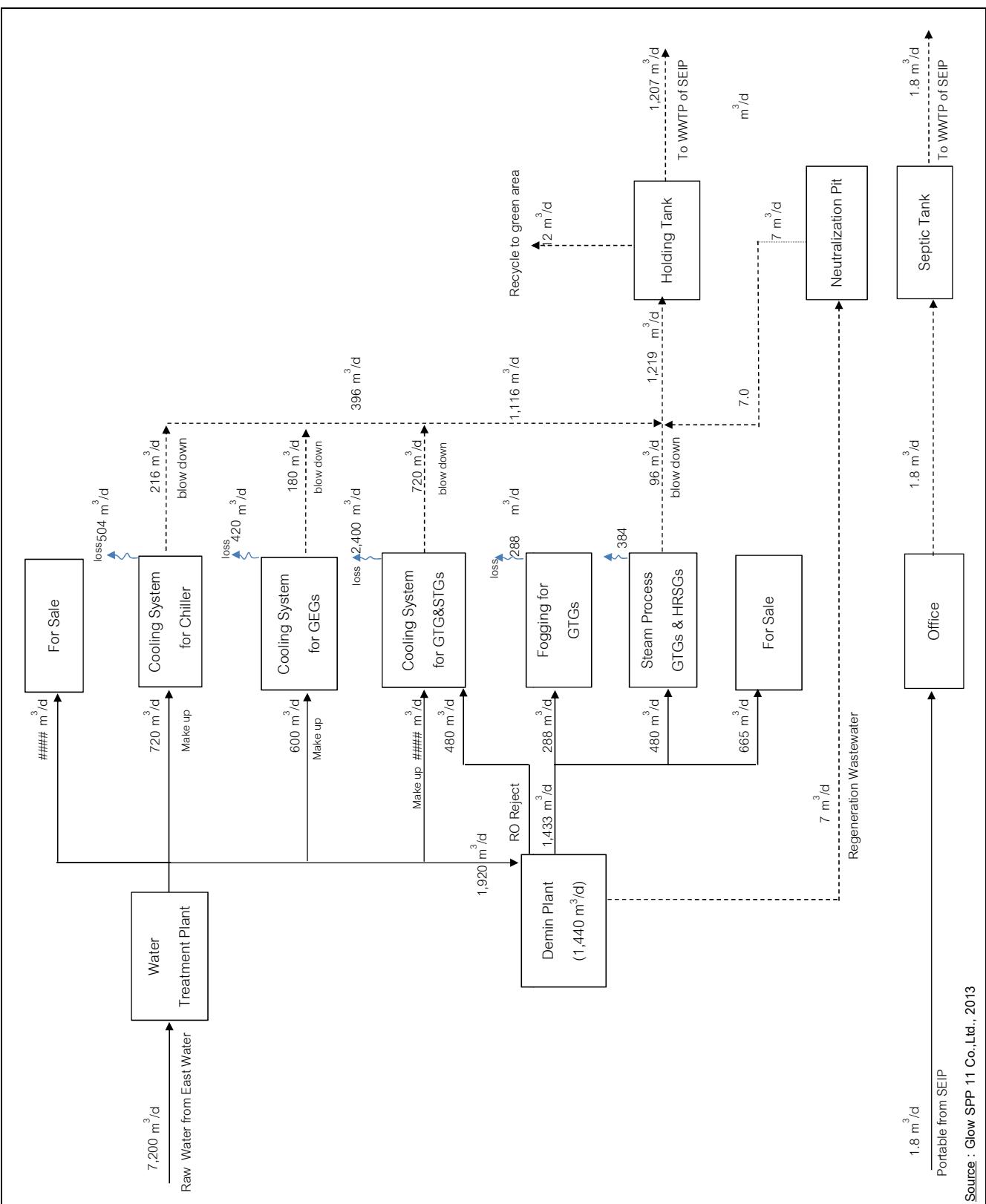


Figure 2.9.1-3 Water balance In case of sales water and demineralized water to other company

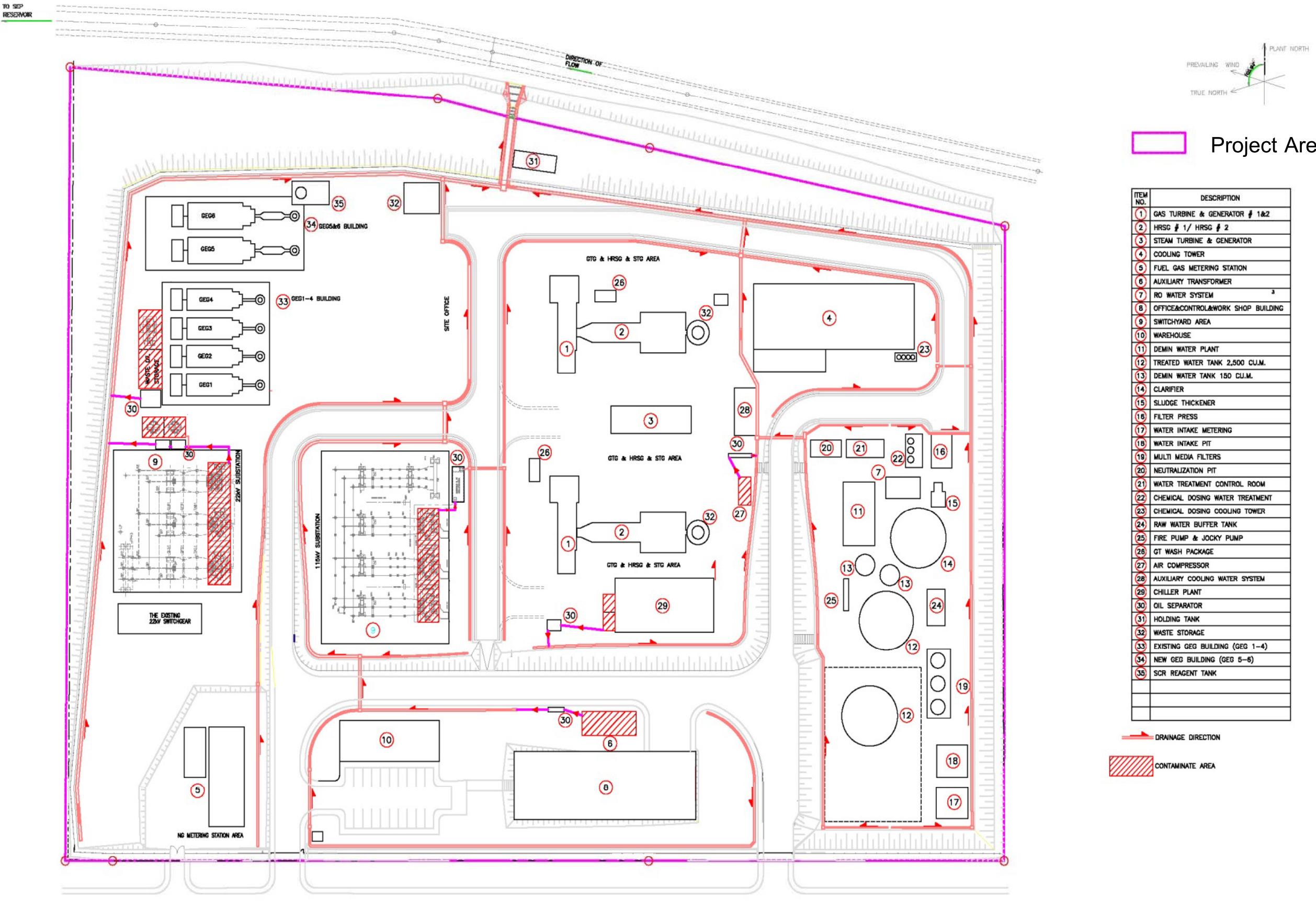
Source : Glow SPP 11 Co.,Ltd., 2013

## 2.10 Drainage System

Rainwater drainage system plan of the Project site is shown in Figure 2.10-1 and details are manifested below.

1) **General rainwater drainage system**, the rainwater will be runoff and flow follows the drainage ditch to the eastern of the Project site and it is connected with the Industrial Estate's raw water pond for further drain-off.

2) **Contaminated rainwater system**, the oil stains at transformer and air compressor unit (Figure 2.10.1) may cause the contaminated rainwater. The drainage way shall be separated from another rainwater drainage system in order to ensure that the contaminated water will be sent to Oil Separator unit in each area.



## Figure 2.10-1 Drainage system

## 2.11 Pollution and pollution control

### 2.11.1 Air pollution and air pollution control

1) Construction Period Major pollutant is dust from area preparation activities and vehicles for transportation purpose. However, project will provide the prevention and mitigation measures to reduce total suspended particulate (TSP), generated during the construction period, such as spraying water in construction area at least 2 times per day for reducing the distribution of total suspended particulate, vehicle speed limitation of not to exceed 20 km/hour. In construction zone, all loading trucks required to have the cover sheet, and no open-air burning all waste from construction and garbage in construction zone.

### 2) Operation Period

(1) Air pollution and air pollution control All numbers of stacks in expansion phase is concluded in table 2.11.1-1, and there are 8 of total stacks in the project. The main fuel for power generator is natural gas, and then the most pollutants are Sulfur Dioxide gas ( $\text{SO}_2$ ) and Total Suspended Particulate (TSP) respectively. The air pollution control of an existing plant and expansion project will provide in following section.

- Gas Turbine Generator (GTG)/Steam Turbine Generator (STG) of existing plant.

Steam injection was used to control oxides of nitrogen in incineration chamber, and also monitored with Continuous Emission Monitoring System (CEMs) at the stack with transmitting data system to the related government agencies.

- 4 sets of Gas Engine Generator (GEG) set no. 1-4 of existing plant.

Lean burn gas engine was used to control the ratio of mixture between natural gas and air at the incineration chamber lower than the usual ratio. Therefore, this technology will control the formation of oxides of nitrogen.

- 2 sets of Gas Engine Generator (GEG) set no. 5-6 of expansion project.

Selective Catalyst Reduction (SCR) will be installed and release the nitrogen gas to stack. It will conduct the reaction between ammonia solution and oxides of nitrogen, so this reaction will change the oxides of nitrogen form to nitrogen gas, which is not the air pollution anymore. In addition, the CEMs will provide for monitoring pollutions data from stacks and transmitted system will send all data collections to the related government agencies.

Table 2.11.1-1  
Air Pollution Sources from current and expansion project

Sources	Stack quality (set)	
	Current Project	Expansion Project
Current Project		
1. Gas Turbine Generator and Steam Turbine 1 set	2	2
2. Gas Engine Generator (GEG 1-4)	4	4
Expansion Project		
3. Gas Engine Generator (GEG 5-6)	-	2
Total	6	<u>8</u>

(2) **Air emission pollution** Air emission pollution has been concluded in table 2.11.1-2 to 2.11.1-4. The over view of expansion project will decrease the oxides of nitrogen from the activities of project comparison to provided data from the recent approved Environmental Impact Assessment (EIA) report. It will deduct oxides of nitrogen from 59.9 g/sec to 31.48 g/sec (47.4 % reduction rate). Since, the air pollution rate that release from stack in the recent approved EIA report was based on the initial design, but the existing project shown the maximum air emission pollution generated in past 2-3 years, and found the real composition of released gas such as oxygen ratio and humidity. However, the air emission pollution generated by expansion project will refer to the documents of air pollution control of generator manufacture. The additional prevention and mitigation measures stated that if the project running to the steady state or operating in the maximum capacities with lower air pollution released rate than that indicated in the EIA report. Then Glow SPP11 Limited Company will take that value for the project referenced data in air pollution control system and inform that data to the Office of Natural Resources and Environmental Policy and Planning (ONEP).

(3) **Agreeable of air emission pollution produced in industrial area** Project located in Siam Eastern Industrial Park with area about 29.2 Rai. Table 2.11.1-5 shown the limitation data in air emission pollution released rate of this area from stack height criteria. There is the agreeable in air pollution produced rate according to the industrial area.

- **Agreeable with oxides of nitrogen released rate.**

The reference data from the EIA report of Siam Eastern Industrial Park (Expansion) Project in 2010 has evaluated the limitation of air pollution produced rate in this industrial park with the surrounding areas. In this case, the power plant of Glow SPP11 Limited Company was operated before the above limitation evaluation. Therefore, the last EIA informed the limitation of oxides of nitrogen production rate from the maximum operation capacities of the existing power plant at that time, which was 39.8292 g/sec, and 31.48 g/sec in considering due to the operation of expansion project (Table 2.11.1-4) which agree with the limitation of air pollution produced rate in this area.

- **Agreeable with released rate of sulfur dioxide and suspended particles.**

The reference data from the EIA report of Siam Eastern Industrial Park: (Expansion) Project in 2010 has evaluated the limitation of sulfur dioxide and suspended particulate released rate in this area from stack height criteria (Table 2.11.1-5). The stack height of the current and the expansion phase are not the same, and in order to consider the agreement of air pollution released rate with the evaluated limitation, we have to consider the quantity of air pollution released rate as the pollution storage area (Table 2.11.1-6). Hence, the total accumulated SO<sub>2</sub> and suspended particles areas are 25.944 and 27.7 Rai respectively compare to the actual size as 29.2 Rai. Conclusion, the current and expansion phase operation will agree with air pollution produced rate limitation in this area.

Table 2.11.1-2  
Stack information and air pollution emission rate detailed in old EIA report

NAME OF STACK	STACK			EXHAUST GAS			CONCENTRATION			LOADING		
	COORDINATE	D	H	Temp	V	Q <sub>actual</sub>	Q <sup>1/</sup> <sub>standard</sub>	NO <sub>x</sub>	SO <sub>2</sub>	TSP	NO <sub>x</sub>	SO <sub>2</sub>
X	Y	(m)	(°C)	(m/s)	(m <sup>3</sup> /s)	(Nm <sup>3</sup> /s)	(ppm)	(ppm)	(mg/m <sup>3</sup> )	(g/s)	(g/s)	(g/s)
1. GTG&HRSG 1	731732	1438121	3.5	45	105	15.7	151.2	119.2	108	-	24.22	-
2. GTG&HRSG 2	731782	1438107	3.5	45	105	15.7	151.2	119.2	108	-	24.22	-
3. GEG 1	731808	1438227	1	12	170	17.8	14.0	9.4	108	-	1.91	-
4. GEG 2	731815	1438225	1	12	170	17.8	14.0	9.4	108	-	1.91	-
5. GEG 3	731797	1438224	1	12	170	17.8	14.0	9.4	108	-	1.91	-
6. GEG 4	731825	1438222	1	12	170	17.8	14.0	9.4	108	-	1.91	-
7. GEG 5	731817	1438207	1	12	170	17.8	14.0	9.4	108	-	1.91	-
8. GEG 6	731812	1438205	1	12	170	17.8	14.0	9.4	108	-	1.91	-
STANDARD <sup>2/</sup>			TOTAL AIR EMISSION LOADING			120			60			-
STANDARD <sup>2/</sup>			-			-			59.90			-

Remark : <sup>1/</sup> At 1 atm, 760 mm.Hg and excess oxygen 7% dry basis, 25 ° C

<sup>2/</sup> from Ministry of Natural Resources and Environment, 2010

Table 2.11.1-3

## Stack information and air pollution emission rate detailed in current project

NAME OF STACK	STACK				EXHAUST GAS				CONCENTRATION				LOADING		
	COORDINATE	D	H	Temp	V	O <sub>2</sub>	Humidity	Q <sub>actual</sub>	Q <sup>1/</sup> standard	NOx	SO <sub>2</sub>	TSP	NOx	SO <sub>2</sub>	TSP
X	Y	(m)	(m)	(°C)	(m/s)	(%)	(%)	(m <sup>3</sup> /s)	(Nm <sup>3</sup> /s)	(ppm)	(mg/m <sup>3</sup> )	(g/s)	(g/s)	(g/s)	
1. GTG&HRSG 1	731732	1438121	3.42	45	107	17.6	13.4	7.4	1611.6	63.3	108	5.0	7.0	12.86	0.83
2. GTG&HRSG 2	731782	1438107	3.42	45	107	17.6	13.4	7.4	1611.6	63.3	108	5.0	7.0	12.86	0.83
3. GEG 1	731808	1438227	0.95	14.7	380	34.4	12.5	10.7	24.4	6	105	5.0	15.0	1.19	0.08
4. GEG 2	731815	1438225	0.95	14.7	380	34.4	12.5	10.7	24.4	6	105	5.0	15.0	1.19	0.08
5. GEG 3	731797	1438224	0.95	14.7	380	34.4	12.5	10.7	24.4	6	105	5.0	15.0	1.19	0.08
6. GEG 4	731825	1438222	0.95	14.7	380	34.4	12.5	10.7	24.4	6	105	5.0	15.0	1.19	0.08
STANDARD <sup>2/</sup>												120	20	60	-
TOTAL AIR EMISSION LOADING												-	-	30.48	1.98
												-	-	30.48	1.98
												-	-	30.48	1.98
												-	-	30.48	1.98
												-	-	30.48	1.98
												-	-	30.48	1.98
												-	-	30.48	1.98

Remark: <sup>1/</sup> At 1 atm, 760 mm.Hg and excess oxygen 7% dry basis, 25 ° C<sup>2/</sup> from Ministry of Natural Resources and Environment, 2010

Table 2.11.1-4

## Stack details and air pollution emission rate

NAME OF STACK	STACK			EXHAUST GAS			CONCENTRATION			LOADING						
	X	Y	(m)	D	H	Temp (^°C)	V	O <sub>2</sub>	Humidity (%)	Q <sub>actual</sub>	Q <sub>standard</sub> 1/ <sup>1/</sup>	NOx	SO <sub>2</sub>	TSP		
Existing																
1. GTG&HRSG 1	731732	1438121	3.42	45	107	17.6	13.4	7.4	161.6	63.3	108	5.0	7.0	12.86	0.83	0.44
2. GTG&HRSG 2	731782	1438107	3.42	45	107	17.6	13.4	7.4	161.6	63.3	108	5.0	7.0	12.86	0.83	0.44
3. GEG 1	731808	1438227	0.95	14.7	380	34.4	12.5	10.7	24.4	6	105	5.0	15.0	1.19	0.08	0.09
4. GEG 2	731815	1438225	0.95	14.7	380	34.4	12.5	10.7	24.4	6	105	5.0	15.0	1.19	0.08	0.09
5. GEG 3	731797	1438224	0.95	14.7	380	34.4	12.5	10.7	24.4	6	105	5.0	15.0	1.19	0.08	0.09
6. GEG 4	731825	1438222	0.95	14.7	380	34.4	12.5	10.7	24.4	6	105	5.0	15.0	1.19	0.08	0.09
<b>Expansion Project</b>																
7. GEG 5	731837	1438213	1.2	30.0	367	23.4	11.2	12.4	26.5	7.54	35	5.0	24.0	0.50	0.1	0.18
8. GEG 6	731845	1438211	1.2	30.0	367	23.4	11.2	12.4	26.5	7.54	35	5.0	24.0	0.50	0.1	0.18
<b>STANDARD<sup>2/</sup></b>																
<b>TOTAL AIR EMISSION LOADING</b>										-	-	-	-	31.48	2.18	1.6

Remark <sup>1/</sup> At 1 atm, 760 mm.Hg and excess oxygen 7% dry basis, 25 ° C<sup>2/</sup> from Ministry of Natural Resources and Environment. 2010

Table 2.11.1-5  
**Air Pollution Emission Quota of Siam Eastern Industrial Park**

Stack Height (metres)	Industrial Park Emission Rate control		
	NOx	SO2	TSP
10	0.69	2.31	2.06
20	1.34	5.09	5.83
30	1.68	6.75	7.53
40	3.20	12.57	8.98
50	7.21	28.57	23.07
60	7.91	76.52	43.02

Source: Siam Eastern Industrial Park Environmental Impact Assessment (EIA) Report (Expansion), 2010

Table 2.11.1-6  
Used Air Pollution capacity area calculatiion (SO<sub>2</sub> and TSP)  
from project stack in current and expanded project.

Stack	Stack Height (m)	Industrial Park Emission quota		Used area	
		SO <sub>2</sub> (kg/rai-day)	TSP (kg/rai-day)	SO <sub>2</sub> (rai)	TSP (rai)
<u>Current Project</u>					
1. GTG&HRSG 1	45	12.57	8.98	5.706	4.234
2. GTG&HRSG 2	45	12.57	8.98	5.706	4.234
3. GEG 1	14.7	2.31	2.06	2.993	3.775
4. GEG 2	14.7	2.31	2.06	2.993	3.775
5. GEG 3	14.7	2.31	2.06	2.993	3.775
6. GEG 4	14.7	2.31	2.06	2.993	3.775
<u>Expanded Project</u>					
7. GEG 5	30.0	6.75	7.53	1.280	2.066
8. GEG 6	30.0	6.75	7.53	1.280	2.066
Total				25.944	27.7

## 2.11.2 Wastewater management

**1) Construction Period.** Wastewater generated by workers due to construction activities is 4.8 m<sup>3</sup>/d. There is sufficient temporary restrooms providing for all workers, and will contact the certified agency for treatment all of wastewater in this construction phase.

### 2) Operation Period

**(1) Wastewater quantity and management.** Wastewater quantity from the existing plant and the expansion project are shown in Table 2.11.2-1 (Figure 2.9.1-1, 2.9.1-2, and 2.9.1-3). The operation of expansion project will reduce the amount of wastewater from 1,261.8 m<sup>3</sup>/day to 1,220.8 m<sup>3</sup>/day (decreasing 41 m<sup>3</sup>/day). However, there is improvement plan for installing the reverse osmosis system in pretreatment water system and changing the cooling system for gas engine generators (expansion project) from water-cooling to air-cooling system. Wastewater collection pipeline system as shown in Figure 2.11.2-1 for the existing and the expansion project was provided and all wastewater will collect into the settling pond before transferring to the central wastewater treatment of industrial park.

**(2) Wastewater treatment of industrial park.** The Wastewater treatment plant has capacities to treat wastewater 9,500 m<sup>3</sup>/day including 2 polishing ponds with capacities 464,000 and 624,000 m<sup>3</sup> respectively. Treated water will be used in green area of industrial park (200 Rai) and drain to Hin-Loi canal. The wastewater balance between before and after establishing the expansion project (Figure 2.11.2-2) about 3,228 m<sup>3</sup>/day and 3,187 m<sup>3</sup>/day respectively. In addition, the expansion project will reduce the wastewater quantity from the project site. The total wastewater generation just reaches 33.5% of wastewater treatment capacity.

Table 2.11.2-1

Wastewater and management from current and expansion project

Sources	Quantity (cu.m./day)		
	Existing	After Expansion	Management
1. Wastewater from cooling tower of Gas Turbine Generators and Steam Turbine	720	720	Water through cooling towers to reduce the temperature of the water before draining into gutters to collect water into the pond. And check the quality before sending them to a central wastewater treatment system of the industrial park
2. Wastewater from cooling tower of Gas Engine Generators	180	180	
3. Wastewater from cooling tower of cold water system	216	216	
4. Wastewater from steam system	96	96	
5. Wastewater from demineralized water system	48	7	Send to Neutralization Pit to adjust to neutral water before entering the clarifier effluent of the wastewater treatment system and sent to the central wastewater treatment system of the industrial park
6. Wastewater from office	1.8	1.8	Send to septic tank before draining into central wastewater treatment system of the industrial park
<b>Total</b>	<b>1,261.8</b>	<b>1,220.8</b>	

Source : Glow SPP 11 Co.,Ltd. ,2013

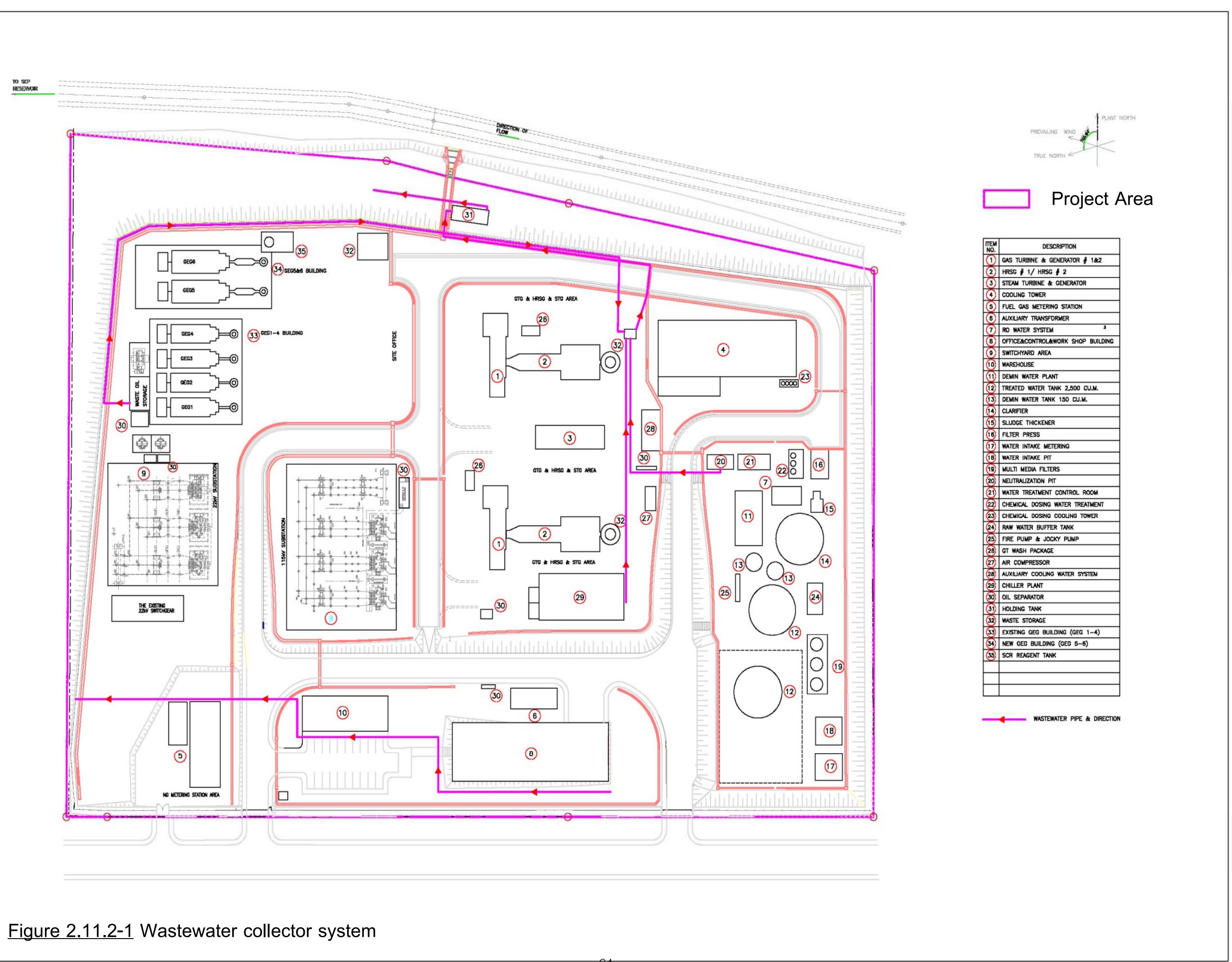


Figure 2.11.2-1 Wastewater collector system

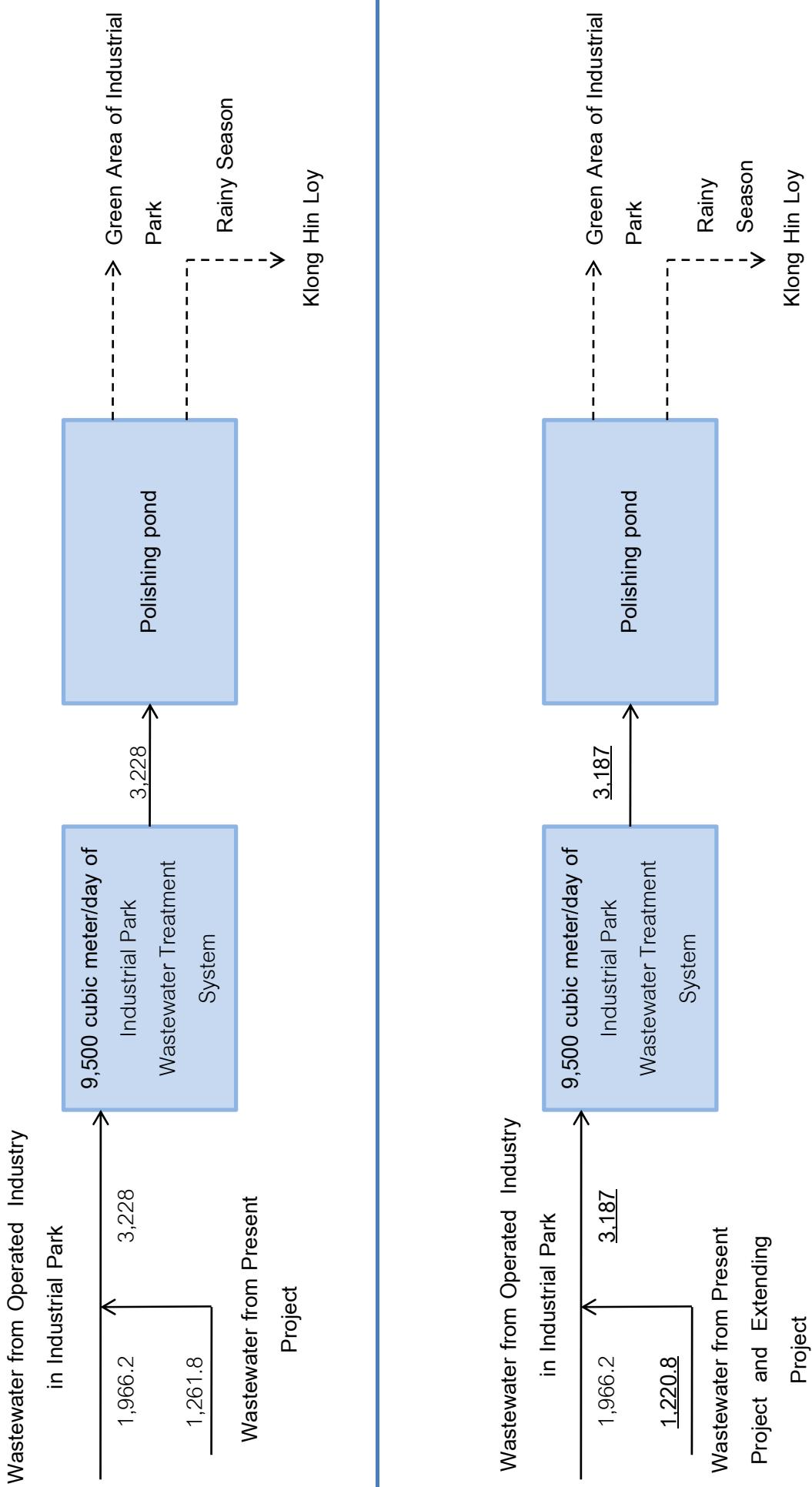


Figure 2.11.2-2\_Wastewater from factories were collected to center wastewater treatment system of Siam Eastern Industrial Park

### 2.11.3 Noise pollution management

**1) Construction Period.** Noise pollution from construction activities such as machine operating in construction field referenced from Larry W. Canter, Environmental Impact Assessment 2<sup>nd</sup> edition, McGraw Hill, Inc., 1996 (1 meter measurement from source) as following;

- |                                      |                |
|--------------------------------------|----------------|
| - Drilling and combining compartment | (Leq) 89 dB(A) |
| - Area preparation                   | (Leq) 84 dB(A) |
| - Correcting and furnishing          | (Leq) 89 dB(A) |
| - Basement construction              | (Leq) 77 dB(A) |

There is temporary noise impact in short term. However, noise mitigation plan will provide as no construction activities in during 19.00 -07.00, providing personal noise protection equipment in area with noise level above 85 dB(A), avoiding to operate high level noise equipment in the same time, giving construction information to the surrounding area before the beginning of the construction phase.

**2) Operation Period.** Noise pollution source that may arise from the implementation of the project is machinery or equipment used in the production and production-supporting process, which are Gas Turbine Generator (GTG)/Steam Turbine Generator (STG), Gas Engine Generator (GEG), air compressor and cooling tower. The project has control volume along fence in accordance with the Ministry of Industry regarding the noise level and the noise level caused by the operation of the plant B.E. 2548 , which provides 24-hour average noise level resulting from the operation of not exceeding 70 dB. The existing plant monitoring report of 2012 shown the found that the noise levels (Leq 24 hr.) around the fence in the range of 54.8 to 67.0 dB , which is in the standard. The building for Gas Engine Generator (GEG) set no.5 and 6 of this expansion project are not significantly different from the Gas Engine Generator (GEG) set no.1 to 4 that have already been installed in enclosed building. It is estimated that the volume is not different from a Gas Engine Generator of the existing project . However, the project set the prevention and mitigation measures to prevent impacts caused by the project , such as planting trees to prevent the noise , when the project is necessary to carry out the activities that cause noise. Company needs to advance the public or community, Provide the noise contour map within production area once the operation began and update noise contour map every three years and etc.

#### 2.11.4 Waste management

**1) Construction Period.** The waste from 80 workers is considering from the plastic container, glass bottle, papers, etc. The total estimation is 0.064 tons/day (personal waste generation rate at 0.8 kg/person/day). The construction company has to sign contrast in order to provide enough the specific waste-collecting container with lid and distribution in all area of the construction sites, and employed an authorized agencies for waste collecting and disposal. The waste estimation from construction activities (wood, brick, iron) is 0.5 tons/day, which they are in under responsibility of the construction company for separation, reuse, resell or distribution to an authorized agency for disposal all the rest of construction waste.

**2) Operation Period.** The current waste generation from the existing and the expansion project are shown in Table 2.11.4-1 (2 sections) The main waste types are waste from production process and waste from workers. The expansion project will increase waste generation from 131.6 tons/day to 142.1 tons/day (increasing 10.5 tons/day). Sanitary waste containers will provide in this operation phase. Waste collection building has area about 80-m<sup>2</sup> covering with roof and separated space for each of waste type. Waste disposal procedure will conduct by authorized agencies. Furthermore, waste generated in operation period will manage by authorized agencies (Waste Management Siam Ltd., Pluak Daeng Waste and Energy Ltd., and Better World Green Public Ltd.) for transferring from the plant as soon as they can (less 7 days storage).

#### 2.12 Transportation

Volume of transportation resulting from the existing and expansion projects are summarized in Table. 2.12-1

#### 2.13 Workers and officer

**1) Construction Period.** The construction schedule in 13 months with approximation 80 workers, and all workers will live in outside the construction area.

**2) Operation Period.** The present 40 officers were already in the plant. The expansion project does not require additional officer (Figure 2.13-1), which include the plant manager, operation manager, maintenance manager, and safety and environmental management manager. There are 3 shifts (8 hrs per shift) for the operation work schedule.

Table 2.11.4-1

Type, Quantity and management of Solid waste from current and after expansion project

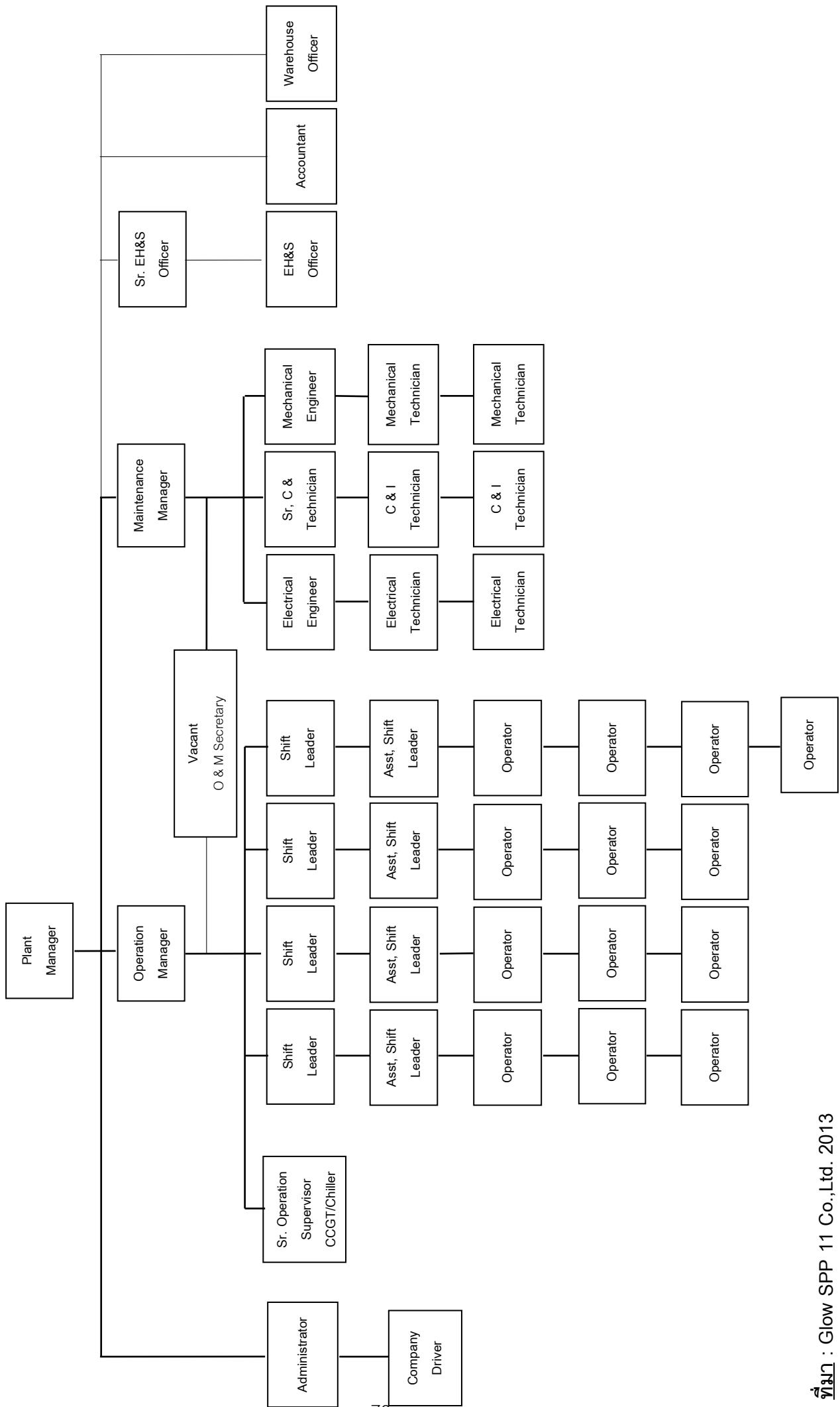
Type	Quantity (ton/year)		Management
	Existing	Expansion project	
1 Waste of employees	1.5	1.5	Sent to Siam Eastern Industrial Park
2 Waste from the production process			
1.1 Metal	10	10	
1.2 Used oil	40	50	
1.3 Sludge	70	96	
1.4 Degraded resin	2	2	
1.5 Air filter	3	3.5	
1.6 Insulation rock wool	4	4	
1.7 Used chemical	0.5	0.5	
1.8 Contaminated materials	0.5	0.5	
1.9 Used battery	0.1	0.1	
Total	131.6	168.1	

Source : Glow SPP 11 Co.,Ltd. ,2013

Table 2.12-1  
Traffic volume occurs from current and expanded project

Transportation activity	Vehicle type	volume (trip/day)		
		Current project	Expanded project	Part
<b>Construction Phase</b>				
1. Materials	10 wheels truck	-	10	+10
2. Construction Workers	6 wheels truck	-	4	+4
<b>Total (Construction)</b>		-	14	+14
<b>Operation Phase</b>				
1. Employees transportation	Private car	6	6	-
	Van	4	4	-
2. Chemical	10 wheels truck	13	15	+2
3. Waste	10 wheels truck	8	10	+2
<b>Total (operation phase)</b>		31	35	+4

Source: Glow SPP 11 Co.,Ltd. 2013



## 2.14 Occupational health and safety

### 1) Fire Prevention and Control

Fire distinguishing systems and fire extinguishers are installed over the areas of the modern power plant according to the laws and regulations/standards involved such as Ministry of Industry Announcement on the topic of Fire Prevention in Industrial Factories B.E.2552, standards issued by The Engineering Institute of Thailand Under H.M. The King's Patronage, and standards of National Fire Protection Association (NFPA). The details of the fire prevention equipment and fire extinguishers of the current project and the expansion project are summarized in Table 2.14-1 while the places where the fire prevention equipment and fire extinguishers are installed in the project after increasing the production capacity are shown in Figure 2.14-1.

The consideration of the sufficiency of the fire pumps formerly used in the project is based on the standards from the institutes involved by the fire pumps must be installed and sufficiently available for the emergency area that needs the most fire extinguishing water. According to the Ministry of Interior Announcement on the topic of Fire Prevention and Control in Establishment for Employee's Safety, it is defined that the reserved water used for distinguishing the fire in 1,000 square meter area must be 36 cubic meter. Moreover, the Ministry of Industry Announcement on the topic of Fire Prevention in Industrial Factories B.E.2552 mentioned that the reserved water must be enough to distinguish the fire for at least 30 minutes continuously. When considering the need of maximum fire distinguishing water in the transformer area, that is designed to simultaneously use 2 firefighting nozzles along with water spray system, it is found that the maximum water need for that area is 858 gallon/minute or 195 cubic meter/hour (using 2 firefighting nozzles in the same time requires 750 gallon of water/minute while the water spray system needs 108 gallon of water/minute or 0.25 gallon of water/square foot). The project will use the fire distinguishing water from reserved treated water tank sized 2,500 cubic meter that is designed for storing enough water used to continuously stop the fire at 1,250 cubic meter or 50% of the industrial reserved water tank volume. So the reserved water can be used for distinguishing fire at the area of maximum water need for 6.4 hours.

### 2) Emergency Action Plan

This project has prepared the emergency action plan in order to control and stop any emergency cases that could happen as fast as possible and to efficiently protect against any possible damages. The emergency action plan can be categorized into 3 levels from how severe it is.

Table 2.14-1  
**Fire protection equipment of current projects and project expansion**

Equipment	Installation location	Quantity (Unit)	
		Existing	After expansion
1. Wet sprinkler	Admin building	1	1
2. Water Spray & deluge valve	Workshop	1	1
	Aux Transformer	2	2
	22 kv switchyard	3	3
	115 kv switchyard	3	3
	GEG 1-4 Transformer	1	1
	GEG 5-6 Transformer	-	1
3. Fire Hydrant & FHC	22 kv switchyard	3	3
	115 kv switchyard	1	1
	Gas turbine 1	2	2
	Gas turbine 2	2	2
	Cooling tower	2	2
	MRS area	1	1
	Utility Area	2	2
	Admin building	3	3
	GEGs 1-4 Buliding	2	2
	GEGs 5-6 Buliding	-	2
4. Dry chemical (Portable fire extinguisher)	Admin building	10	10
	MRS area	8	8
	Chiller plant	4	4
	Steam turbine	3	3
	GEGs 1-4 Buliding	14	14
	GEGs 5-6 Buliding	-	8
5. CO <sub>2</sub> (Portable fire extinguisher)	Admin building	7	7
	MRS area	1	1
	Chiller plant	4	4
	22 KV Substaion room	4	4
	GEGs 1-4 Buliding	4	4
	GEGs 5-6 Buliding	-	2

Table 2.14-1 (continued)

Equipment	Installation location	Quantity (Unit)	
		Existing	After expansion
6. CO <sub>2</sub> Fire Suppression system	Gas turbine 1	15	15
	Gas turbine 2	15	15
7. Gas detector	Gas turbine 1	3	3
	Gas turbine 2	3	3
	GEGs 1-4 Buliding	2	2
	GEGs 5-6 Buliding	-	2
8. Smoke detector	Chiller Area	4	4
	Admin building	29	29
	Cable trench	44	44
	22 KV Substaion room	6	6
9. Heat detector	Cooling tower	24	24
	Gas turbine 1	13	13
	Gas turbine 2	13	13
	Steam turbine	1	1
	GEGs 1-4 Buliding	1	1
	GEGs 5-6 Buliding	-	2
	Admin building	20	20
	Aux Transformer	8	8
	Chiller transformer	8	8
	22 KV Substation room	1	1
9. Fire pump			
	Diesel fire pump (1,000 GPM)	water storage tank	1
	Electrical fire pump (1,000 GPM)	water storage tank	1
	Jocky Pump (100 GPM)	water storage tank	2

Source : Glow SPP 11 Co.,Ltd. ,2013

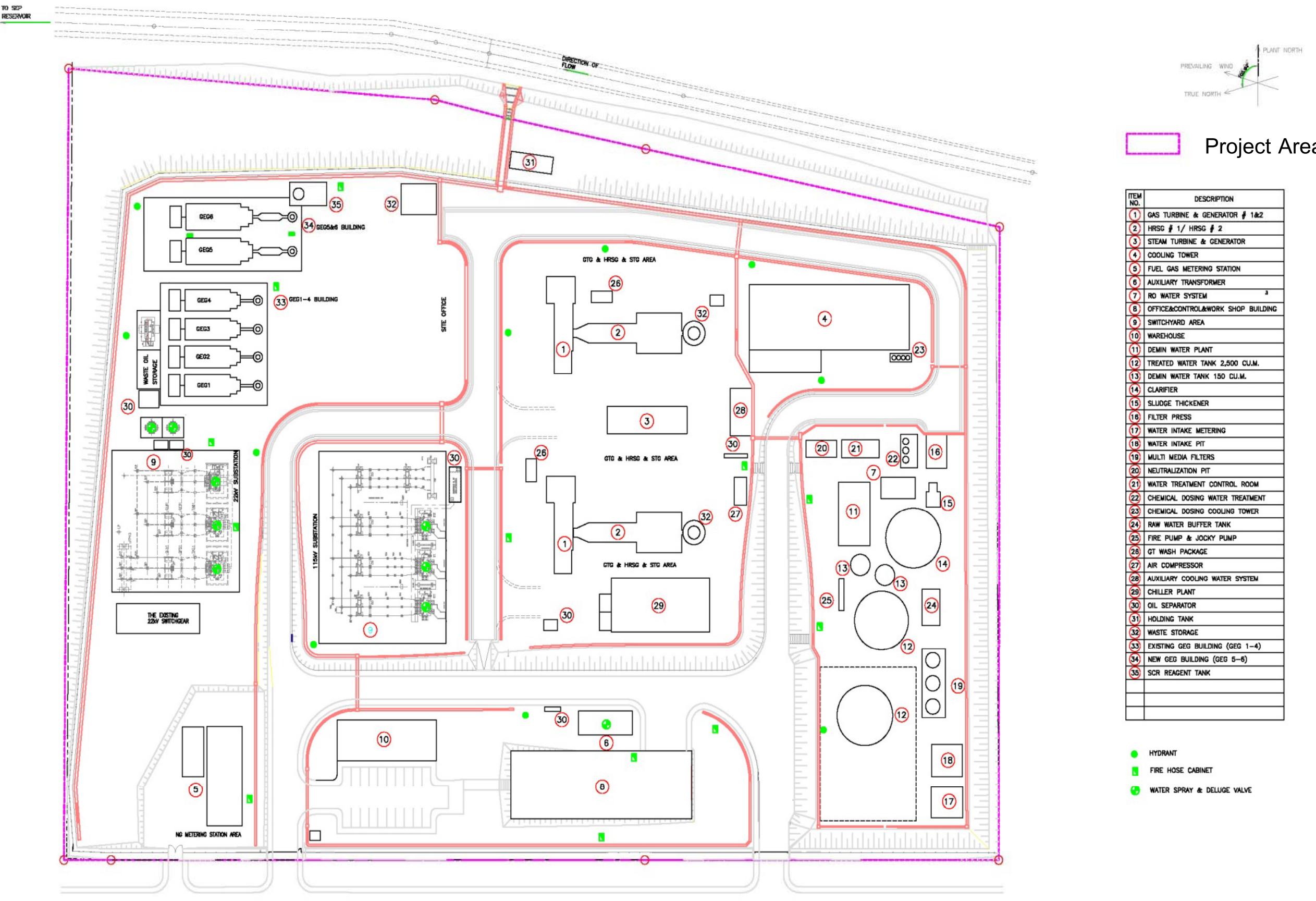


Figure 2.14-1 Fire fighting equipments installation location

- **Emergency Case at Factory/Establishment Level** means any emergency cases which happen in the project area that do not have any external impacts and the cases can be controlled and stopped by the project's emergency response team. When there is the emergency cases occurred at any factories/establishments, these factories/establishments must inform the responsible institutes in the location such as the Local Administration, Local Hospitals/Contracted Private Hospitals (in case that there are injured people), neighbor factories/establishments, industrial estate/industrial zone that the case occurs, district/province office, principal/community, in order to keep them acknowledged and be ready. While the emergency response team must stop the case right away

- **Emergency Severity Level 1** The disaster situation exceeds the capacity of the plant at the site, or operator cannot control the situation. Helping from outside agencies is required, such as the Director of Disaster Prevention and Mitigation, local governments, or factories nearby, to control the situation or stop the emigration also helping those affected (Details of the emergency response plan in the first level). In such case, the project will be coordinated to inform and seeking help from external agencies. The procedure of external coordination in case of emergency shown in Figure 2.14-2.

- **Emergency Severity Level 2** The Director of the Division of Prevention and Mitigation, local governments in disaster areas and districts cannot suppress and control the situation, have to request assistance from the Director of Disaster Prevention and Mitigation of Rayong province and Neighbors. Also the support from others related agencies.

## 2.15 Complaint Plan

The company was aware of the impact on neighboring communities that may result from the implementation of the project. Therefore, the company have provided a procedure for complaints, and environmental issues of the project (Figure 2.15-1) in order to accommodate the complaints of those who have or are suspected of being affected by the implementation of the existing and this expansion projects, which covers employees of the project, surrounding communities or factories nearby. To prepare measures to be taken to determine the cause, correction and prevention promptly. The project has set measures to

- Providing a complaint taken plan on the environmental issues.
- Prepare annual plans of public relations in order to reach the community. And the community can contact the project directly. Including the information and prepare plans to address complaints from community issues and develop a database to support a plan for the next release.
- Set up a committee to monitor the environmental impact, which include representative of the project, government agencies and the community in order to monitor the implementation of the project.

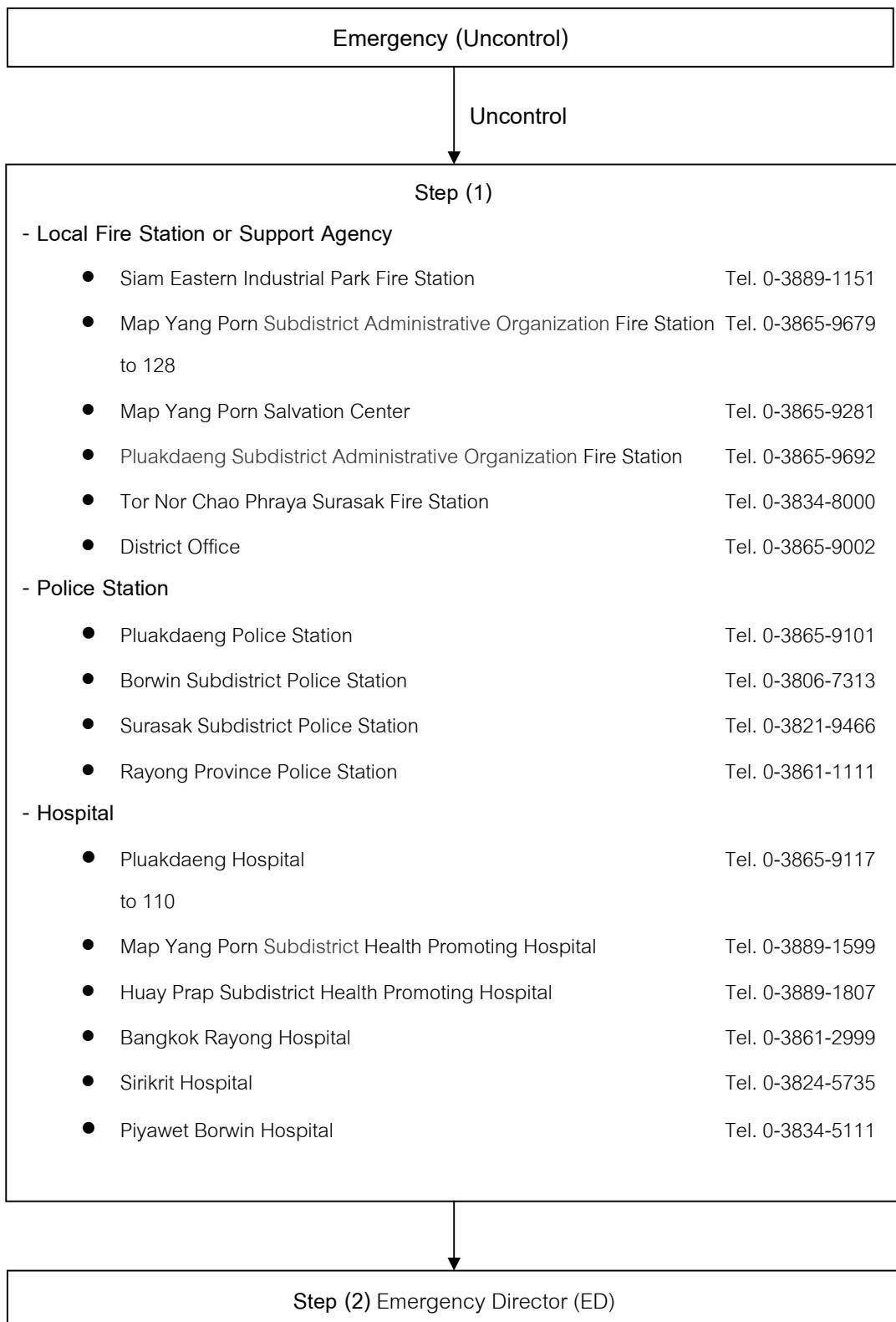
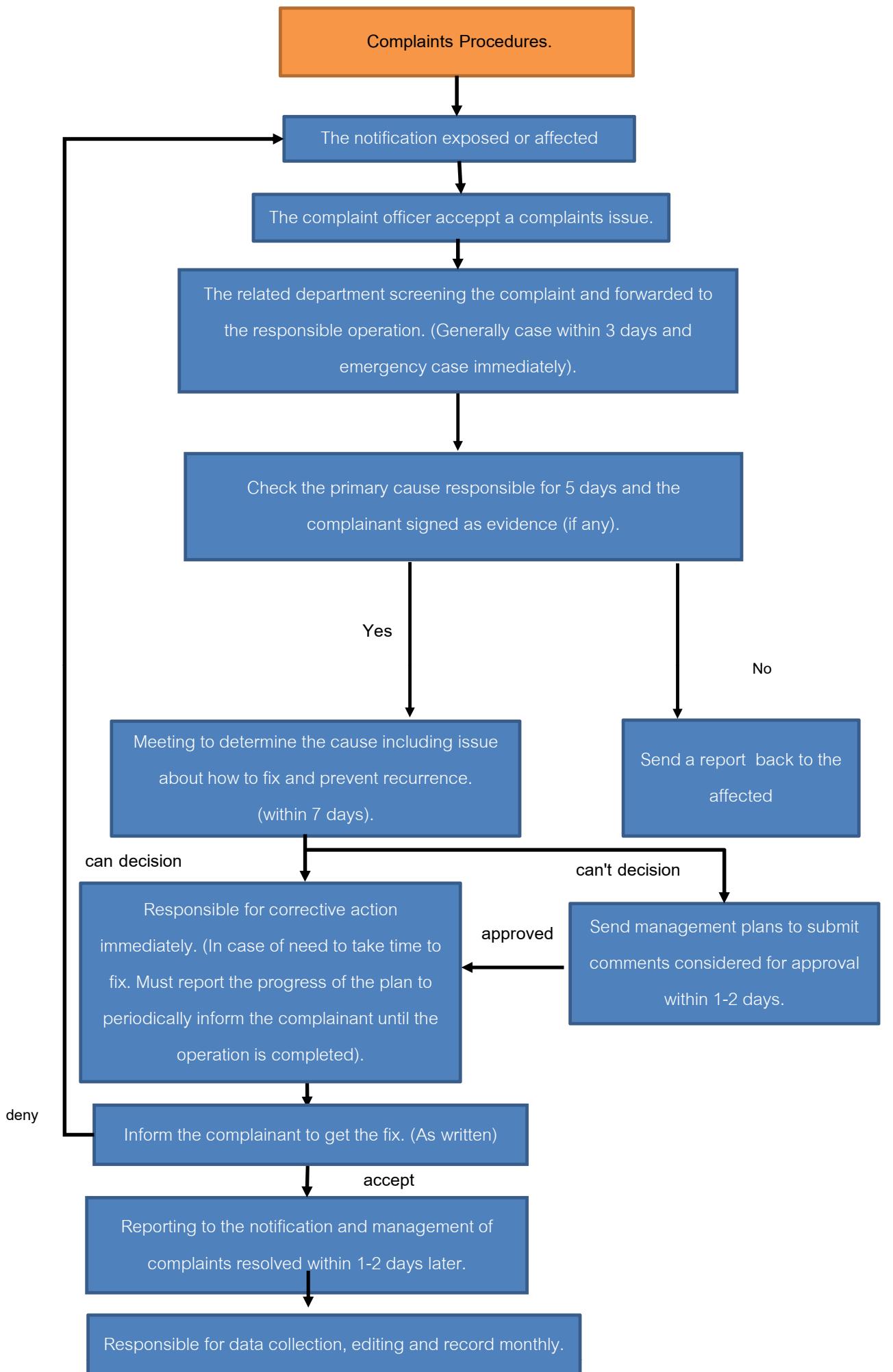


Figure 2.14-2 Procedure the coordination of external agency in case of violence emergency.



**Source:** Glow SPP 11 Co.,Ltd. 2013

**Figure 2.15-1 Complaint chart**

## 2.16 EIA Auditor Committee

Opinion Suggestion and Public participation are also crucial for Glow SPP 11 Co., Ltd. Therefore, We organized EIA Auditor Committee, composed representative of People, representative of government and representative of private sector and detailed as following :

### 1) Objective of establish the EIA Audit Committee

Determine the public and stakeholders to participate in the formulation for the implementation and monitoring the project measurement to prevent environmental impact . Consider the obstacles associated with concerns and complaints in different section.

### 2) The composition of the Committee

The composition of the Committee composed of representatives from various groups including community leaders, government agencies and representatives of Glow SPP 11 co.,ltd. which has a total of 19 persons with the following details.

(1) Representative of People include 10 members representing people from the Tambon Mabyangporn 5 persons and Tambon Pluak Daeng 5 persons, then the representatives of the governments will be selected in the recruitment of the local government.

(2) Representative of Community leader include 1 person that recruited at a meeting of representatives.

(3) Representative of government/Local government include 6 members that consist of the Provincial Public Health 1 person, Environment and Natural Resources Region 1 person, Energy of Province 1 person, Commission for Natural Resources and Environment 1 person, representative of Tambon Mab Yang Porn 1 person and representative of Tanbon Pluak Daeng 1 person.

(4) Representative of Glow SPP 11 Co., Ltd include 2 members that appointed by the Company's management.

When the committee completed, to conduct a meeting appointment and invited the sheriff of tambon Pluak Daeng as the chair the committee. The meeting shall notify the public at least 15 days and have the recording sessions and publishing to communities thoroughly at least of 2 channels.

### 3) Committee qualification

Committee shall have general qualification as follows:

- A) Have attained the age of 25;
- B) Must not be adjudged as bankrupt;
- C) Must not be adjudged incompetent or quasi-incompetent;

D) Must not be a person sentenced to imprisonment by a court judgment and is in custody by a court warrant, except that it is an offense committed through contravention or negligence;

E) For the representatives of civil society, the community leaders and government agencies must be no conflict of interest with Glow SPP 11 Co.,Ltd.. And no relatives working under Glow SPP 11 Co.,Ltd..

#### 4) Terms and Longer of the board

The Committee has the authority to operate a 2 year. Term of the selection committee must take before the establishment of the committee at least 3 months.

The Committee may resign when resignation (in case of people representing) will no longer employees or related entities (the representative of Glow SPP 11 Public Company Limited, Energy of provinces, Provincial Environment and Natural Resources, and representatives of local government agencies) and the incompetence of the committee.

If there is any board longer under the above conditions. The selection committee will be replaced by the conditions set to be completed within 60 days.

#### 5) The board Authority

A detail of committee role are shown as follows.

- Consultation, comments and feedback on the implementation and coordination with community

- Coordination with the project or report problems to fix it.

- Monitoring the implementation of the project.

- Monitoring the complaints from the public by gathering information once a year and submission to the relevant authorities..

- Proposed a environment and community development plan for the benefit of the people of the people.

#### 6) Improving the regulations or conditions

Condition and qualification of committee including method of recruitment may be updated to be appropriate. In accordance with the situation in each period and up to the decision of the committee.

#### 7) Frequency of Meeting

Regular meeting scheduled for at least 6 months / time. If a emergency was occur , a meeting can be arranged according to the situation.

### 3. Environmental Impact Assessment of Expansion Project.

Environmental impact assessment of the issues that may arise from the expansion project are detailed as below.

#### 3.1 Air Quality

**1) Construction Period** The expansion project will have to install 2 sets of Gas Engine Generator (GEG) (GEGset no. 5&6)on the empty space of power plant, which requires the space approximately 0.6 rai. Activities that could cause impacts on air quality during construction period are 1) Preparing construction area may cause the dust and 2) Machinery for construction activities, using oil as fuel could cause nitrogen dioxide, sulfur dioxide, and particulate matter up to 10 micrometers in size. The affected groups are construction workers and communities nearby the project.

Assessment of the air pollution from construction activities using Box model has shown that the air quality of study area still compliance with air quality standards as following details.

- Total Suspended Particulate (TSP) average 24 hours,resulting to the Total Suspended Particulate(TSP)average 24 hours of the study area increased from 260 to 268.09 ug/m<sup>3</sup>,while the standard is 330 ug/m<sup>3</sup>.

- Particulate matter up to 10 micrometers in size (PM-10) average 24 hours, resulting to the Particulate matter up to 10 micrometersin size (PM-10) average 24 hours of the study area increased from 110 to 111.36 ug/m<sup>3</sup>,while the standard is 120 ug/m<sup>3</sup>.

- Nitrogen Dioxide (NO<sub>2</sub>) average 1hour, resulting to the Nitrogen Dioxide (NO<sub>2</sub>) average 1 hour of the study area increased from 220 to 246.73 ug/m<sup>3</sup>,while the standard is 320 ug/m<sup>3</sup>.

- Sulfur Dioxide (SO<sub>2</sub>) average 1 hour, resulting to the SulfurDioxide (SO<sub>2</sub>) average 1 hour of the study area increased from 62 to 64.33 ug/m<sup>3</sup>,while the standard is 780 ug/m<sup>3</sup>.

**2) Operation Period** Existing sources of air pollutionare from 2 parts with 6 stacks in total, which are 1) 2 stacks from HRSG of Gas Turbine Generator (GTG)/Steam Turbine Generator (STG) and 2) 4 stacks of Gas Engine Generator (GEG). For expansion project, 2 sets of Gas Engine Generator (GEG) will be installed, which will generate 2 more stacks, resulting to have 8 stacks in total. The project uses natural gas as a primary fuel, which could generate major air pollutant such as Oxide of Nitrogen (NO<sub>x</sub>). Secondary air pollutants are (SO<sub>2</sub>) and Particulate Matter (PM). The project is using various technology to control air pollution better than the standard. (Details of air emission pollutions are shown in Topic 2.11.1).

Assessment of the air pollution from operation activities using AERMOD model has shown that the air quality of study area (20x20 square kilometers/10 kilometers redius around the plant) still compliance with ambient air quality standards as following details.

- Nitrogen Dioxide (NO<sub>2</sub>) average 1hour, The maximum of Nitrogen Dioxide (NO<sub>2</sub>) average 1 hour that this project could generate is 7 ug/m<sup>3</sup>. Resulting to the Nitrogen Dioxide average 1 hour of the study area increased to the maximum of 269 ug/m<sup>3</sup>, while the standard is 320 ug/m<sup>3</sup>.

- Nitrogen Dioxide (NO<sub>2</sub>) average 1year The maximum of Nitrogen Dioxide (NO<sub>2</sub>) average 1 year that this project could generate is 1 ug/m<sup>3</sup>. After considering with other existing sources of pollution the result shown that Nitrogen Dioxide (NO<sub>2</sub>) average 1 year of the study area increased to the maximum of 17 ug/m<sup>3</sup>, while the standard is 57 ug/m<sup>3</sup>.

- Sulfur Dioxide (SO<sub>2</sub>) average 1 hour The maximum of Sulfur Dioxide (SO<sub>2</sub>) average 1 hour that this project could generate is 1 ug/m<sup>3</sup>. After considering with other existing sources of pollution the result shown that Sulfur Dioxide (SO<sub>2</sub>) average 1 hour of the study area increased to the maximum of 111.8 ug/m<sup>3</sup>, while the standard is 780 ug/m<sup>3</sup>.

- Sulfur Dioxide (SO<sub>2</sub>) average 24 hours The maximum of Sulfur Dioxide (SO<sub>2</sub>) average 24 hours that this project could generate is 0.3 ug/m<sup>3</sup>. After considering with other existing sources of pollution the result shown that Sulfur Dioxide (SO<sub>2</sub>) average 1 hour of the study area increased to the maximum of 26.099 ug/m<sup>3</sup>, while the standard is 300 ug/m<sup>3</sup>.

- Sulfur Dioxide (SO<sub>2</sub>) average 1 year The maximum of Sulfur Dioxide (SO<sub>2</sub>) average 1 year that this project could generate is 0.07 ug/m<sup>3</sup>. After considering with other existing sources of pollution the result shown that Sulfur Dioxide (SO<sub>2</sub>) average 1 year of the study area increased to the maximum of 3.90 ug/m<sup>3</sup>, while the standard is 100 ug/m<sup>3</sup>.

- Total Suspended Particulate (TSP) average 24 hours The maximum of Total Suspended Particulate (TSP) average 24 hours that this project could generate is 0.5 ug/m<sup>3</sup>. After considering with other existing sources of pollution the result shown that Total Suspended Particulate (TSP) average 24 hour of the study area increased to the maximum of 27.8 ug/m<sup>3</sup>, while the standard is 330 ug/m<sup>3</sup>.

- Total Suspended Particulate (TSP) average 1 year The maximum of Total Suspended Particulate (TSP) average 1 year that this project could generate is 0.12 ug/m<sup>3</sup>. After considering with other existing sources of pollution the result shown that Total Suspended Particulate (TSP) average 1 year of the study area increased to the maximum of 7.30 ug/m<sup>3</sup>, while the standard is 100 ug/m<sup>3</sup>.

### 3.2 Noise Level

**1) Construction Period** Sources of noise are uses of machineries/equipment including construction activities such as excavation, foundation, area preparation and decoration. The activities during construction period that may cause the noise have already been mentioned in Topic 2.11.3. The result of noise level assessment during construction period at the nearest communities, which is Ban Map-Yang-Phon (distance of approximately 530 meters.), and found that the construction activities of the project has slightly affect to noise Leq 24 hours (Increased from 51.8 to 51.88 dB). and still within the standard (not exceeding 70 dB). The result of noise level assessment during operation period at the nearest communities as above mentioned has shown the maximum of noise level (during the day) would be 0.2 dB, which is still within the standard (not exceeding 10 dB). There is no activity during the night; therefore, it is not necessary to evaluate the impact during the night.

**2) Operation Period** Noise level during operation period will focus on noise level at the project's fence, which must be controlled in accordance with the notification of Department of Industrial Works regarding the noise level and the noise level caused by the operation of the factory, B.E. 2548, which controls noise level at the fence of the factory not to exceed 70 dB. The result of noise level assessment during operation period at the nearest communities (Ban Map-Yang-Phon) has shown that noise Leq 24 hours at the nearest communities would be the same level as before the project implementation (still at 51.8 dB), which is still within the standard (not exceeding 70 dB). The result of noise level assessment during operation period at the nearest communities as above mentioned has shown the maximum of noise level (during the day) would be 0.1 dB, and 4.4 dB during the night, which are still within the standard (not exceeding 10 dB).

### 3.3 Wastewater and Water Quality

**1) Construction Period** Major source of wastewater during construction process is the wastewater from construction workers, which have maximum volume of  $4.8 \text{ m}^3/\text{day}$ . The project requires the contractor to provide the toilet with a ratio of at least one room for 20 people, also septic tank. The project will be coordinated with the local waste disposal company or the licensed agencies to pump sewage from the septic tank for disposal. About the stormwater that may be contaminated with sand or debris from construction activities will be drained to stabilization pond for settling those contaminants before draining to the SEP's gutter. It can be seen that the volume of wastewater arising from the construction is not much, and the project is preparing for adequate wastewater treatment. During construction period, the project will generate low level of impact on water quality.

**2) Operation Period** The project has prepared an appropriate management of wastewater generated from each source. Also monitoring the effluent prior to discharge to the wastewater treatment system of SEP. Current volume of wastewater of existing plant that drain to wastewater treatment plant is 1,261.8 m<sup>3</sup>/day. This project will decrease the volume of wastewater to 1,220.8 m<sup>3</sup>/day (decrease of 41 m<sup>3</sup>/day) as mentioned in topic 2.11.2. The capacity of SEP's wastewater treatment plant is 9,500 m<sup>3</sup>/day, while the total volume of wastewater drained to SEP's wastewater treatment is 3,228 m<sup>3</sup>/day, or 33.98 percent of total capacity. Therefore, the operation of this project will have positive impact to water quality by decreasing the total volume of wastewater drained to SEP's wastewater treatment plant.

### 3.4 Land use

**1) Pattern of land use** The study of 5 kilometer around the plant has shown that 43.26 percent of study areautilized for industrial area, which including Siam Eastern Industrial Park, Eastern Seaboard Industrial Estate (Rayong), G.K. Land Industrial Zone, Amata City Industrial Estate and factories that located outside the industrial estate, 40.25 percent of study area utilized for agricultural, 7.22 percent of study areautilized for communities and commercials, 3.61 percent of study areautilized for water resources, 3.49 percent of study areautilizedfor empty space, 1.44 percent of study areautilized forroad, 0.42 percent of study areautilized forlivestock and 0.31 percent of study areautilized for the forest nearby the hill. Considering that the project is located in the Siam Eastern Industrial Park, which is an area that has been allocated to support the development of the industry since 1996. Therefore, the project does not affect to a change of the proportion of land use within the study area.

**2) Impact on compliance with the comprehensive plan.** There are seven comprehensive plans thathas been declared effective, including Rayong urban planning, Phe community city plan, industrial and industrial communities urban planning, MuangKlangcity plan,Ta-Phongcity plan, Ban Kai – Map Khacity plan, ThungKwai Kin-Kong Din city plan.But there are three comprehensive plans/city plans remained in force, which arePhe community city plan,Ta-Phong city plan, Ban Kai – Map Kha city plan, ThungKwai Kin-Kong Din city plan (the rest are in the improvement process). However, the project site is not located in those seven comprehensive plans as mentioned above, so the project is not contrary to the related regulations. Moreover, TheDepartment of Public Works and Town & Country Planning is preparing the draft of ministerial regulations to enforce of using Rayong comprehensive plan. The project site is located in purple zone (Designated as industrial and warehouses). As a result, the project complies with the above chart.

### 3.5 Transportation

Transportation during construction period expect to have the number of vehicles 9trips/hour (Compared to the private car), while the operation period of this project is expected to generate 4 trips/hour (Compared to the private car). For evaluating, the impact on traffic due to this expansion project will consider the traffic volume that generated by this expansion project, traffic volume of other sources in the study area and existing traffic volume on highway 331, 3245 and route RY 3031. The indicator used to evaluate the impact on the transportation is V/C ratio, whichcalculated from number of vehicles divided by the capacity of road for each route.

V/C ratio	Traffic Condition
0.88-1.00	very high congestion
0.67-0.88	high congestion
0.52-0.67	moderate congestion
0.36-0.52	low congestion
0.20-0.36	no congestion

Traffic Impact Assessment due to the project implementation has shown that this expansion project does not change the traffic condition of each route significantly. Vehicles increased due to the operation of the project are still in the capacity of the route. Details are as follows.

1) Highway 331. The impact during construction period wouldaffect to the increase of V/C ratio in rush hour from 0.214 to 0.215, which is still in no congestion condition. While the impact during operation period of the project and traffic volume of other sources in the study area does not have an effect to V/C ratio (0.228), which is still in no congestion condition.

2) Highway3245. The impact during construction period would affect to the increase of V/C ratio in rush hour from 0.156 to 0.157, which is still in no congestion condition. While the impact during operation period of the project and traffic volume of other sources in the study area does not have an effect to V/C ratio (0.166), which is still in no congestion condition.

3) Route RY 3013. The impact during construction period would affect to the increase of V/C ratio in rush hour from 0.693 to 0.697, which is still in high congestion condition. While the impact during operation period of the project and traffic volume of other sources in the study area would affect to the increase of V/C ratiofrom 0.737 to 0.739, which is still in high congestion condition.

### 3.6 Water Resources

1) **Construction Period** estimated that water consumption could be up to  $14.8 \text{ m}^3/\text{day}$ . The contractor is responsible for supplying water consumption, and the water used for construction. Moreover, when considering the above description, there is very small volume of water used during the construction. Thus, the impact of this project on water resources in the area is low.

2) **Operation Period** The demand of water for the existing plant is  $5,257.8 \text{ m}^3/\text{day}$ . The generators of this expansion project do not require addition water supply since the air cool system is used (no water-cooling). However, the project plans to produce more clarify water and demineralized water to supply to nearby factories. For that reason, the project needs more water because such activities. Therefore, the demand of water supply will increase from  $5,257.8 \text{ m}^3/\text{day}$  to  $7,201.8 \text{ m}^3/\text{day}$  (additional of  $1,944 \text{ m}^3/\text{day}$ ). Water resource of the project is the raw water, which taken from Eastern Water Resources Development and Management Public Company Limited. in volume of  $7,200 \text{ m}^3/\text{day}$ , and portable water from SEP in the amount of  $1.8 \text{ m}^3/\text{day}$ . When considering water resources mentioned above, found that the water resource is the same as the majority of users in various sectors, which are DokKrai reservoir, NongPla Lai reservoir and KlongYai reservoir. Current water users are using 351.74 million cubic meters/year, the project implementation will increase amount of water usage in addition volume of 0.7 million cubic meters/year or  $1,944 \text{ m}^3/\text{day}$ , resulting in total demand of raw water at 352.44 million cubic meters/year. The information from Royal Irrigation Department show that the volume of raw water in the reservoirs with water from several projects set up to improve water resources would be in the potential volume of water available to water users in total 481 million cubic meters / year. In conclusion, the amount of water use after project implementation remains in the potential of water resources in the area. Therefore, this expansion project has an acceptable level impact on water resources.

### 3.7 Solid Waste Management

The management of general solid waste of an existing plant is providing sufficient amount of garbage bins for solid waste generated by the project before transferring to SEP for disposal in the method that according to the prevention and mitigation measures of SEP. SEP is hiring Siam Environmental Technologies Co., Ltd. to collect solid waste from all factories located in SEP. Then transfer general solid waste to Krai Thong Group Ltd. to disposal at sanitary landfill. Maximum capacity of solid waste that Krai Thong Group Ltd. is able to collect is 13.6 tons/day, while current amount of solid waste from all factories to collect is 7.9 tons/day. There would be 0.564 tons/day of solid waste generated during construction period of this project; and the agency responsible for solid waste has sufficient capacity to accommodate solid waste from construction activities.

The management of solid waste from production process of an existing plant is providing sufficient amount of waste bins for each type of waste. Then stored in waste storage area, where covered entirely with the wall to divide the area into sections for separate each type of waste, before contacting licensed agencies for disposal, such as Waste Management Siam Co., Ltd, PluakDeang Waste Energy Co, Ltd. and Better World Green Public Co., Ltd. The operation period of the project would increase solid waste from 131.6 tons/year to 142.1 tons/year (additional of 10.5 tons/years). Mentioned agencies has informed that amount of solid waste due to project implementation is still within the capacity.

### 3.8 Agricultural

Considering the project's activities on important factors which could cause impacts on agricultural in the study area is air pollution caused by fuel combustion in electricity generation process, including Nitrogen Dioxide, and Sulfur Dioxide.

**1) Impact caused by nitrogen dioxide** United States of America has set secondary standards of air quality; Nitrogen Dioxide average 1 year at 100 ug/m<sup>3</sup> intended to protect visibility, prevent damage to animals, crops, vegetation and buildings. Considering the effects of this expansion project with the existing sources of pollution of the study area, found Nitrogen Dioxide average 1 year in ambient air at the maximum of 17 ug/m<sup>3</sup>, which is six times better than the standard. Refer to the document of Department of Industrial Work indicated concentrations of Nitrogen Dioxide that damage the crop equal to 2.5 ppm or 4,700 ug/m<sup>3</sup> for a period of 4 consecutive hours. The study shows that air pollution of this expansion project combined to existing sources would generate Nitrogen Dioxide average 1 hour in ambient air at the maximum of 269 ug/m<sup>3</sup>, which is seventeen times better than the standard. Therefore, the project does not effect to nitrogen dioxide levels in ambient air even affect agricultural area.

**2) Impact caused by sulfur dioxide** United States of America has set secondary standards of air quality; Sulfur Dioxide average 3 hours at 1,308 ug/m<sup>3</sup> intended to protect visibility, prevent damage to animals, crops, vegetation and buildings. Considering the effects of this expansion project with the existing sources of pollution of the study area, found Sulfur Dioxide average 3 hours in ambient air at the maximum of 57 ug/m<sup>3</sup>, which is twenty-three times better than the standard. Refer to the document of Department of Industrial Work indicated concentrations of Sulfur Dioxide that damage the crop equal to 0.3 ppm or 785 ug/m<sup>3</sup> for a period of 8 consecutive hours. The study shows that air pollution of this expansion project combined to existing sources would generate Sulfur Dioxide average 1 hour in ambient air at the maximum of 111.82 ug/m<sup>3</sup>, which is seven times better than the standard. Therefore, the project does not effect to Sulfur Dioxide levels in ambient air even affect agricultural area.

### 3.9 Health

Major pollutant that effected to the health of the communities are Nitrogen Dioxide, Sulfur Dioxide, and Total Suspended Particulate. Quantitative Health Risk Assessment, which is the calculation of the risk of exposure to air pollution in term of Hazard Quotient (inhalation) or HQ (Inh) considering Reference Concentration (RfC) according to US EPA Region 6 (2005), has been used for air quality impact assessment. If the Hazard Quotient is calculated to be less than 1, then no adverse health effects are expected as a result of exposure. If the Hazard Quotient is greater than 1, then adverse health effects are possible, and prevention and mitigation measures are required.

**1) Risk assessment of Nitrogen Dioxide ( $\text{NO}_2$ ) exposure** The study shows that Hazard Quotient at the communities nearby the project equal to 0.000011-0.005089, After combining with existing sources, Hazard Quotient would be equal to 0.009934-0.138906, which is less than 1, then no adverse health effects are expected as a result of exposure.

**2) Risk assessment of Sulfur Dioxide ( $\text{SO}_2$ ) exposure** The study shows that Hazard Quotient at the communities nearby the project equal to 0.000001-0.000394, After combining with existing sources, Hazard Quotient would be equal to 0.001007-0.023590, which is less than 1, then no adverse health effects are expected as a result of exposure.

**3) Risk assessment of Total Suspended Particulate (TSP) exposure** The study shows that Hazard Quotient at the communities nearby the project equal to 0.000004-0.001420, After combining with existing sources, Hazard Quotient would be equal to 0.004641-0.081726, which is less than 1, then no adverse health effects are expected as a result of exposure.

**4) The sum of hazard quotients/Hazard Index (HI)** The sum of more than one hazard quotient for multiple substances and/or multiple exposure pathwayss shows that Hazard Index at the communities nearby the project equal to 0.000016-0.006903. After combining with existing sources, Hazard Index would be equal to 0.018051-0.184705, which is less than 1, then no adverse health effects are expected as a result of exposure.

### 3.10 Major Hazard

Major Hazard Assessment is the study of the area where may be affected for life and property. The assumptions include the case and the protection of various disorders, and then cause natural gas leaking from the pipe system. Details are as follows.

**1) Natural gas pipe (main & minor pipes) of Gas Turbine Generator (GTG)/Steam Turbine Generator** The dimension of pipe is 8 inches (250 meters in length) and pressure at 24 bar (g) found that the level of damage that has occurred the most is the leak size of 0.25 and 1 inch ( $2.475 \times 10^{-4}$  times/year), while the opportunity of pipe being broken is equal to  $1.65 \times 10^{-5}$  times/year. Impact assessment in case the worst happens on pipe using BREEZE HAZ shows that the natural gas leaking from the system 95.33 km/s. In case of fire would make the territory affected by the heat radiation of  $12.5 \text{ kW/m}^2$  (Causing fire on the wood, plastic melting. The

exposure more than 1 minute, there is 1% chance causing death, while exposure more than 10 minute can cause burns in the first level.) at the distance 58.33 meters from the leaking spot, which is still within project area and road of SEP.

**2) Natural gas pipe (main pipe) of Gas Engine Generator (GEG) set no. 1-4 of an existing plant.** The dimension of pipe is 8 inches(130 meters in length) and pressure at 9 bar (g) found that the level of damage that has occurred the most is the leak size of 0.25 and 1 inch ( $1.287 \times 10^{-4}$  times/year), while the opportunity of pipe being broken is equal to  $1.858 \times 10^{-6}$  times/year. Impact assessment in case the worst happens on pipe using BREEZE HAZ shows that the natural gas leaking from the system 35.75 km/s. In case of fire would make the territory affected by the heat radiation of  $\text{kW/m}^2$ , at the distance of 42.2 meters from the leaking spot, which is still within project area.

**3) Natural gas pipe (minor pipe) of Gas Engine Generator (GEG) set no. 1-4 of an existing plant.** The dimension of pipe is 3 inches (90 meters in length) and pressure at 9 bar (g) found that the level of damage that has occurred the most is the leak size of 1 inch ( $8.91 \times 10^{-5}$  times/year), while the opportunity of pipe being broken is equal to  $1.782 \times 10^{-4}$  times/year. Impact assessment in case the worst happens on pipe using BREEZE HAZ shows that the natural gas leaking from the system 5.03 km/s. In case of fire would make the territory affected by the heat radiation of  $12.5 \text{ kW/m}^2$ , at the distance of 19.67 meters from the leaking spot, which is still within project area.

**4) Natural gas pipe (main pipe) of Gas Engine Generator (GEG) set no. 5-6 of this expansion project.** The dimension of pipe is 6 inches (45 meters in length) and pressure at 9 bar (g) found that the level of damage that has occurred the most is the leak size of 0.25 and 1 inch ( $5.94 \times 10^{-5}$  times/year), while the opportunity of pipe being broken is equal to  $1.188 \times 10^{-5}$  times/year. Impact assessment in case the worst happens on pipe using BREEZE HAZ shows that the natural gas leaking from the system 20.11 km/s. In case of fire would make the territory affected by the heat radiation of  $12.5 \text{ kW/m}^2$ , at the distance of 33.61 meters from the leaking spot, which is still within project area.

**5) Natural gas pipe (minor pipe) of Gas Engine Generator (GEG) set no. 5-6 of this expansion project** The dimension of pipe is 4 inches (40 meters in length) and pressure at 9 bar (g) found that the level of damage that has occurred the most is the leak size of 1 inch ( $1.188 \times 10^{-4}$  times/year), while the opportunity of pipe being broken is equal to  $9.24 \times 10^{-6}$  times/year. Impact assessment in case the worst happens on pipe using BREEZE HAZ shows that the natural gas leaking from the system 8.94 km/s. In case of fire would make the territory affected by the heat radiation of  $12.5 \text{ kW/m}^2$ , at the distance of 24.57 meters from the leaking spot, which is still within project area.

#### 4. Environmental Impact Prevention and Mitigation Measures and Environmental Impact Monitoring Measures.

The consultant has revised the latest version of the environmental impact prevention and mitigation measures and the environmental impact monitoring measures for both construction and operation periods, that are approved by ONEP, together with the revision of impact assessment on each aspect to ensure compliance with the regulations issued by Ministry of Natural Resources and Environment and covering of health impact assessment. Suggestions from public and stakeholders received during public scoping, study of impact assessment, and public review are taken into consideration.

The consultant has revised the prevention and mitigation measures for impacts potentially posing on environmental quality, natural resources, and health by considering both construction and implementation periods, as presented in Table 4-1 and Table 4-2, respectively.

The consultant has revised the environmental impact monitoring measures to be used as a guideline for monitoring of change potentially occurring on environment, natural resources, and health in various aspects. The revision also helps in inspecting the efficiency and appropriateness of the environmental and health impact monitoring measures being carried out by the project. Details of the environmental impact monitoring measures are shown in Table 4-3 and Table 4-4.

Table 4-1

Environmental impact prevention and mitigation measures (during construction period)

## Gas-Fired Combined Cycle Power Plant (Expansion) Project of Glow SPP 11 Co., Ltd.

ENVIRONMENTAL IMPACTS	MITIGATION MEASURES	OPERATION LOCATION	OPERATION PERIOD	RESPONSIBLE PARTY
1. Air quality	<ul style="list-style-type: none"> <li>- Spray water over the construction area to prevent dust dispersion from construction activities at least 2 times per day (except in raining period).</li> <li>- Remove dirt and soil that might be stuck on the truck's wheels before leaving the construction area.</li> <li>- 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.</li> <li>- Prohibit to burn materials or garbage in construction area.</li> <li>- Limit the speed of the construction material truck in the construction area of not exceeding 20 km/hr to reduce particulate matter and accident.</li> <li>- The trucks must be properly covered in order to prevent spilling of the loading materials and dust dispersion.</li> </ul>	<ul style="list-style-type: none"> <li>- within the construction area</li> <li>- within the construction area</li> <li>- machines and engines used for construction</li> <li>- within the construction area</li> <li>- within the construction area</li> <li>- transport routes</li> </ul>	<ul style="list-style-type: none"> <li>- throughout the construction period</li> </ul>	<ul style="list-style-type: none"> <li>- Glow SPP 11 Co., Ltd.</li> </ul>

Table 4-1 (continued)

ENVIRONMENTAL IMPACTS	MITIGATION MEASURES	OPERATION LOCATION	OPERATION PERIOD	RESPONSIBLE PARTY
- Provide sufficient dust protection for workers in the construction area.	- within the construction area	- throughout the construction period	- Glow SPP 11 Co., Ltd.	
- Clean up and redevelopment of the area after completion of construction.	- within the construction area	- throughout the construction period	- Glow SPP 11 Co., Ltd.	
2. Noise Level	<ul style="list-style-type: none"> <li>- Avoid transportation during rush hours (07.00-08.00 and 17.00-18.00 hrs.).</li> <li>- Providing noise protection equipment such as ear plugs, ear muffs adequately for construction workers operating in the area where noise level more than 85 decibels (A).</li> <li>- 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.</li> <li>- Provide clearly construction plans to avoid using the noisy machines working simultaneously.</li> <li>- Conduct public relations to the communities closed to the project on the project construction plan prior to beginning the construction work.</li> </ul>	<ul style="list-style-type: none"> <li>- within the construction area</li> <li>- within the construction area</li> <li>- within the construction area</li> <li>- throughout the construction period</li> <li>- throughout the construction period</li> <li>- throughout the construction period</li> </ul>	<ul style="list-style-type: none"> <li>- Glow SPP 11 Co., Ltd.</li> </ul>	

Table 4-1 (continued)

ENVIRONMENTAL IMPACTS	MITIGATION MEASURES	OPERATION LOCATION	OPERATION PERIOD	RESPONSIBLE PARTY
3. Water quality	<ul style="list-style-type: none"> <li>- Provide sufficient toilets for the workers in accordance with the public health standard before contacting licensed company to take waste disposal.</li> <li>- Setting up water drainage and bar screen for garbage in the project area to prevent direct discharge of solid wastes into gutter of industrial land.</li> <li>- Provide a settling basin for sediment and waste material in the effluent before discharge into gutter of industrial land.</li> <li>- Prohibit contractors dumped waste and scrap materials into water.</li> <li>- Occasionally remove dirt and construction materials from the sewer to prevent blocking.</li> </ul>	<ul style="list-style-type: none"> <li>- within the construction area</li> </ul>	<ul style="list-style-type: none"> <li>- throughout the construction period</li> </ul>	<ul style="list-style-type: none"> <li>- Glow SPP 11 Co., Ltd.</li> </ul>
4. Water resources	<ul style="list-style-type: none"> <li>- The contractor to provide adequate water for construction activities.</li> <li>- The contractor to provide clean drinking water and adequate sanitation for construction workers.</li> </ul>	<ul style="list-style-type: none"> <li>- within the construction area</li> <li>- within the construction area</li> </ul>	<ul style="list-style-type: none"> <li>- throughout the construction period</li> <li>- throughout the construction period</li> </ul>	<ul style="list-style-type: none"> <li>- Glow SPP 11 Co., Ltd.</li> <li>- Glow SPP 11 Co., Ltd.</li> </ul>

Table 4-1 (continued)

ENVIRONMENTAL IMPACTS	MITIGATION MEASURES	OPERATION LOCATION	OPERATION PERIOD	RESPONSIBLE PARTY
5. Transportation	<ul style="list-style-type: none"> <li>- Provide training to the truck/bus drivers to strictly pursue the traffic rules and regulations.</li> <li>- Limit the vehicle speed in the construction area to not exceeding 20 km/hour.</li> <li>- 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.</li> <li>- Manage the road traffic within the construction site by assigning responsible persons to facilitate the incoming and outgoing of vehicles.</li> <li>- Avoid transportation during rush hours (07.00-08.00 and 17.00-18.00 hrs.).</li> <li>- Limit the vehicle weight to be under the related standard and law in order to avoid the damage of the road surface.</li> <li>- Define the transport routes by avoiding communities as much as possible.</li> </ul>	<ul style="list-style-type: none"> <li>- transport routes</li> <li>- within the construction area</li> <li>- construction equipment / workers vehicles</li> <li>- within the construction area</li> <li>- transport routes</li> <li>- transport routes</li> <li>- within the construction area</li> </ul>	<ul style="list-style-type: none"> <li>- throughout the construction period</li> </ul>	<ul style="list-style-type: none"> <li>- Glow SPP 11 Co., Ltd.</li> </ul>

Table 4-1 (continued)

ENVIRONMENTAL IMPACTS	MITIGATION MEASURES	OPERATION LOCATION	OPERATION PERIOD	RESPONSIBLE PARTY
6. Drainage and flood protection.	<ul style="list-style-type: none"> <li>- Provide temporary drainage system to be constructed in line with permanent gutters to collect stormwater in the project area before draining into the gutters of industrial land.</li> <li>- Setting up water drainage and bar screen for garbage in the project area to prevent direct discharge of solid wastes into gutter.</li> <li>- Remove dirt and soil that might be stuck on the truck's wheels before leaving the construction area.</li> </ul>	<ul style="list-style-type: none"> <li>- within the construction area</li> <li>- within the construction area</li> <li>- within the construction area</li> </ul>	<ul style="list-style-type: none"> <li>- throughout the construction period</li> <li>- throughout the construction period</li> <li>- throughout the construction period</li> </ul>	<ul style="list-style-type: none"> <li>- Glow SPP 11 Co., Ltd.</li> <li>- Glow SPP 11 Co., Ltd.</li> <li>- Glow SPP 11 Co., Ltd.</li> </ul>
7. Solid Waste Management	<ul style="list-style-type: none"> <li>- Provide sufficient numbers of garbage bags and bins to store waste from the worker.</li> <li>- Provide sufficient numbers of closed containers to store hazardous waste.</li> <li>- Prohibit littering of waste into the sewers.</li> <li>- Appoint responsible persons for waste management during construction period stored in a closed container, also sort out recyclable waste for further selling to recycling companies before contact the licensed agencies to transport the waste out of the project for disposal.</li> </ul>	<ul style="list-style-type: none"> <li>- within the construction area</li> </ul>	<ul style="list-style-type: none"> <li>- throughout the construction period</li> </ul>	<ul style="list-style-type: none"> <li>- Glow SPP 11 Co., Ltd.</li> </ul>

Table 4-1 (continued)

ENVIRONMENTAL IMPACTS	MITIGATION MEASURES	OPERATION LOCATION	OPERATION PERIOD	RESPONSIBLE PARTY
	<ul style="list-style-type: none"> <li>- Prohibit dispose of waste by burning waste in the open.</li> <li>- Contact the government licensed agencies to transport the waste out of the project for disposal.</li> </ul>	<ul style="list-style-type: none"> <li>- within the construction area</li> <li>- within the construction area</li> </ul>	<ul style="list-style-type: none"> <li>- throughout the construction period</li> <li>- throughout the construction period</li> </ul>	<ul style="list-style-type: none"> <li>- Glow SPP 11 Co., Ltd.</li> <li>- Glow SPP 11 Co., Ltd.</li> </ul>
8. Socio – Economic	<ul style="list-style-type: none"> <li>- Strictly comply with the project environmental policy in order to preserve the surrounding community interests.</li> <li>- The project and communities cooperate in inspecting and guarding the community for illegal conduct of construction workers living in community or housing camp such as burglary, drugs, gambling, etc by prescribing rules and penalty.</li> <li>- Promote the construction details of each step and detailed measures to prevent impacts on the community's continuously.</li> <li>- Provide the action plan for community petition on environmental impact.</li> <li>- Considering employment of local workers.</li> </ul>	<ul style="list-style-type: none"> <li>- within the construction area and surrounding communities</li> <li>- within the construction area</li> <li>- surrounding communities</li> <li>- surrounding communities</li> <li>- within the construction area</li> </ul>	<ul style="list-style-type: none"> <li>- throughout the construction period</li> </ul>	<ul style="list-style-type: none"> <li>- Glow SPP 11 Co., Ltd.</li> </ul>

Table 4-1 (continued)

ENVIRONMENTAL IMPACTS	MITIGATION MEASURES	OPERATION LOCATION	OPERATION PERIOD	RESPONSIBLE PARTY
- Do not support employment of illegal immigrant labor, also establish personnel records of construction workers	- Within the construction area	- throughout the construction period	- Glow SPP 11 Co., Ltd.	
- Establish channel to receive complaint on nuisance caused by construction workers, concluded and provide correction plan for every each complaint.	- within the construction area and surrounding communities	- throughout the construction period	- Glow SPP 11 Co., Ltd.	
9. Public Health	<ul style="list-style-type: none"> <li>- Follow the following measures to prevent the spread of diseases:           <ul style="list-style-type: none"> <li>* Provide clean drinking water for the construction workers.</li> <li>* Manage the waste in accordance with the sanitary principals.</li> <li>* Personal protective equipment to workers adequately.</li> <li>* Provide enough first-aid kits and pharmacies, along with the arrangement of ambulance stand-by in case of emergency.</li> <li>- Follow the measures strictly.</li> </ul> </li> <li>- Set up a record of health examination information of construction workers prior to start working.</li> <li>- Setting up an inspection routine for worker housing camp to ensure sanitation.</li> </ul>	<ul style="list-style-type: none"> <li>- within the construction area</li> <li>- within the construction area</li> <li>- within the worker's camp</li> </ul>	<ul style="list-style-type: none"> <li>- throughout the construction period</li> <li>- throughout the construction period</li> <li>- throughout the construction period</li> </ul>	<ul style="list-style-type: none"> <li>- Glow SPP 11 Co., Ltd.</li> <li>- Glow SPP 11 Co., Ltd.</li> <li>- Glow SPP 11 Co., Ltd.</li> </ul>

Table 4-1 (continued)

ENVIRONMENTAL IMPACTS	MITIGATION MEASURES	OPERATION LOCATION	OPERATION PERIOD	RESPONSIBLE PARTY
10. Occupational Health and Safety	<ul style="list-style-type: none"> <li>- Ensure that there is occupational health and safety management indicated in contract which covers the occupational health and safety for the employees.</li> <li>- Comply with occupational health and safety regulations, such as Health and Environment B.E. 2554, and the regulations regarding labor standards for the administration and management of occupational health and safety in the working environment on construction B.E. 2551. etc.</li> <li>- The area with machine installation must be isolated, and the equipment and machinery must be placed tidily.</li> <li>- Provide sufficient toilets for the workers.</li> <li>- Constructing temporary fence and lighting around the projects construction area.</li> <li>- Check the condition of the equipment is in good condition before each use.</li> <li>- Provide personal protective equipment for the construction workers and enforce the usage of such equipment.</li> </ul>	<ul style="list-style-type: none"> <li>- Within the construction area</li> </ul>	<ul style="list-style-type: none"> <li>- throughout the construction period</li> </ul>	<ul style="list-style-type: none"> <li>- Glow SPP 11 Co., Ltd.</li> </ul>

Table 4-1 (continued)

ENVIRONMENTAL IMPACTS	MITIGATION MEASURES	OPERATION LOCATION	OPERATION PERIOD	RESPONSIBLE PARTY
	<ul style="list-style-type: none"> <li>- 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.</li> <li>- Assign security officers to facilitate the traffic and generally inspect within the construction areas throughout 24 hours every day.</li> <li>- Arrange orientation and training for the construction workers concerning safety rules and equipment usage.</li> <li>- Provide enough first-aid kits and pharmacies, along with the arrangement of ambulance stand-by in case of emergency.</li> <li>- Designate the supervisor to inspect and ensure the compliance with the safety regulations.</li> <li>- Provide fire extinguishers located in areas at risk of fire adequately.</li> <li>- <u>The welding workers must be trained and tested by the agency that has been established to achieve proficiency before operation. Including the need to provide staff with the expertise to work closely throughout the duration of the operation.</u></li> </ul>	<ul style="list-style-type: none"> <li>- within the construction area</li> </ul>	<ul style="list-style-type: none"> <li>- throughout the construction period</li> </ul>	<ul style="list-style-type: none"> <li>- Glow SPP 11 Co., Ltd.</li> </ul>

Table 4-1 (continued)

ENVIRONMENTAL IMPACTS	MITIGATION MEASURES	OPERATION LOCATION	OPERATION PERIOD	RESPONSIBLE PARTY
<ul style="list-style-type: none"> <li>- Allows the use of machinery, materials, methods of construction, including natural gas pipeline system to meet international standards.</li> <li>- Provide engineering staff with expertise in the design and construction of natural gas pipeline systems.</li> <li>- Requires a pipe weld inspection and test their ability to handle the pressure of the pipe according to international standards.</li> </ul>	<ul style="list-style-type: none"> <li>- within the construction area</li> <li>- within the construction area</li> <li>- within the construction area</li> </ul>	<ul style="list-style-type: none"> <li>- throughout the construction period</li> <li>- throughout the construction period</li> <li>- throughout the construction period</li> </ul>	<ul style="list-style-type: none"> <li>- Glow SPP 11 Co., Ltd.</li> <li>- Glow SPP 11 Co., Ltd.</li> <li>- Glow SPP 11 Co., Ltd.</li> </ul>	

**Remark :** Glow SPP 11 Co., Ltd. is responsible for oversight of the contractor's operations.

TABLE 4-2

Environmental impact prevention and mitigation measures (during operation period)

Gas-Fired Combined Cycle Power Plant (Expansion) Project of Glow SPP 11 Co., Ltd.

ENVIRONMENTAL IMPACTS	MITIGATION MEASURES	OPERATION LOCATION	OPERATION PERIOD	RESPONSIBLE PARTY
1. General Measures	<ul style="list-style-type: none"> <li>- Strictly follow prevention-mitigation and monitoring measures presented in the environmental impact assessment report of Gas-Fired Combined Cycle Power Plant Project of Glow SPP11 Co., Ltd. And used as guidelines for regulatory monitoring of public agencies and organizations involved.</li> <li>- The detailed action plans and measures to determine the environmental conditions of the contract and the contractor shall comply strictly to achieve practical results.</li> <li>- Glow SPP11 Co., Ltd. is required to submit the monitoring report to Office of Natural Resources and Environmental Policy and Planning (ONEP), Office of Natural Resources and Environment, Rayong (ONE, Rayong), Department of Industrial Works (DIW), Rayong Provincial Industrial Office, Siam Eastern Industrial Park Industrial Estate and the local government concerned , every six months.</li> <li>- Maintenance of the cooling system, to be in good usable condition and safe for workers and residents nearby, regularly.</li> </ul>	<ul style="list-style-type: none"> <li>- within project area and study area</li> <li>- throughout the operation period</li> <li>- within project area and study area</li> <li>- throughout the operation period</li> <li>- within project area</li> <li>- throughout the operation period</li> </ul>	<ul style="list-style-type: none"> <li>- throughout the operation period</li> </ul>	<ul style="list-style-type: none"> <li>- Glow SPP11 Co., Ltd.</li> </ul>

TABLE 4-2 (continued)

ENVIRONMENTAL IMPACTS	MITIGATION MEASURES	OPERATION LOCATION	OPERATION PERIOD	RESPONSIBLE PARTY
	<ul style="list-style-type: none"> <li>- If the monitoring results from project operation expose a sign of environmental problem, Glow SPP 11, Co., Ltd. shall solve and improve the cause of problem immediately. If there is any incident that may affect the environmental quality, the company shall inform to Office of Natural Resources and Environment, Rayong, Offices, Rayong, Rayong Provincial Industrial Office, Siam Eastern Industrial Park Industrial Estate, The Siam Eastern Industrial Gases Industrial Park, Office of Natural Resources and Environmental Policy and Planning (ONEP) and related agencies suddenly in order to solve such problems.</li> <li>- In case of Glow SPP 11 Co., Ltd. needs to modify its project description or its environmental impact prevention and mitigation measures and environmental monitoring measures that were proposed in the approve EIA report, the company must notify approval/permit-issuing agencies as described below <ul style="list-style-type: none"> <li>1) 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, 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.</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>- within project area</li> <li>- throughout the operation period</li> </ul>	<ul style="list-style-type: none"> <li>- Throughout the operation period</li> <li>- When there is a desire to change the project description.</li> <li>- throughout the operation period</li> </ul>	<ul style="list-style-type: none"> <li>- Glow SPP11 Co.,Ltd.</li> <li>- Glow SPP11 Co.,Ltd.</li> <li>- Glow SPP11 Co.,Ltd.</li> </ul>

TABLE 4-2 (continued)

ENVIRONMENTAL IMPACTS	MITIGATION MEASURES	OPERATION LOCATION	OPERATION PERIOD	RESPONSIBLE PARTY
2) 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 expert committee for consideration of approval. After the approval of such modification, the agency must notify the result of such modification to ONEP.	<ul style="list-style-type: none"> <li>- within project area</li> </ul>	<ul style="list-style-type: none"> <li>- throughout the operation period</li> </ul>	<ul style="list-style-type: none"> <li>- throughout the operation period</li> </ul>	- Glow SPP11 Co.,Ltd.
2. Air quality	<ul style="list-style-type: none"> <li>- Hiring a third party to monitor the implementation of environmental impact prevention and mitigation measures and environmental monitoring measures of project.</li> <li>- If the results of ambient air quality monitoring at project area and the surrounding area have approached the ambient air quality standard. Company needs to cooperate with relevant departments to resolve air quality impacts.</li> <li>- Control Air pollution emissions of air pollutants from stacks of GTG &amp; HRSGs and GEG, each not to exceed the standards set by the relevant law or regulation.</li> </ul>	<ul style="list-style-type: none"> <li>- within project area</li> </ul>	<ul style="list-style-type: none"> <li>- throughout the operation period</li> </ul>	- Glow SPP11 Co.,Ltd.

- \* NO<sub>x</sub> not to exceed 108 ppm or not to exceed 12.86 g/s
- \* SO<sub>2</sub> not to exceed 5 ppm or not to exceed 0.83 g/s
- \* TSP not to exceed 7 mg/m<sup>3</sup> or not to exceed 0.44 g/s

TABLE 4-2 (continued)

ENVIRONMENTAL IMPACTS	MITIGATION MEASURES	OPERATION LOCATION	OPERATION PERIOD	RESPONSIBLE PARTY
HRSGs Stacks	<ul style="list-style-type: none"> <li>* NO<sub>x</sub> not to exceed 108 ppm or not to exceed 12.86 g/s</li> <li>* SO<sub>2</sub> not to exceed 5 ppm or not to exceed 0.83 g/s</li> <li>* TSP not to exceed 7 mg/m<sup>3</sup> or not to exceed 0.44 g/s</li> </ul> <p>GEG Stacks</p> <p>GEG set no. 1-4</p> <ul style="list-style-type: none"> <li>* NO<sub>x</sub> not to exceed 105 ppm or not to exceed 1.19 g/s</li> <li>* SO<sub>2</sub> not to exceed 5 ppm or not to exceed 0.08 g/s</li> <li>* TSP not to exceed 15 mg/m<sup>3</sup> or not to exceed 0.09 g/s</li> </ul> <p>GEG set no. 5-6</p> <ul style="list-style-type: none"> <li>* NOx not to exceed 35 ppm or not to exceed 0.50 g/s</li> <li>* SO2 not to exceed 5 ppm or not to exceed 0.1 g/s</li> <li>* TSP not to exceed 24 mg/m<sup>3</sup> or not to exceed 0.18 g/s</li> </ul> <ul style="list-style-type: none"> <li>- Provide technology to control temperature in the combustion chamber by using steam injection system to reduce the amount of NOx from the combustion chamber of the GTGs.</li> <li>- Provide 2 set of SCR type for NOx emission control to reduce the amount of NOx from combustion of 2 set of GEG, which will be installed.</li> <li>- In the case of using of diesel as fuel or ignition, Project will only use the Euro 4 compliant diesel with sulfur content less than 0.005 percent by weight or control according to the Department of Energy or the relevant laws in force at that time.</li> </ul> <p>GEGs</p>	<ul style="list-style-type: none"> <li>- GTG</li> <li>- GEG no. 5-6</li> <li>- GEGs</li> </ul>	<ul style="list-style-type: none"> <li>- throughout the operation period</li> </ul>	<ul style="list-style-type: none"> <li>- Glow SPP11 Co., Ltd.</li> <li>- Glow SPP11 Co., Ltd.</li> <li>- Glow SPP11 Co., Ltd.</li> </ul>

TABLE 4-2 (continued)

ENVIRONMENTAL IMPACTS	MITIGATION MEASURES	OPERATION LOCATION	OPERATION PERIOD	RESPONSIBLE PARTY
<ul style="list-style-type: none"> <li>- Control valve is installed to optimize the steam De-NOx system and monitor the performance of such a valve in order to function effectively.</li> <li>- In the case of air pollution control systems of GTG is malfunction. The system will shut down the GTG, which has problem, immediately. And will continue only when air pollution control system is improved and repaired to work as normal.</li> <li>- Installation of continuous emission monitoring system (CEMs) to measure the discharge of NOx, SO2, CO and O2 from HRSGs (2 stacks) and collect results from CEMs and report ONEP.in every six months, including the audit CEMs according to the theory continuously.</li> <li>- Installation of continuous emission monitoring system (CEMS) to measure the discharge of NOx, SO2, CO and O2 from GEG5-6 (2 stacks) and collect results from CEMs and report ONEP.in every six months, including the audit CEMs according to the theory continuously.</li> <li>- If the continuous emission monitoring system (CEMS) crashes or does not work. The project will use portable gas detector to measure air pollutants and every 4 hours instead. Also repair continuous emission monitoring system (CEMS) to be available as soon as possible.</li> </ul>	<ul style="list-style-type: none"> <li>- GTGs</li> <li>- GTG</li> <li>- HRSGs stacks</li> <li>- GEG5-6 stacks</li> <li>- HRSGs stack</li> </ul>	<ul style="list-style-type: none"> <li>- throughout the operation period</li> </ul>	<ul style="list-style-type: none"> <li>- Glow SPP11 Co., Ltd.</li> </ul>	

TABLE 4-2 (continued)

ENVIRONMENTAL IMPACTS	MITIGATION MEASURES	OPERATION LOCATION	OPERATION PERIOD	RESPONSIBLE PARTY
	<ul style="list-style-type: none"> <li>- In the case of the continuous emission monitoring system (CEMs) are outliers, the project will need to record the cause of such abnormalities and solution to fix the problem every time. Including in the case of GTGs maintenance or CEMs calibration or problem with NOx control system. Project must record all such action as well.</li> <li>- In the case of air pollution emission rates is greater the limits specified. Company has to record the number and duration of ventilation air pollutants exceed certain values. Also determine the cause and make a plan to prevent recurrence</li> <li>- Provide staff with the knowledge to act on the air pollution control system of power plants.</li> <li>- Prepare parts of the air pollution control system in sufficient amount for repairing, when the system crashes, immediately.</li> <li>- Provide preventive maintenance program. For equipment related to air pollution control. Which was maintained over the period of use or the hours of operation of the machine is set for the maintenance activities.</li> </ul>	<ul style="list-style-type: none"> <li>- Continuous Emission Monitoring Systems (CEMs)</li> </ul>	<ul style="list-style-type: none"> <li>- throughout the operation period</li> </ul>	<ul style="list-style-type: none"> <li>- Glow SPP11 Co., Ltd.</li> </ul>

TABLE 4-2 (continued)

ENVIRONMENTAL IMPACTS	MITIGATION MEASURES	OPERATION LOCATION	OPERATION PERIOD	RESPONSIBLE PARTY
3. Noise Level	<ul style="list-style-type: none"> <li>- Symbols or marks that any area is an area with noise levels above 80 dB.</li> <li>- Prepare noise personal protective equipment such as ear plugs and ear protectors to employees who work in a noisy area adequately. For employees work in areas where noise levels exceed 80 dB</li> <li>- Employees working in the control room with the air conditioning system to avoid directly exposure of noise.</li> <li>- Plant trees around the project area as a protection strip.</li> <li>- Provide a plan for inspection or maintenance of machinery and equipment is a significant source of noise.</li> <li>- When the project is necessary to carry out the activities that cause noise. Company needs to advance the public or community.</li> <li>- Provide the noise contour map within production area once the operation began. And update noise contour map every three years.</li> <li>- Prepared by the hearing conservation program according to the laws. And review every year.</li> <li>- Provide a silencer over the safety release valve.</li> </ul>	<ul style="list-style-type: none"> <li>- within project area</li> </ul>	<ul style="list-style-type: none"> <li>- throughout the operation period</li> </ul>	<ul style="list-style-type: none"> <li>- Glow SPP11 Co., Ltd.</li> </ul>

TABLE 4-2 (continued)

ENVIRONMENTAL IMPACTS	MITIGATION MEASURES	OPERATION LOCATION	OPERATION PERIOD	RESPONSIBLE PARTY
4. Water Quality	<ul style="list-style-type: none"> <li>- Provide neutralization pit for retention and rehabilitation of wastewater pretreatment of demineralized water system.</li> <li>- Provide a water- oil separators to separate oil from water contaminated with oil or stormwater that may be contaminated with oil from different areas.</li> <li>- Provide inspection manhole for wastewater from office after the treatment before discharge into the wastewater collection system of the industrial estate.</li> <li>- Control characteristics of the wastewater to be treated according to the criteria of the industrial estate.</li> <li>- <u>Control quality of water in holding pond to meet the requirement before draining to wastewater treatment plant of the industrial estate..</u></li> <li>- Install monitor pH, temperature and conductivity values automatically in order to check the quality of wastewater from production process in the monitoring pond.</li> <li>- Set the alarm for employees to shut off the valve of effluent from various sources. The gate where water discharge must be closed in the case of water quality shown in automatic measurement is not in the range defined in order to stop the draining out of the project.</li> </ul>	<ul style="list-style-type: none"> <li>- within project area</li> </ul>	<ul style="list-style-type: none"> <li>- throughout the operation period</li> </ul>	<ul style="list-style-type: none"> <li>- Glow SPP11 Co., Ltd.</li> </ul>

TABLE 4-2 (continued)

ENVIRONMENTAL IMPACTS	MITIGATION MEASURES	OPERATION LOCATION	OPERATION PERIOD	RESPONSIBLE PARTY
	<ul style="list-style-type: none"> <li>- If the result of the monitoring of effluent from automatic measurement shows that the water feature is not in the range specified. Wastewater will be kept in a gutter before being pumped back to the equalization tank or to adjust the quality or to wastewater treatment plant of industrial estate.</li> <li>- The sizes of the gutters (around the plants) are the width, length and height of about 0.6, 550 and 1.5 m respectively, or to retain water. (in case of closed gate) about 500 cubic meters.</li> <li>- Provide a complete water treatment system for wastewater from buildings.</li> </ul>	<ul style="list-style-type: none"> <li>- within project area</li> </ul>	<ul style="list-style-type: none"> <li>- throughout the operation period</li> </ul>	- Glow SPP11 Co., Ltd.
5. Water resources	<ul style="list-style-type: none"> <li>- Set up wastewater reuse policy.</li> <li>- Plan to ensure that the project can have enough water when water shortage.</li> <li>- Submit the information of water demand of the project to government agencies or private entities that are responsible for water allocation. Overall water management plan for the area.</li> <li>- Check the condition of water pipes, and repair water leaks immediately to prevent water loss.</li> <li>- If the water shortage in the area. Company needs to reduce capacity in order not to affect the community.</li> </ul>	<ul style="list-style-type: none"> <li>- within project area</li> </ul>	<ul style="list-style-type: none"> <li>- throughout the operation period</li> </ul>	- Glow SPP11 Co., Ltd.

TABLE 4-2 (continued)

ENVIRONMENTAL IMPACTS	MITIGATION MEASURES	OPERATION LOCATION	OPERATION PERIOD	RESPONSIBLE PARTY
6. Transportation	<ul style="list-style-type: none"> <li>- Cooperation with the industrial estate to control drivers to use caution and follow traffic rules strictly.</li> <li>- Provide a security guard or staff to facilitate the entrance - exit of the project.</li> <li>- Limit the speed of vehicles in the transport of chemicals within the industrial estate and the project, not to exceed 40 and 20 km/h, respectively.</li> <li>- Avoid chemical transport during rush hour (7:00 to 8:00 am and at 5:00 to 6:00 pm).</li> <li>- Define the transport routes by avoiding as much as possible source community.</li> <li>- Limit the speed of the truck in the community as required by law.</li> <li>- Weight truck or chemical waste in accordance with the legal standard or to prevent damage to the road surface.</li> <li>- Provide a shuttle-bus/vans for employees in sufficient numbers to reduce the number of vehicles in the road. The pick-up point for the employees by avoiding areas where there is traffic.</li> </ul>	<ul style="list-style-type: none"> <li>- transportation route</li> <li>- project's entrance and exist point</li> <li>- project's entrance and exist point</li> <li>- transportation route</li> </ul>	<ul style="list-style-type: none"> <li>- throughout the operation period</li> </ul>	<ul style="list-style-type: none"> <li>- Glow SPP11 Co., Ltd.</li> </ul>

TABLE 4-2 (continued)

ENVIRONMENTAL IMPACTS	MITIGATION MEASURES	OPERATION LOCATION	OPERATION PERIOD	RESPONSIBLE PARTY
	<ul style="list-style-type: none"> <li>- Provide management information in case of an accident, such as the transport of chemical safety data sheets, approach to emergency response, guidelines for First Aid, or documents. "To prevent accidents," the Department of Industrial Works prepared. These information must be stored separately from the packaging of dangerous goods.</li> <li>- Defined in the contract to transport the chemicals required to have an emergency response plan to meet the transport of chemical accidents.</li> <li>- Trucks chemicals must be labeled to show the risks related to the vehicle specification and driver must be licensed to drive the type 4.</li> </ul>	<ul style="list-style-type: none"> <li>- chemical trucks</li> <li>- chemical trucks</li> <li>- chemical trucks</li> </ul>	<ul style="list-style-type: none"> <li>- throughout the operation period</li> <li>- throughout the operation period</li> <li>- throughout the operation period</li> </ul>	<ul style="list-style-type: none"> <li>- Glow SPP11 Co.,Ltd.</li> <li>- Glow SPP11 Co.,Ltd.</li> <li>- Glow SPP11 Co.,Ltd.</li> </ul>
7. Drainage and flood protection	<ul style="list-style-type: none"> <li>- Provide the gutters connected to the stormwater drainage system of the industrial estate.</li> <li>- Collect rainwater contaminants to separate oil tank to remove oil. Before draining into the industrial estate.</li> </ul>	<ul style="list-style-type: none"> <li>- within project area</li> <li>- within project area</li> </ul>	<ul style="list-style-type: none"> <li>- throughout the operation period</li> <li>- throughout the operation period</li> </ul>	<ul style="list-style-type: none"> <li>- Glow SPP11 Co., Ltd.</li> <li>- Glow SPP11 Co., Ltd.</li> </ul>
8. Solid Waste Management	<ul style="list-style-type: none"> <li>- Provide garbage bins three categories of wastes generated by employees including general solid waste, waste that can be recycled and hazardous waste from office.</li> </ul>	<ul style="list-style-type: none"> <li>- within project area</li> </ul>	<ul style="list-style-type: none"> <li>- throughout the operation period</li> </ul>	<ul style="list-style-type: none"> <li>- Glow SPP11 Co., Ltd.</li> </ul>

TABLE 4-2 (continued)

ENVIRONMENTAL IMPACTS	MITIGATION MEASURES	OPERATION LOCATION	OPERATION PERIOD	RESPONSIBLE PARTY
	<ul style="list-style-type: none"> <li>- The segregation of waste that can be recycled for re-use as much as possible. Or collected for distribution to the buyer.</li> <li>- Collection of various types of industrial waste in a suitable container with the lid closed and easy for unloading. Before contacting the agency authorized by the Department of Industrial Works to pick up later disposal.</li> <li>- Provide a covered waste storage room to store waste. Before contacting the agency authorized by the Department of Industrial Works to pick up later disposal.</li> <li>- Record the amount of industrial waste generated by each project including specify the source or disposal or sale of a specific source. Summary the data every six months.</li> <li>- Narrowing of a hazardous waste disposal company installed GPS system to track the transport of waste to dispose of it properly.</li> <li>- Transport of chemicals or hazardous waste contractor must be the name and telephone number of the contractor clearly.</li> </ul>	<ul style="list-style-type: none"> <li>- within project area</li> </ul>	<ul style="list-style-type: none"> <li>- throughout the operation period</li> </ul>	<ul style="list-style-type: none"> <li>- Glow SPP11 Co., Ltd.</li> </ul>

TABLE 4-2 (continued)

ENVIRONMENTAL IMPACTS	MITIGATION MEASURES	OPERATION LOCATION	OPERATION PERIOD	RESPONSIBLE PARTY
9. Socio-Economic and Public Participation	<ul style="list-style-type: none"> <li>- Set up a committee to monitor the environmental impact, which include representative of the project, government agencies and the community in order to monitor the implementation of the project.</li> <li>- Provide remedial measures compensated if there is the prove that the impact of the project.</li> <li>- Provide funding for community development in the area surrounding the plant.</li> <li>- Consider hiring local people with knowledge of the project staff first. To work according to their ability and suitability for the job.</li> <li>- Participate or to fund the activities of the local authorities to produce a good relationship with the community.</li> <li>- Coordinate the release of information to the community leaders and people who live around the area with an industrial estate.</li> <li>- Provide a plan complaint environmental issues.</li> <li>- Details of protective measures and action plans of the project in the event of an impact on the community. And community participation in the prevention and mitigation measures.</li> </ul>	<ul style="list-style-type: none"> <li>- within project area</li> <li>- communities around the project</li> <li>- within project area and communities around the project</li> <li>- within project area and communities around the project</li> </ul>	<ul style="list-style-type: none"> <li>- throughout the operation period</li> </ul>	<ul style="list-style-type: none"> <li>- Glow SPP11 Co.,Ltd.</li> </ul>

TABLE 4-2 (continued)

ENVIRONMENTAL IMPACTS	MITIGATION MEASURES	OPERATION LOCATION	OPERATION PERIOD	RESPONSIBLE PARTY
	<ul style="list-style-type: none"> <li>- Support to the community in areas such as career promotion to promote youth education, public advocacy, promote awareness about health.</li> <li>- Monitoring the employee's behavior, such as theft, illegal drugs and gambling, etc. by putting strict rules and punishments.</li> <li>- Prepare annual plans of public relations in order to reach the community. And the community can contact the project directly. Including the information and prepare plans to address complaints from community issues and develop a database to support a plan for the next release.</li> </ul>	<ul style="list-style-type: none"> <li>- within project area and communities around the project</li> <li>- within project area</li> <li>- within project area and communities around the project</li> </ul>	<ul style="list-style-type: none"> <li>- throughout the operation period</li> <li>- throughout the operation period</li> <li>- throughout the operation period</li> </ul>	<ul style="list-style-type: none"> <li>- Glow SPP11 Co.,Ltd.</li> <li>- Glow SPP11 Co.,Ltd.</li> <li>- Glow SPP11 Co.,Ltd.</li> </ul>
10. Aesthetic	<ul style="list-style-type: none"> <li>- The allocation of not less than 5.18 percent (11,512 rals or 2,419 square meters) of green area of power plant to be planted in rows 3 rows staggered.</li> </ul>	<ul style="list-style-type: none"> <li>- perimeter fencing around the project area</li> </ul>	<ul style="list-style-type: none"> <li>- throughout the operation period</li> </ul>	<ul style="list-style-type: none"> <li>- Glow SPP11 Co., Ltd.</li> </ul>
11. Occupational Health and Safety	<ul style="list-style-type: none"> <li>- The project will be conducted on occupational health and safety to ensure compliance with relevant laws, regulations, or announcements relating to the safety, health and environmental conditions in the workplace by the government.</li> </ul>	<ul style="list-style-type: none"> <li>- within project area</li> </ul>	<ul style="list-style-type: none"> <li>- throughout the operation period</li> </ul>	<ul style="list-style-type: none"> <li>- Glow SPP11 Co., Ltd.</li> </ul>

TABLE 4-2 (continued)

ENVIRONMENTAL IMPACTS	MITIGATION MEASURES	OPERATION LOCATION	OPERATION PERIOD	RESPONSIBLE PARTY
	<ul style="list-style-type: none"> <li>- Provide occupational health and safety program according to prevention and mitigation measures to prevent such impacts identified.           <ul style="list-style-type: none"> <li>* The transportation of chemicals.</li> <li>* Regulations for working in hazardous areas.</li> <li>* The electrical and thermal protection.</li> <li>* Safety in the workplace monitoring.</li> <li>* The use of personal protective equipment.</li> <li>* Practice using fire extinguishers.</li> </ul> </li> <li>- Establishment of a safety committee to serve the health and safety policy.</li> <li>- Set an occupational health and safety policies and inform all employees strictly follow.</li> <li>- Provide a monitoring system and automatic alarm in the event of an emergency.</li> <li>- Provide warning signs in the area may be at risk, such as no smoking signs, danger of the drop, dangerous chemicals etc.</li> <li>- Provide adequate personal protective equipment including safety glasses, safety shoes, safety helmets etc.</li> <li>- Provide a suitable vehicle for use in an emergency.</li> </ul>	<ul style="list-style-type: none"> <li>- within project area</li> </ul>	<ul style="list-style-type: none"> <li>- throughout the operation period</li> </ul>	<ul style="list-style-type: none"> <li>- Glow SPP11 Co., Ltd.</li> </ul>

TABLE 4-2 (continued)

ENVIRONMENTAL IMPACTS	MITIGATION MEASURES	OPERATION LOCATION	OPERATION PERIOD	RESPONSIBLE PARTY
	<ul style="list-style-type: none"> <li>- Provide measures about work permit.</li> <li>- Provide for the training, knowledge, safety and environmental practices, including safety and environment for employees by type, and include all those involved.           <ul style="list-style-type: none"> <li>* Safety in the workplace.</li> <li>* Protection against electrical and heat.</li> <li>* The use of personal protective equipment.</li> <li>* Safety practices in each job.</li> </ul> </li> <li>- Provide a danger of fire detection systems, such as heat detector, gas detector</li> <li>- Provide bound of fuel tank, every tank size <math>10 \times 11 \times 0.5</math> meters in order to retain at least 110 % of the fuel tank size.</li> <li>- Define and prepare for the danger signs, such as the smoking ban, risk areas include chemical storage tanks. Natural gas pipeline and valves.</li> <li>- Monitor the health of all employees before starting work; also provide employees health check annually.</li> <li>- Provide first aid facilities within the project area.</li> </ul>	<ul style="list-style-type: none"> <li>- within project area</li> <li>- within project area</li> <li>- throughout the operation period</li> <li>- throughout the operation period</li> <li>- within project area</li> <li>- throughout the operation period</li> <li>- within project area</li> <li>- within project area</li> </ul>	<ul style="list-style-type: none"> <li>- throughout the operation period</li> </ul>	<ul style="list-style-type: none"> <li>- Glow SPP11 Co., Ltd.</li> </ul>

TABLE 4-2 (continued)

ENVIRONMENTAL IMPACTS	MITIGATION MEASURES	OPERATION LOCATION	OPERATION PERIOD	RESPONSIBLE PARTY
	<ul style="list-style-type: none"> <li>- Provide training to employees about safety at work for all new employees and annually for current employees. It covers topics such as the dangers of electricity, work in areas where the risk of fire protection equipment, safety in the workplace about chemical plant safety inspection etc.</li> </ul>	<ul style="list-style-type: none"> <li>- within project area</li> </ul>	<ul style="list-style-type: none"> <li>- throughout the operation period</li> </ul>	- Glow SPP11 Co.,Ltd.
11.2 Safety in working with chemicals	<ul style="list-style-type: none"> <li>- Provide information of Material Safety Data Sheet (MSDS) of the individual chemicals. Kept the work area.</li> <li>- To educate and explain the dangers of handling the spill, including possible solutions.</li> <li>- Provide an emergency eyewash and body wash area in the process, and chemical storage tank farms with adequate installation.</li> <li>- Provide Material Safety Data Sheet (MSDS) of all kinds of chemicals that are used in the vicinity of chemical storage areas and a sign affixed to the container details all kinds of chemicals.</li> <li>- Separate storage chemical reactions like acid - alkaline or chemical substances that can not be stored near each other.</li> <li>- Chemical storage area must be well ventilated to allow circulation of air flow.</li> </ul>	<ul style="list-style-type: none"> <li>- within project area</li> </ul>	<ul style="list-style-type: none"> <li>- throughout the operation period</li> </ul>	<ul style="list-style-type: none"> <li>- Glow SPP11 Co., Ltd.</li> </ul>

TABLE 4-2 (continued)

ENVIRONMENTAL IMPACTS	MITIGATION MEASURES	OPERATION LOCATION	OPERATION PERIOD	RESPONSIBLE PARTY
	<ul style="list-style-type: none"> <li>- Prepare concrete bund around chemical storage tanks that may have leaked from the storage tank. The potential impact is limited. And to collect the chemicals easily.</li> <li>- Chemical storage area must be well ventilated to allow circulation of air flow - a concrete way around the container tank chemicals that have leaked from the storage tank. To limit the potential impacts and to collect chemical spill easily.</li> </ul>			
11.3 Fire protection equipment.	<ul style="list-style-type: none"> <li>- Provide fire protection equipment that is designed in accordance with the National Fire Protection Association (NFPA) as follows.           <ul style="list-style-type: none"> <li>* Hand-held fire extinguishers and trolley.</li> <li>* Firefighting nozzles and fire hose cabinet.</li> <li>* Automatic sprinkler (wet) system.</li> <li>* Automatic sprinkler (dry) system.</li> <li>* Fire pumps.</li> <li>* Reserve fire water tanks.</li> <li>* Automatic Carbon Dioxide system</li> <li>* Initiation devices such as heat detection, smoke detection and etc.</li> <li>* Alarm systems such as fire alarm and alarm button and etc.</li> </ul> </li> <li>- Provide a fire protection equipment maintenance plan.</li> </ul>	<ul style="list-style-type: none"> <li>- within project area</li> <li>- throughout the operation period</li> </ul>	<ul style="list-style-type: none"> <li>- Glow SPP11 Co., Ltd.</li> <li>- throughout the operation period</li> </ul>	

TABLE 4-2 (continued)

ENVIRONMENTAL IMPACTS	MITIGATION MEASURES	OPERATION LOCATION	OPERATION PERIOD	RESPONSIBLE PARTY
11.4 Emergency response plan	<ul style="list-style-type: none"> <li>- Provide emergency response plans in the level of factories / establishments and customize a training emergency response plans before the project and after the operation, and then to practice at least one time per year.</li> <li>- Establish a communication plan in case of emergencies in the level of factories/establishment. Shall at least include the notification and evacuation drills.</li> <li>- Training to comply with emergency response plans that may be associated with the community should be informed in advance through various channels, such as banners, radio and audio line etc.</li> <li>- Coordination with internal and external agencies to follow the emergency response plans for each level of the project and the industrial estate.</li> </ul>	<ul style="list-style-type: none"> <li>- within project area</li> </ul>	<ul style="list-style-type: none"> <li>- throughout the operation period</li> </ul>	- Glow SPP11 Co., Ltd.
11.5 Major Hazard	<ul style="list-style-type: none"> <li>- Provide a control pressure and volumetric gas station (MRS) with various control devices. Located in an open area with good ventilation.</li> <li>- Establish a system or device that can suppress the gas supply system transporting of natural gas from a central control room. If it detects that the leakage of the system.</li> <li>- Provide tools to detect leakage of natural gas such as the gas detector in MRS station and pipe system.</li> </ul>	<ul style="list-style-type: none"> <li>- within project area</li> </ul>	<ul style="list-style-type: none"> <li>- throughout the operation period</li> </ul>	- Glow SPP11 Co., Ltd.

TABLE 4-2 (continued)

ENVIRONMENTAL IMPACTS	MITIGATION MEASURES	OPERATION LOCATION	OPERATION PERIOD	RESPONSIBLE PARTY
	<ul style="list-style-type: none"> <li>- Provide preventive maintenance plan in particular about the security of the system equipment transporting natural gas. Including the inspection of pipes and the neatness of natural gas pipelines within the project area regularly.</li> </ul>	- within project area	- throughout the operation period	- Glow SPP11 Co.,Ltd.
	<ul style="list-style-type: none"> <li>- Establish an emergency response plans to be adopted in practice in case of emergency, the accident was caused by a mistake of the person and the accident of natural disasters that are beyond their expectations.</li> </ul>	- within project area	- throughout the operation period	- Glow SPP11 Co.,Ltd.
	<ul style="list-style-type: none"> <li>- After practicing emergency response plans must include the results of the training, especially the obstacles and deficiencies that occur. To bring such information to improve emergency response plans to complete and more productive.</li> </ul>	- within project area	- throughout the operation period	- Glow SPP11 Co.,Ltd.
	<ul style="list-style-type: none"> <li>- Cooperation with the Disaster Prevention and Mitigation agencies in the area and the local police station. To prepare the working group can be called immediately when an emergency event of gas pipe.</li> </ul>	- within project area and communities around the project	- throughout the operation period	- Glow SPP11 Co.,Ltd.
	<ul style="list-style-type: none"> <li>- Provide a preventive maintenance plan of removal of nitrogen oxides from a gas engine with SCR system and related equipment during operation.</li> </ul>	- within project area	- throughout the operation period	- Glow SPP11 Co.,Ltd.

TABLE 4-2 (continued)

ENVIRONMENTAL IMPACTS	MITIGATION MEASURES	OPERATION LOCATION	OPERATION PERIOD	RESPONSIBLE PARTY
11.6 Risk	<ul style="list-style-type: none"> <li>- Provide training, knowledge, safety and environmental practices, including safety and environment for the employees in each job, and all those involved.</li> <li>- Provide staff patrolling in the manufacturing process to determine abnormalities of the equipment on a regular basis.</li> <li>- Preparing a maintenance plan for equipment and machinery (especially safety equipments) in order to protect the equipment above normal working continuously.</li> <li>- Preparing work instruction in each activity to achieve the security and control risks which may arise from the operation.</li> </ul>	<ul style="list-style-type: none"> <li>- within project area</li> <li>- within project area</li> <li>- within project area</li> <li>- within project area</li> </ul>	<ul style="list-style-type: none"> <li>- throughout the operation period</li> </ul>	<ul style="list-style-type: none"> <li>- Glow SPP11 Co.,Ltd.</li> <li>- Glow SPP11 Co.,Ltd.</li> <li>- Glow SPP11 Co.,Ltd.</li> <li>- Glow SPP11 Co.,Ltd.</li> </ul>
12. Public Health	<ul style="list-style-type: none"> <li>- Provide basic necessities for first aid and first aid training.</li> <li>- Coordination with local health agencies to gather information on the health of communities near the project area.</li> <li>- Supporting public health agencies such as health promotion or health education to the community and the availability of facilities.</li> <li>- Specify the main hospital to treat the case of employee illness.</li> </ul>	<ul style="list-style-type: none"> <li>- within project area</li> <li>- within project area and public health agency</li> <li>- within project area and public health agency</li> <li>- within project area</li> </ul>	<ul style="list-style-type: none"> <li>- throughout the operation period</li> </ul>	<ul style="list-style-type: none"> <li>- Glow SPP11 Co.,Ltd.</li> <li>- Glow SPP11 Co.,Ltd.</li> <li>- Glow SPP11 Co.,Ltd.</li> <li>- Glow SPP11 Co.,Ltd.</li> </ul>

TABLE 4-2 (continued)

ENVIRONMENTAL IMPACTS	MITIGATION MEASURES	OPERATION LOCATION	OPERATION PERIOD	RESPONSIBLE PARTY
	<ul style="list-style-type: none"> <li>- Provide adequate first aid rooms and medical infrastructure of the project. As well as provide a vehicle for bringing the patient to the hospital immediately in case of emergency.</li> </ul>	- within project area	- throughout the operation period	- Glow SPP11 Co., Ltd.
	<ul style="list-style-type: none"> <li>- If the health check shows any irregularities. Companies need to make a specific diagnosis and causes of anomalies to determine a suitable job.</li> </ul>	- within project area	- throughout the operation period	- Glow SPP11 Co., Ltd.
	<ul style="list-style-type: none"> <li>- Establish a database of employee health to adopt the analysis of the causes of the failure of the employee's annual health check of each operational area, also specify the age of workers who work in that area. Analysis annual health check results in order to monitor exposure to health threats with health database.</li> </ul>	- within project area	- throughout the operation period	- Glow SPP11 Co., Ltd.
	<ul style="list-style-type: none"> <li>- Provide health promotion projects in communities near the project area such as mobile medical units, the fitness of the elderly etc.</li> </ul>	- communities around the project	- throughout the operation period	- Glow SPP11 Co., Ltd.

Table 4-3

Environmental impact monitoring measures (during construction period)

## Gas-Fired Combined Cycle Power Plant (Expansion) Project of Glow SPP 11 Co., Ltd.

PARAMETER	SAMPLING STATIONS	FREQUENCY	RESPONSIBLE PARTY
1. Air Quality			
- Total Suspended Particulate (TSP)	- 2 stations * Moo 3 Ban Map Yang Pon (A1)	- Every 6 months. (7 consecutive days per each time)	- Glow SPP 11 Co., Ltd.
- Particulate Matter (PM-10) (average 24 hour)	* Moo 3 Ban Map Yang Pon (A2)  (Select only 1 station to measure wind speed & wind direction)		
- Wind speed			
- Wind direction			
2. Noise Level			
- Leq-24 hour	- 2 stations * Moo 3 Ban Map Yang Pon (N1)	- Every 6 months. (5 consecutive days per each time)	- Glow SPP 11 Co., Ltd.
- L <sub>90</sub>	* Moo 3 Ban Map Yang Pon (N2)		
3. Transportation	- Record of the number / cause of the accident of the project.	- Record every day and provide the report every 6 months throughout the construction period.	- Glow SPP 11 Co., Ltd.
4. Solid Waste Management	- Record the information of waste from the project in terms of type, quantity, transportation method and types of disposal, monthly.	- Once a month throughout the construction period.	- Glow SPP 11 Co., Ltd.

Table 4-3 (continued)

PARAMETER	SAMPLING STATIONS	FREQUENCY	RESPONSIBLE PARTY
<b>5. Occupational Health and Safety</b> - Record the type, area, severity, cause and solution of all accidents within the project.	- Within the construction area	- Once a month throughout the construction period.	- Glow SPP 11 Co., Ltd.
<b>6. Socio - Economic</b>	- Summary of grievances or complaints about the construction and correction action every times.	- Provide the report every 6 months throughout the construction period.	- Glow SPP 11 Co., Ltd.

Table4-4

Environmental impact monitoring measures (during operation period)

## Gas-Fired Combined Cycle Power Plant (Expansion) Project of Glow SPP 11 Co., Ltd.

PARAMETER	SAMPLING STATIONS	FREQUENCY	RESPONSIBLE PARTY
1. Air Quality	<ul style="list-style-type: none"> <li>- 3 stations           <ul style="list-style-type: none"> <li>* Moo 4 Ban Wang Ta Phin (A1)</li> <li>* Moo 6 Ban Map Yang Phon Mai (A2)</li> <li>* Moo 3 Ban Map Yang Phon (A3)</li> </ul> </li> <li>- Total Suspended Particulate (TSP) (avg 24 hr.)</li> <li>- Particulate Matter up to 10 micrometers in Size (PM-10) (avg 24 hr.)</li> <li>- Wind speed and direction</li> </ul>	<ul style="list-style-type: none"> <li>- Every 6 months. (7 consecutive days per each time)</li> </ul>	- Glow SPP11 Co., Ltd.
1.1 Ambient Air Quality	<ul style="list-style-type: none"> <li>- Nitrogen dioxide (<math>\text{NO}_2</math>) (avg 1 hr.)</li> <li>- Sulfur dioxide (<math>\text{SO}_2</math>) (avg 1 hr. and 24 hr.)</li> <li>- Oxide of Nitrogen (<math>\text{NO}_x</math>)</li> <li>- Sulfur dioxide (<math>\text{SO}_x</math>)</li> <li>- carbon monoxide (<math>\text{CO}</math>)</li> <li>- Oxygen (<math>\text{O}_2</math>)</li> <li>- Audit CEMs system, which monitor air pollution of project</li> <li>* Stack sampling           <ul style="list-style-type: none"> <li>- Oxide of Nitrogen (<math>\text{NO}_x</math>)</li> <li>- Sulfur dioxide (<math>\text{SO}_2</math>)</li> <li>- Sulfur dioxide (TSP)</li> <li>- Oxygen (<math>\text{O}_2</math>)</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>- Continuously and report to ONEP every six months.</li> <li>- Once a year.</li> <li>- Every 6 months (same period with the ambient air sampling)</li> </ul>	<ul style="list-style-type: none"> <li>- Glow SPP11 Co., Ltd.</li> <li>- Glow SPP11 Co., Ltd.</li> <li>- Glow SPP11 Co., Ltd.</li> </ul>

Table 4-4 (continued)

PARAMETER	SAMPLING STATIONS	FREQUENCY	RESPONSIBLE PARTY
<b>2. Noise Level</b>			
2.1 Leq-24 hr. and L <sub>90</sub>	<ul style="list-style-type: none"> <li>- 6 stations           <ul style="list-style-type: none"> <li>* The fence around the project (four sides.)</li> <li>* Moo 3 Ban Map Yang Phon #1 (N1)</li> <li>* Moo 3 Ban Map Yang Phon #2 (N2)</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>- Every 3 months. (5 consecutive days per each time)</li> </ul>	<ul style="list-style-type: none"> <li>- Glow SPP11 Co., Ltd.</li> </ul>
2.2 Leq-8 hr.	<ul style="list-style-type: none"> <li>- 3 stations           <ul style="list-style-type: none"> <li>* Air Compressor</li> <li>* Gas Turbine Generator</li> <li>* Cooling Tower</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>- Every 3 months</li> </ul>	<ul style="list-style-type: none"> <li>- Glow SPP11 Co., Ltd.</li> </ul>
<b>3. Water Quality</b>			
3.1 Flowrate, BOD, SS, grease & oil	<ul style="list-style-type: none"> <li>- Inspection manhole of wastewater from building.</li> </ul>	<ul style="list-style-type: none"> <li>- Once a month.</li> </ul>	<ul style="list-style-type: none"> <li>- Glow SPP11 Co., Ltd.</li> </ul>
3.2 Flowrate, pH, TDS, Temperature, oil & grease , Free chlorine and Heavy Metal (Cr <sup>+6</sup> , Cr <sup>+3</sup> , Fe, Mn,)	<ul style="list-style-type: none"> <li>- Holding pond of wastewater from production process.</li> </ul>	<ul style="list-style-type: none"> <li>- Once a month.</li> </ul>	<ul style="list-style-type: none"> <li>- Glow SPP11 Co., Ltd.</li> </ul>
<b>4. Socio-Economic</b>			
4.1 Explore the socio-economic survey of the surrounding communities and public opinion, local leaders and representatives of the agencies involved.	<ul style="list-style-type: none"> <li>- Communities surrounding the project area in a radius of five kilometers and the community in the areas of environmental monitoring. Including community leaders and government agencies involved.</li> </ul>	<ul style="list-style-type: none"> <li>- Once a year.</li> </ul>	<ul style="list-style-type: none"> <li>- Glow SPP11 Co., Ltd.</li> </ul>

Table 4-4 (continued)

PARAMETER	SAMPLING STATIONS	FREQUENCY	RESPONSIBLE PARTY
4.2 Record complaints from the community including troubleshooting, and the results obtained.	- Communities around the project area.	- Once a year.	- Glow SPP11 Co., Ltd.
4.3 Provide a corporate social responsibility (CSR) activities report.	- Communities around the project area.	- Once a year.	- Glow SPP11 Co., Ltd.
5. Occupational Health and Safety			
5.1 heat stress index (WBGT)	- 4 stations * Gas Turbine Generator. * Boiler * Steam Turbine Generator. * Gas Engine Generator.	- Every 6 months.	- Glow SPP11 Co., Ltd.
5.2 Brightness	- 2 stations * Production area * Maintenance building.	- Every 6 months.	- Glow SPP11 Co., Ltd.
5.3 Conducts employees annual health check			
- General physical check-up - Chest X-Ray - Hemoglobin : HGB - Eyes examination - Hearing ability	- Every employees - Employees who work in a noisy area (Exceeding 85 dB.)	- Once before start working. Then once a year.	- Glow SPP11 Co., Ltd.

Table 4-4 (continued)

PARAMETER	SAMPLING STATIONS	FREQUENCY	RESPONSIBLE PARTY
5.4 Record gas leakage. Also Collecting statistics accident and damage to the project and work.	- Within project area.	- Once a year.	- Glow SPP11 Co., Ltd.
5.5 Compiled ascribes illness and annual health check.	- Within project area.	- Once a year.	- Glow SPP11 Co., Ltd.
5.6 Collecting statistics accident and damage to the plant and the details are as follows.	- Within project area.	- Once a year.	- Glow SPP11 Co., Ltd.
	<ul style="list-style-type: none"> <li>- Causes</li> <li>- Category</li> <li>- Calamity</li> <li>- Correction and prevention of recurrence.</li> <li>- All employees will receive medical treatment in case of accident or illness, throughout the operation period.</li> <li>- Provide first aid training once every year.</li> <li>- Practice emergency response plan once every year.</li> </ul>		