Initial Environmental Examination Report (Draft)

Project Number: 49067-001
October 2017

THA: Southern Thailand Waste-to-Energy Project (Part 2 of 5)

Prepared by Chana Green Company Ltd.

CHAPTER 3
PROJECT DESCRIPTION

3.1 Introduction and suitability of the Project location

3.1.1 Introduction

Chana Green Company Limited (the Project) is an affiliate of Gulf Energy Development Company Limited. The Project planned to develop Chana Green Power Plant. Biomass, wood residue or agricultural residues such as rubber and acacia woods, will be used as a fuel. The Project is located in an area which covers 161.49 rai in Ku Subdistrict, Chana District, Songkhla Province (**Figure 3.1.1-1**). The Project has been approved by the Electricity Generating Authority of Thailand (EGAT) under the project of power purchase from a small power plant (SPP) in accordance with the Notification of power purchase from renewable small power plant B.E.2550 (revision B.E.2552). This will help to reduce fossil-based power production such as natural gas, oil, and coal. It will also help reducing greenhouse gas emission that causes global warming.

The main equipment of the Project is a boiler with a capacity of 98 ton/hour, power generator with a capacity of 25 MW, and supporting system. The designed capacity of the power plant is 25 MW and the maximum operating capacity is 24.915 MW. About 4.293 MW will be used in the Project and the rest of 20.622 MW will be supplied to the grid of Electricity Generating Authority of Thailand (EGAT) in non-firm contract basis.

3.1.2 Suitability of the Project location

(1) Fuel source: The Project is surrounded with rubber plants cultivation area. The area has the potential for various energy crops (parts that can be used are residues such as slab, branch, and root). Thus, the fuel sources are stable (details of a study of fuel potential are described in Section 3.3.1).

(2) Transport: The Project locates on Highway No.408 which connects to main roads, Highway No.43 and Highway No.42. Thus, transport of fuels to the Project can be done conveniently (**Figure 3.1.1-1**).

(3) Power transmission system: The Project locates near the transmission system of Electricity Generating Authority of Thailand along the Highway No.43. The total length of the transmission line from the project site to PEA substation is 8 Km. PEA will use the Highway right of

way (ROW) to lay the transmission line and they will be responsible to conduct the construction permit for the transmission line alignment and construction.

(4) Water sources: The Project's location is near Nathawee irrigation canal under the irrigation project. The canal is capable of supplying water to the Project.

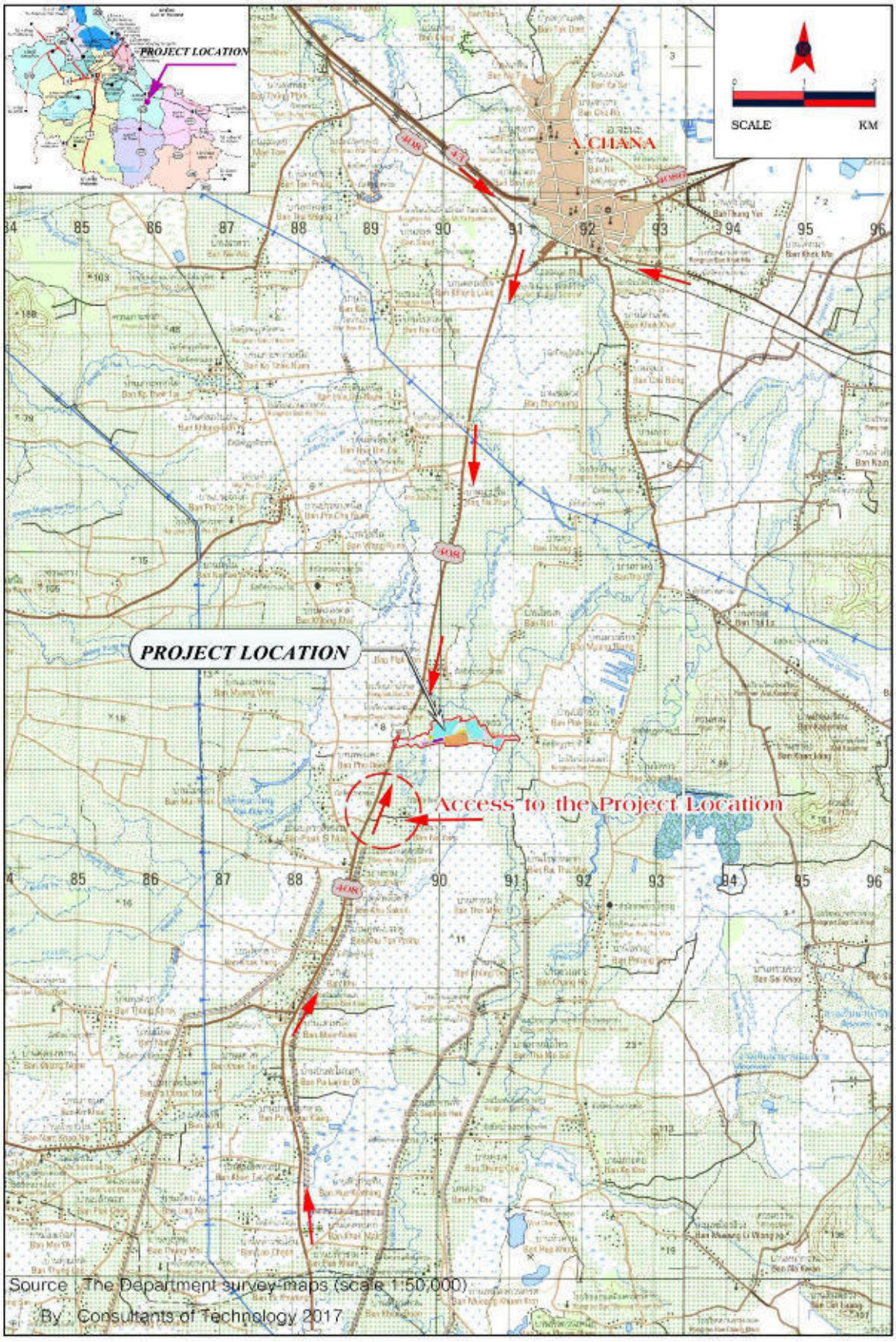


Figure 3.1.1-1 Project Site and Study Area

3.2 Location and the Project area

3.2.1 Area and the surrounding

Chana Green Company Limited is located in Moo 3, Ku Subdistrict, Chana District, Songkhla Province. It covers 161.49 rai of the area for the Project's development.

Boundaries are as follows:

North	Connects to rubber plantation area
South	Connects to rubber plantation area
East	Connects to rubber plantation area
West	Connects to Highway No.408

The Project area is designed in accordance with the concern of impacts to Chana Chanupathum School. The school locates approximately 136 meters (fence to fence) from the Project. Green area is designed as the Project buffer zone follows by water reservoir to attenuate noise levels during project operation. Power generating area and fuel storage and preparation areas where transport and wood chipping will take place are located in the south of the Project area as shown in **Figure 3.2.1-1**. The Project area utilization is summarized in **Table 3.2.1-1** and **Figure 3.2.1-2**

(1) Power generation and transmission system area consists of power generating units (boiler and power generator), a switchyard, and transformers to transform voltage prior connecting to transmission system;

(2) Power generation supporting system area consists of water treatment plant and wastewater treatment plant, cooling tower, water pump, and diesel storage tank for system startup;

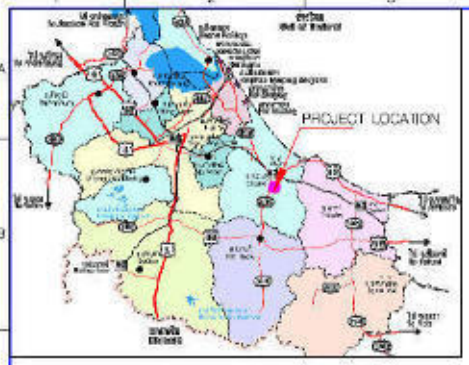
(3) Fuel preparation area consists of wood storage yard, wood chipping building, and chipped wood storage building;

(4) Water reservoir and bottom ash disposal pond area;

(5) Office buildings area such as production control building and maintenance building; and

(6) Green area

The setback area between project buildings/site boundary and public road/public canal has been complied with Ministerial Regulation No.55 (B.E. 2543) Promulgated under the Building Control Act B.E.2522. **(Appendix 3-1)**



NO.	DESCRIPTION
1	STEAM TURBINE GENERATOR
2	BOILER
3	STACK
4	ELECTROSTATIC PRECIPITATOR
5	OPEN STORAGE YARD (WOOD PILE)
6	FUEL PROCESSING AREA (WOOD CHIPPER)
7	FUEL STORAGE (WOOD CHIP)
8	ASH DUMPING PIT
9	OFFICE
10	WORKSHOP, WAREHOUSE
11	SWITCHYARD
12	ELECTRICAL AND CONTROL BUILDING
13	MAIN TRANSFORMER
14	STATION TRANSFORMER
15	EMERGENCY GEN. SET
16	COOLING TOWER
17	FIRE AND RAW WATER PUMP STATION
18	WATER TREATMENT AREA
19	SERVICE WATER TANK
20	DEMIN WATER TANK
21	DEMIN WATER PLANT
22	WASTE WATER HOLDING POND
23	DIESEL FUEL TANK
24	DIESEL FUEL STATION
25	RAW WATER RESERVOIR
26	WATER INTAKE PUMP HOUSE (RIVER)
27	AIR COMPRESSOR
28	WEIGHING STATION
29	CAR PARK
30	RESERVED AREA, GARAGE
31	RETENTION POND
32	WASTE WATER POND (DRY SEASON)
33	ASH DISPOSAL POND
34	AREA FOR EXPANSION
35	EMERGENCY POND
36	HIGH BOD EQ POND
37	ANAEROBIC TANK
38	AERATION LAGOON
39	WASTE STORAGE WAREHOUSE

GENERAL PLANT LAYOUT
SCALE 1:5000

NOTE :
1. PLANT NORTH DIRECTION TO BE CONFIRMED

Project Title :
20.622 MW Rubber Wood Fired Power Plant

Owner :
CHANA GREEN COMPANY LIMITED

Document Title :
PRELIMINARY PLANT LAYOUT

Prpd.	PROP	Document No.:	Page No.: 1/3
Chkd.	CHECK		A1
Appd.	APPD		
Initial	AUTHO		SCALE: SCALE
DATE	DATE	Project No. :	FILENAME

FOR PRELIMINARY ONLY

FIGURE 3.2.1-1 PLANT LAYOUT

Table 3.2.1-1

Land use description of project

Type	Area (m^2)	Percentage
(1) Power Block Area		
- Power Block	3,500.0	1.35
- Switchyard and Electric transformers	1,200.0	0.46
(2) Balance of Plant Area		
- Water Treatment and Waste Water Treatment Area	1,000.0	0.39
- Cooling tower and Pump	1,600.0	0.62
- Diesel tank	25.0	0.01
(3) Fuel Preparation Area		
- Wood Shredder and Fuel Storage House	7,000.0	2.71
- Open Storage Yard	32,300.0	12.50
(4) Reservoir and Ash landfill		
- Raw Water Reservoir	93,660.0	36.25
- Settling Pond and Waste Water Holding Pond	5,300.0	2.05
- Waste Water Reservoir (dry season0	7,700.0	2.98
- Ash landfill	12,000.0	4.64
(5) Building		
- Control Building	400.0	0.15
- Workshop and Warehouse	700.0	0.27
- Administration and Guardhouse	1,900.0	0.74
- Raw Water Pumping Station	30.0	0.01
(6) Green Area	18,000.0	6.97
(7) Other areas: such as roads, parking areas, drainage ditches, area are not developed pipelines and transmission lines	72,062.6	27.89
Total (1)+(2)+(3)+(4)+(5)+(6)+(7)	**258,377.6**	**100.00**

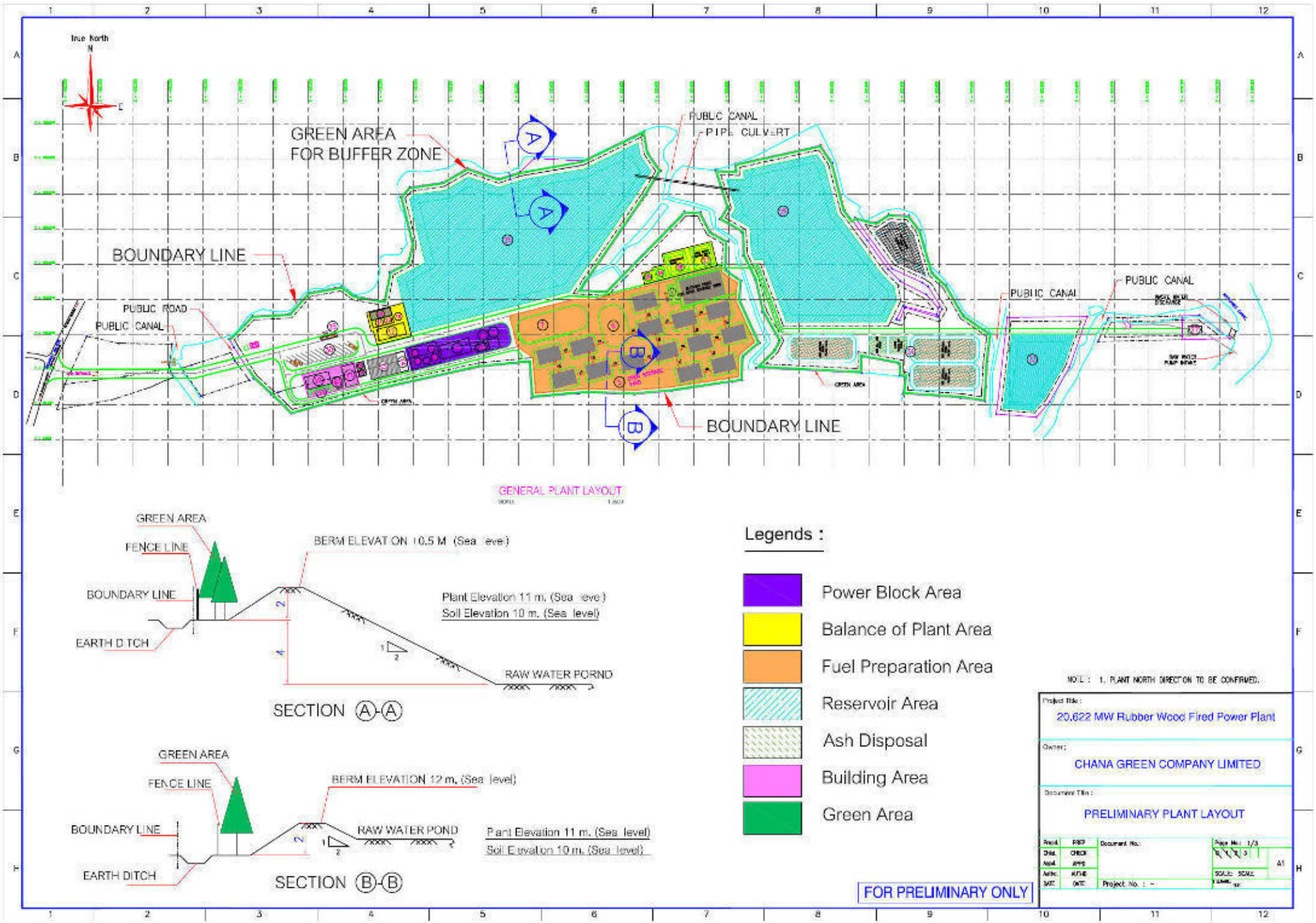


FIGURE 3.2.1-2 PROJECT LAND USE

3.2.2 The Project accessibility

To travel to the Project, land transportation is convenient. For traveling from Hatyai District, Songkhla Province, can travel through Highway No. 43 and turn right at Paching junction to Highway No. 408, then seven kilometers through traffic, the Project is on the left-hand side at km 15 (**Figure 3.1.1-1**). For traffic within the project area and internal roads cross section shown at **Figure 3.2.2-1** and **Figure 3.2.2-2** respectively.

3.3 Fuel and chemical

3.3.1 Fuel

(1) Fuel option

The Project has made a contract in SPP type with Electricity Generating Authority of Thailand. The Project is one of renewable energy projects (solar power is excluded) for the three provinces in the southern border (Pattani, Yala, and Narathiwat provinces) and four districts in Songkhla Province (Chana, Thepha, Sabayoi, and Nathawee subdistricts). Considering of biomass fuels in the adjacent areas found that rubber wood is the main fuel option and another rapid growth plant such as acacia wood is an alternative fuel. The Project considered commercially viable of the power production. Thus, the power generation capacity of 25 MW is selected.

(2) Fuel composition

The compositions of rubber wood to be used as fuel are shown in **Table 3.3.1-1** and the certification from the laboratory is shown in **Appendix 3-2**.

(3) Quantity and source

The Project requires rubber wood residue from wood processing process such as slab, branch, and root to be used as fuel of approximately 800 ton/day or 268,000 ton/year, calculated from 335 days (rubber plants with age between 25-30 years have low yield of latex will be cut and sent to rubber wood processing to produce rubber wood products).

In 2015, the Project hired consultants (Ensol Company Limited and Entic Company Limited) to conduct a study on the suitability of the biomass (rubber wood) to support the power plant development of Gulf Energy Development Company Limited in the southern region of Thailand. The study was conducted under the condition of utilization of 300,000 ton/year of biomass over 25 years as shown in **Appendix 3-3**. The study results can be summarized as follows.

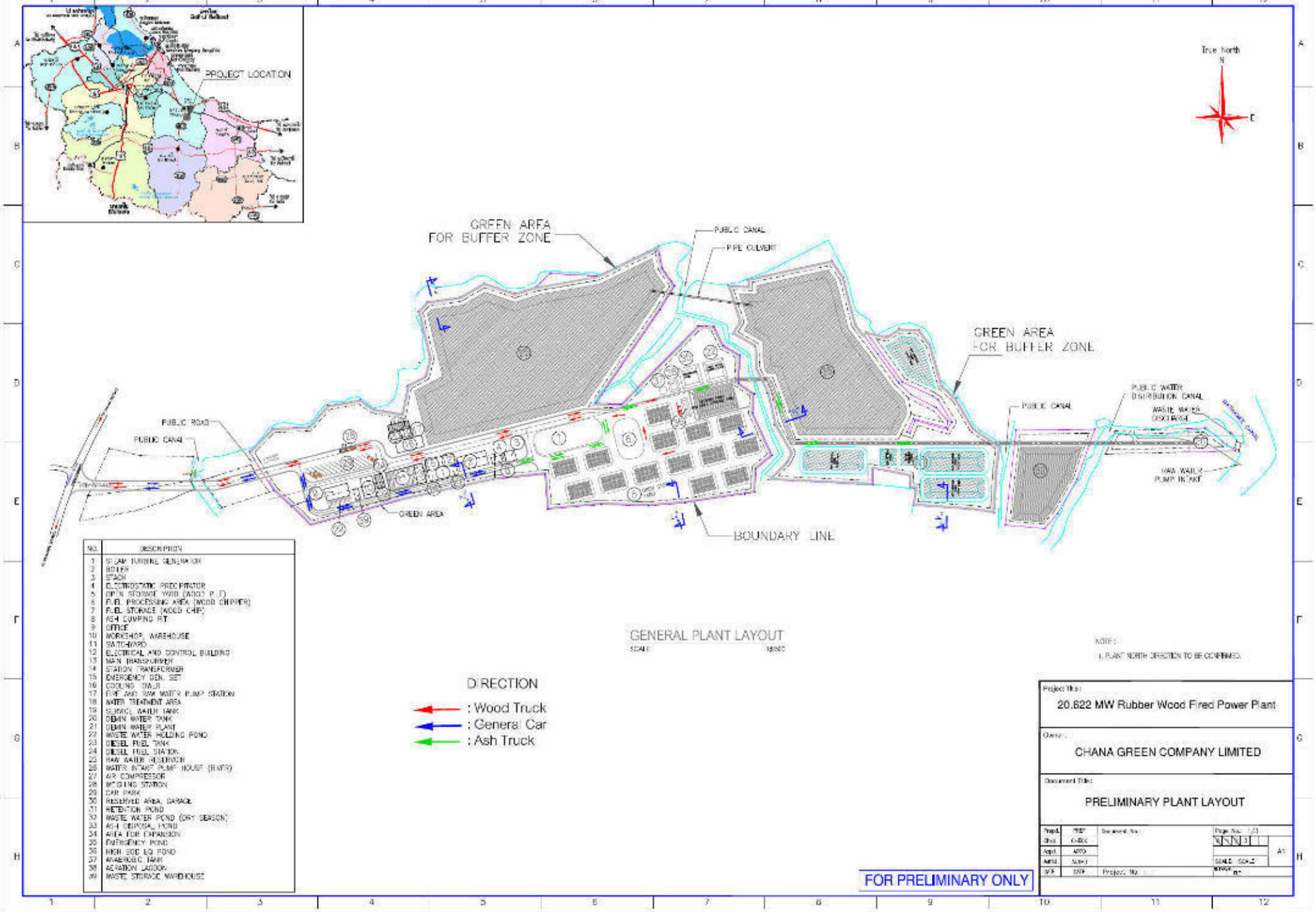
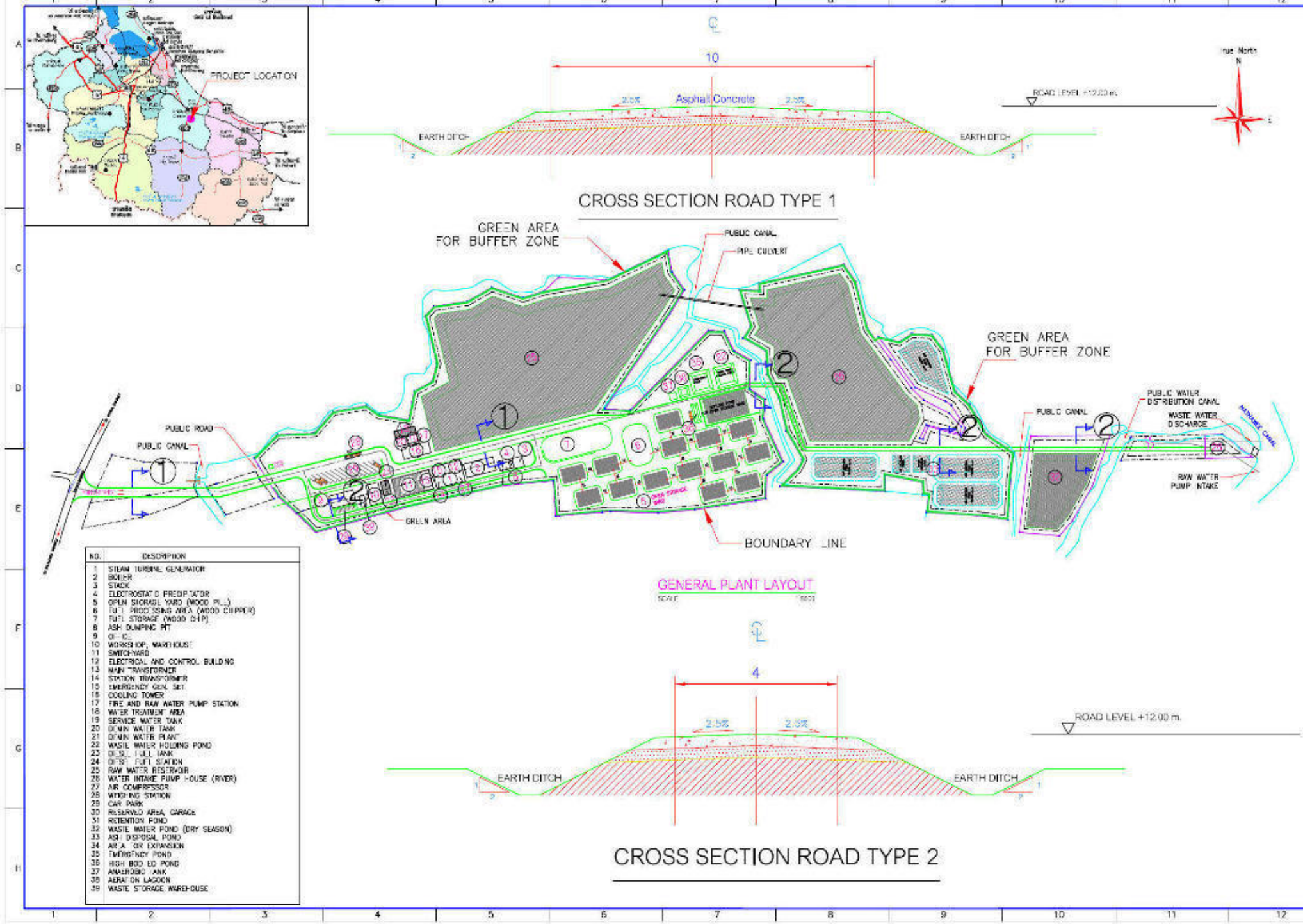


FIGURE 3.2.2-1 THE DIRECTION OF TRAFFIC WITHIN THE PROJECT AREA



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39	WASTE STORAGE WAREHOUSE

FIGURE 3.2.2-2 CROSS SECTION ROAD WITHIN THE PROJECT AREA

Table 3.3.1-1

Compositions of Rubber Wood

Parameter	Unit	Root	Parts
High Heating Value	KJ/Kg	4,197.00	4,242.00
Low Heating Value	KJ/Kg	3,785.00	2,356.00
Moisture	%	8.47	8.24
Fixed Carbon	%	16.46	15.75
Volatile Matter	%	72.91	74.56
Carbon	**%C**	**45.14**	**45.18**
Hydrogen	**%H**	**5.21**	**5.41**
Nitrogen	**%N**	**0.56**	**0.2**
Oxygen	**%O**	**38.35**	**39.42**
Sulfur	**%**	**0.06**	**0.05**
Chlorine (Cl_2)	**%**	**0.05**	**0.05**
Ash	**%**	**2.16**	**1.45**

Source : Chana Green Company Limited, 2016

The study process comprises of collecting data of rubber wood plantation area, consideration of fuel from the plantation area, analysis of fuel consumption, analysis of remaining fuel, and analysis of the adequacy of fuel for the Project over the period of 25 years. The data were collected from three sources.

(1) Quantity of rubber wood with the age of over 25 years was considered based on plantation area, data from the Department of Agricultural Extension

(2) Quantity of cut rubber wood to support the requirement of wood processing plants was considered based on number of wood processing plants, data from the Department of Industrial Works

(3) Quantity of cut rubber wood to support the requirement of wood processing plants was considered based on number of wood processing plants, data from the Royal Forest Department

The rubber wood plantation area of one rai generates fresh biomass (including trunk) of 37.65 tons. Types of fuel can be classified as follows.

Type of biomass	Quantity (ton)
Trunk	22.46
Branch/stalk	8.14
Leaves	1.76
Stump and root	5.29
Total	**37.65**

From the rubber wood required in the 11 southern provinces from the assessment using data from the Department of Agricultural Extension, Department of Industrial Works, and Royal Forest Department found that rubber wood residues from wood processing plants are 13,134,185, 25,293,645, and 11,484,197 tons/year, respectively. After deducting quantity of rubber wood residue required for boilers of various factories such as lumber drying, plastic/chemical, food, biomass power plant, pallet, and particle board, the minimum amount of rubber wood remaining (analyzed from the data of the Royal Forest Department) of 4,543,778 tons/year. However, the Project requires about 268,000 tons/year. Thus, the quantity of fuel is sufficient for the Project development.

Province	Wood residues left from other activities (ton/year)		
	Department of Agricultural Extension	Department of Industrial Works	Royal Forest Department
Songkhla	739,087	3,481,828	-14,244
Yala	969,629	1,222,667	-147,104
Pattani	38,469	228,859	174,752
Narathiwat	920,286	240,978	245,789
Surat Thani	1,016,149	3,680,869	1,102,255
Krabi	238,861	770,454	535,200
Phang Nga	219,490	1,347,463	128,692
Nakhon Sri Thammarat	812,125	3,724,129	1,320,801
Trang	186,322	2,615,986	645,515
Phatthalung	816,358	431,786	406,107
Satun	125,838	381,353	146,015
Total	**6,082,614**	**18,126,372**	**4,543,778**

(4) Fuel transportation into the project area

The biomass fuel to be used in the process will be transported by 20 tons /trucks for 40 travels/day. The transport hours will be arranged to prevent creating traffic problems. The transportation will not be done during rush hours in both morning and evening. The truck will be weighted prior dumping the biomass on the fuel storage yard. The empty truck will be weighted and left the Project immediately to prevent traffic problems in the Project area and to reduce impacts on the adjacent communities.

(5) Fuel storage and preparation

1) Fuel storage yard

Fuel will be stored on the yard of the Project which covers an area of 32,300 square meters as shown in **Figure 3.3.1-1**. The yard is able to store 24,000 tons of fuel or 30 days in case of no fuel increase. It is an open concrete yard. The fuel will be stored in trapezoid pile with the height of 2-4 meters. The Project provided drainage system around the fuel yard and a settling pond with a dimension of 35 meters width, 60 meters length, and 3.5 meters depth. The pond has a capacity to store about 5,365.5 cubic meters of water (Cross section of the pond is shown in **Figure 3.3.1-2**). The water will be reused for root washing, gardening, and spraying on the fuel piles to prevent fire. The Project will assign workers to check and dredging the drainage gutter by using backhoe and labor to prevent water pollution and shallow. Fuel from the dredging will be brought back to the yard.

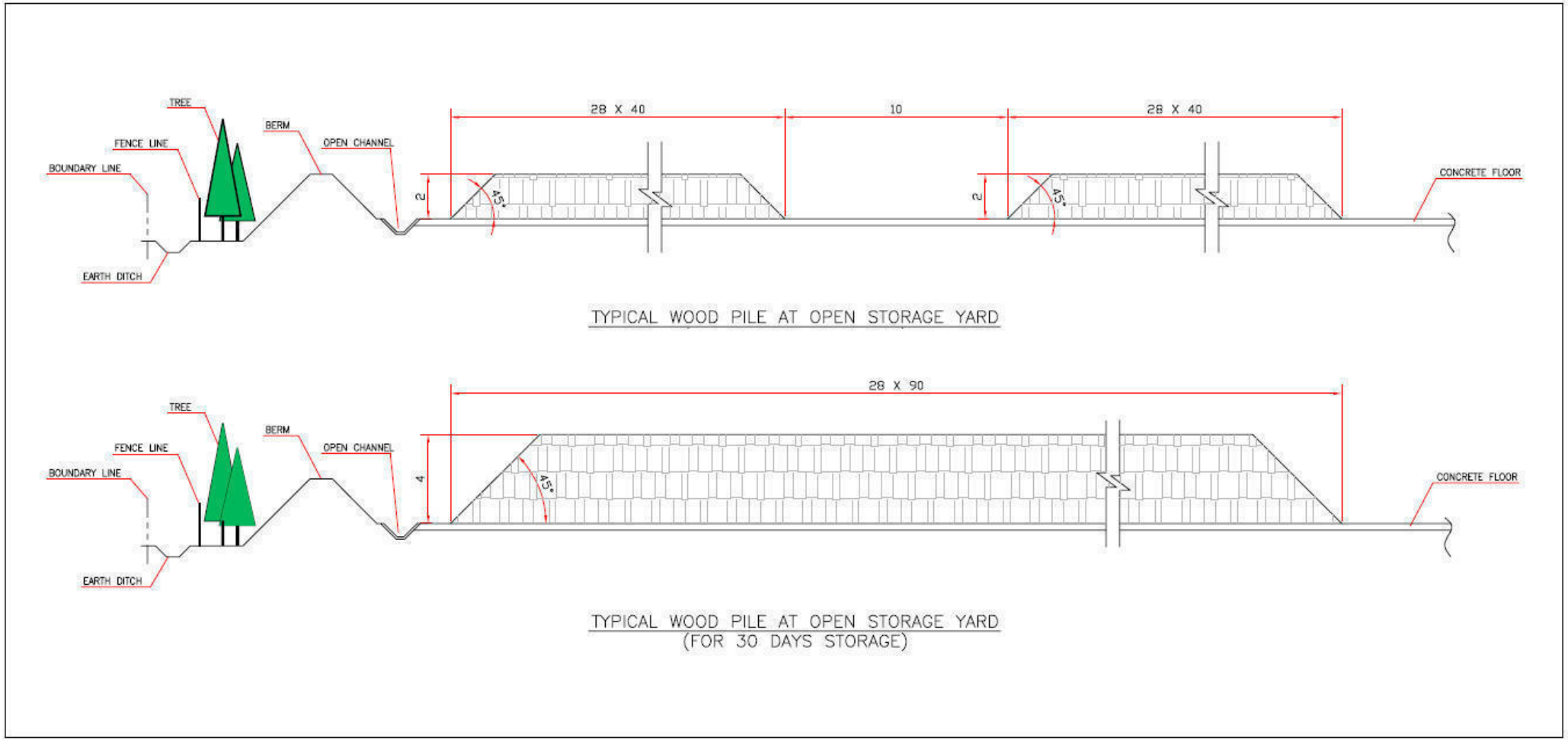
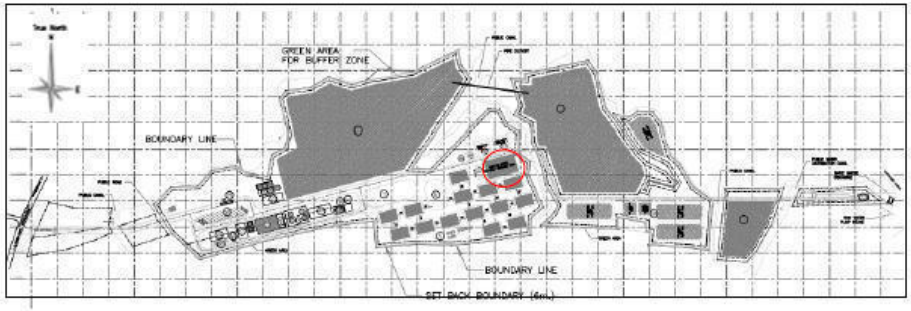
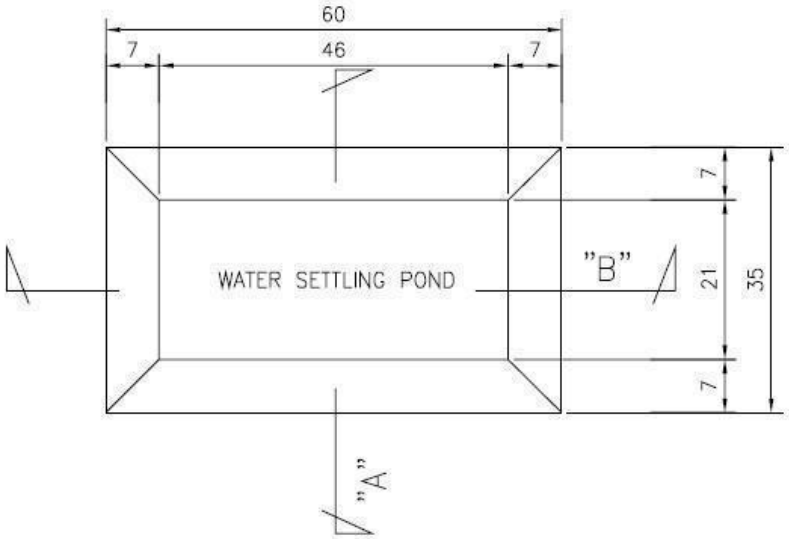


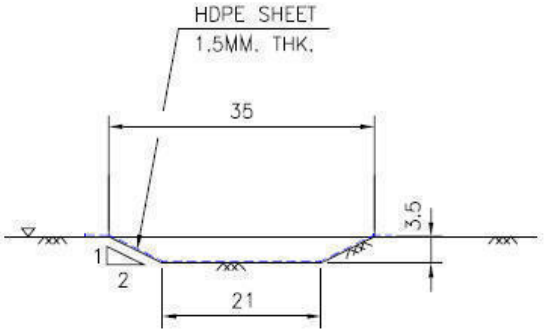
Figure 3.3.1-1 Fuel storage yard



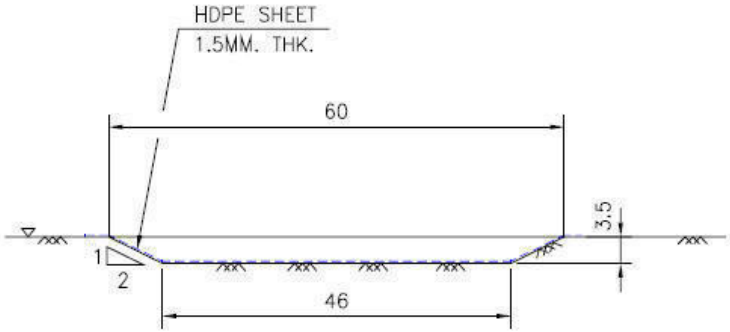


SETTLING POND AT WOOD STORAGE YARD DETAILS

MAXIMUM CAPACITY = ((A1 + A2) / 2) x H
= ((2,100 + 966) / 2) x 3.5
= 5,365.5 CU.M



SECTION "A"



SECTION "B"

รูปที่ 3.3.1-2 Cross Section of Setting Pond at Wood Storage Yard

2) Fuel preparation

These fuels typically have a moisture content of about 40-45 percent. Preparation Units fuel to bring wood into small pieces about 2 inches by using small wood chippers shred (Shredder) with a backlash over the hot sand. Then minced with Grinder in the building to be used as fuel in the combustion chamber. The excess will be stored in the fuel storage building. Circulate back to use as fuel in a combustion chamber, the following. In case of chipping unit maintenance or in an absence of rubber wood.

For fuel preparation, in the case of big rubber root, there is an additional process from the wood residue. The big root will first pass through pre-shredder to reduce the size. This machine has a capacity to shred of 34 tons/hour. The Project has two pre-shredders. After pre-shredded, they will be sent to two shredders with a capacity of 34 tons/hour each. The size of chips is approximately 2 inches prior sending to screening. The big chips will be sent back to the shredder. The shredders locate on area six as shown in number 6 of **Figure 3.2.1-1**.

3) Fuel storage building

The fuel storage building is located in the same area with fuel storage yard and using the same entrance and exit. It covers an area of approximately 7,000 square meters. It is a closed building with vents on all four sides as shown in **Figure 3.3.1-3**. The building is able to store 2,400 tons of fuel or fuel to be used for three days. The First in-First out approach will be used to manage the storage to prevent leftover of old fuel. Loader the main machine to be used in the building to push fuel to the conveyor and send fuel to the boiler building. The fuel pile is in a trapezoidal shape with space around for ease of care.

For cleaning of fuel storage building, the Project will assign workers to sweep the saw dust every day for at least 2 times/day. In order to prevent fire, the workers will check throughout 24 hours. In the case of fire, the Project will provide fire hose nozzles to spray water over the area and will use together with a fire truck.

(6) Preventive and mitigation measures for fuel preparation and storage

1) Noise management in fuel preparation process

The Project has designed the fuel preparation process to be located as far as possible from the school. Shredders were selected instead of choppers that generate loud noise. For pre-shredder, the Project designed a noise barrier to reduce noise level, not to over 85 dB(A) at distance of one meter from the barrier. Moreover, trees will be planted along the fence to become a noise barrier.

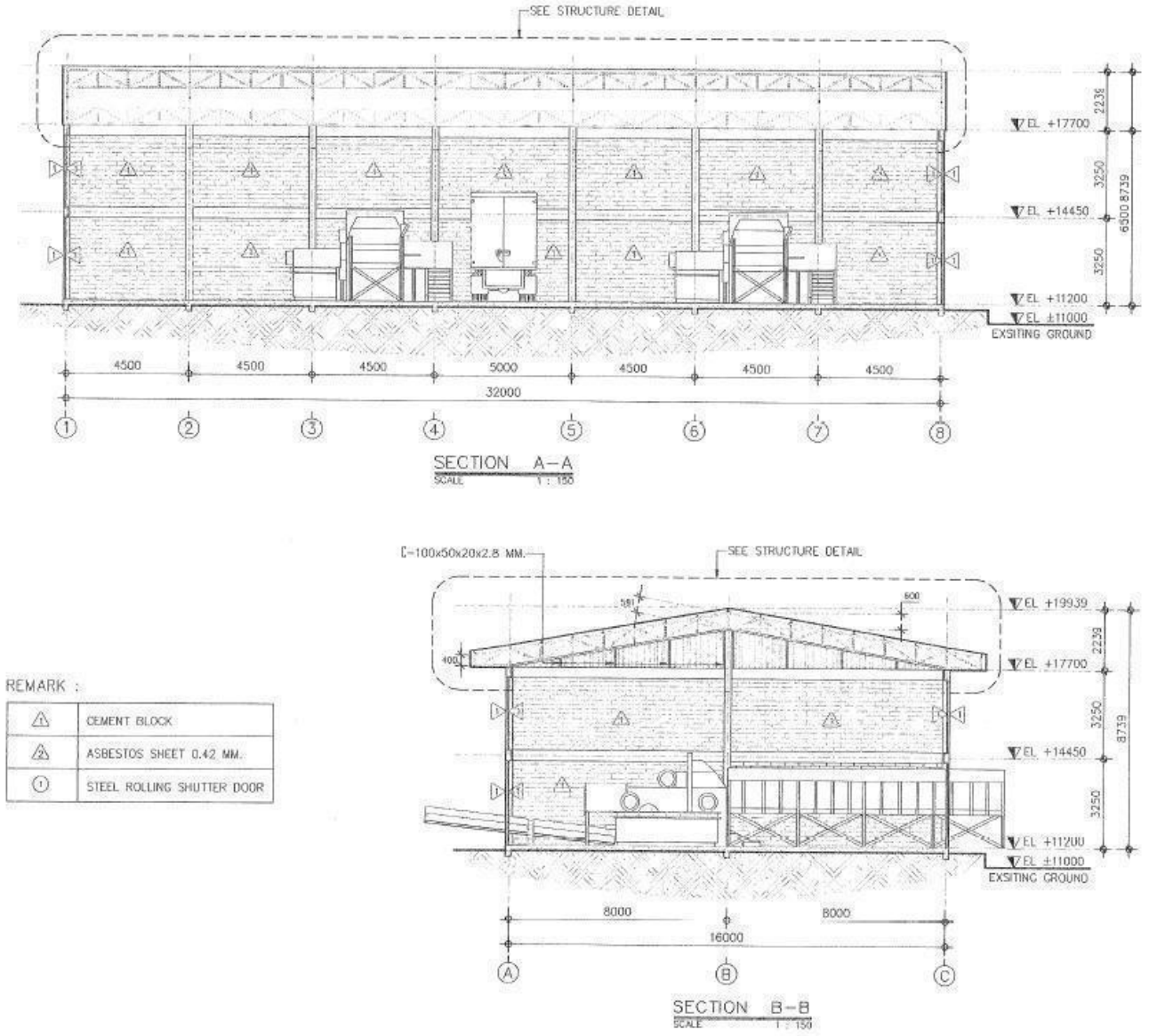


Figure 3.3.1-3 Fuel storage building

2) Dispersion of dust

The Project has a preventive and mitigation measure to reduce dust problems during fuel transport. All fuel trucks must prevent the fuel drop throughout the travel from source to the Project. After fuel dumped, the truck must be cleaned to prevent dispersion of dust and soil residue prior leaving the Project. These will be manipulated as a hire contract for every truck.

3) Odor prevention from fuel storage

Fuel storage yard is designed to equip with water drainage gutter to prevent accumulation of moisture. The floor is designed to have a slope to collect run off to the gutter surrounding of the yard.

The first in-first out approach will be used to manage the fuel. The fuel that comes first will be sent to the fuel preparation process first. This is to prevent biomass fuel degradation. The Project will also provide a buffer zone to prevent dust generated from transportation activity as well as odor to pose impacts on the surrounding communities.

(7) Heavy machinery used at the fuel yard

Machinery used at the fuel yard consists of two backhoes, a truck, and a tractor to push the fuel to the shredders.

3.3.2 Diesel

The project uses the diesel fuel to Emergency Diesel Generator, Wheel loader and truck within the project.

(1) Source and quantity

The diesel used in the Project will be supplied from local petrol company. It will be stored in a diesel storage tank with a capacity of 12,000 liter with 1 tank. The Project requires diesel to be used for the Emergency Diesel Generator, Wheel loader and truck only.

(2) Chemical compositions of diesel

The compositions of diesel which will be used by the Project has properties that comply with the Notification of the Department of Energy Business on Specification of diesel properties (No.6) B.E.2558 as shown in **Table 3.3.2-1**.

Table 3.3.2-1

Compositions of diesel

Parameter	Unit	Composition
Specific Gravity at 15.6/15.6	°C	0.92
Viscosity at 40 °C	*cSt*	8.0
Water and Sediment	*%vol.*	0.3
Ash	*%wt.*	0.02
Sulfur	*%wt.*	1.5
Flash Point	°C	52

(3) Diesel storage

The diesel storage tank has a capacity of 12,000 liter, the maximum of 10,800 liter of diesel will be stored. The amount of diesel to be stored in the Project is considered low. Thus, the Ministerial Regulation No.2 (B.E. 2535) issued under Factory Act B.E. 2535 Section 2 Article 6(7) will not be applicable. The regulation states that container of hazardous materials such as flammable, chemical or liquid that harmful to human, plant, property or the environment with a capacity of 25,000 liters or higher must be strong and coherent with the acceptable standard under the approval of a control a professional engineer. Furthermore, a concrete bund (i.e., 4 x 8 x 0.6 m) must be provided surrounding of the tank which able to receive the whole amount of the material. In case that the number of the container is more than one, the bun must be able to receive the amount of material stored in the biggest tank to prevent the spread of the material. In the case of emergency, material or chemical with suitable property to suppress or reduce the severity of the spread must be provided adequately. However, the project is designed to store and supply fuel **Figure 3.3.2-1**. All fuel, oil or chemical storage areas and other locations where there is a risk of spill or leak will be provided with secondary containment, drip trays or other overflow and drip containment measures in accordance with IFC EHS guidelines. Details will be included during the detailed design stage.

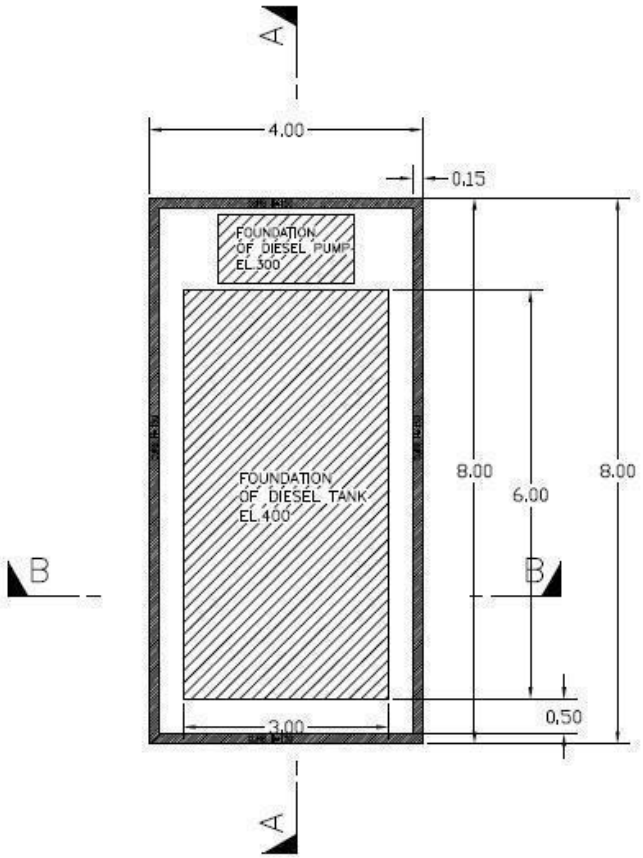
3.3.3 Chemical

(1) Type of chemical and management

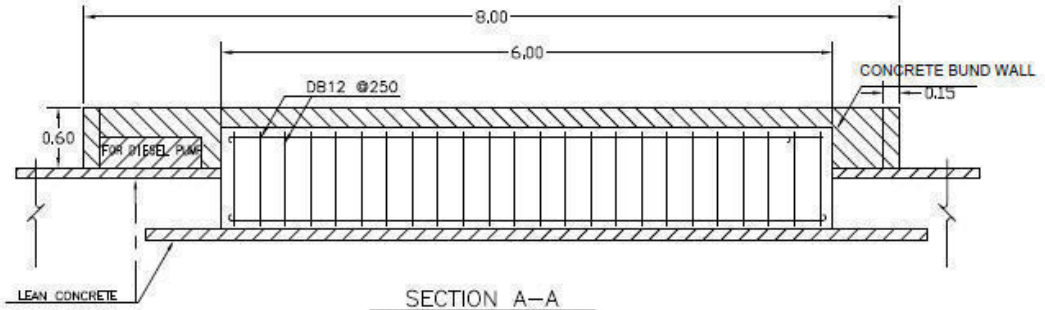
For the option of the Project to use chemicals was considered based on the purpose of use, quantity per product, quality, and harmfulness of the chemicals on the environment and health.

The Project requires chemicals to use in water treatment process, boiler, and cooling tower as shown in **Table 3.3.3-1**. Sources of the chemical are from local suppliers.

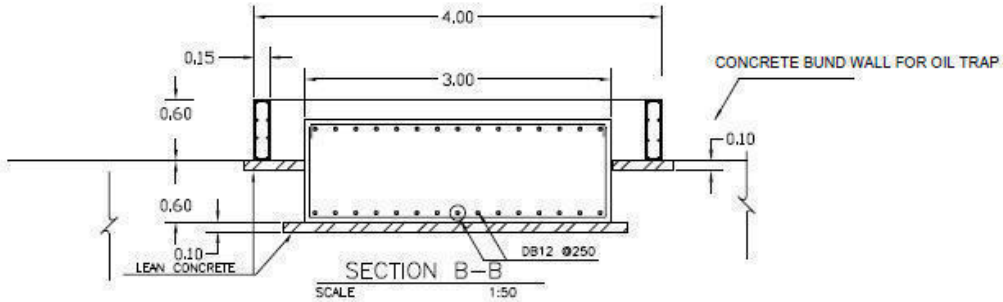
Properties of chemicals to be used in the Project are detailed in the safety data sheet (SDS) in **Appendix 3-4**.



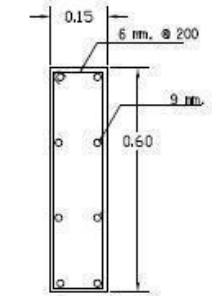
FOUNDATION : PUMP STATION
SCALE 1:75



SECTION A–A
SCALE 1:50



SECTION B–B
SCALE 1:50



DETAIL CONCRETE BUND WALL FOR OIL TRAP
SCALE 1:50

Figure 3.3.2-1 Cross Section for Diesel Tank

Rev.	Date	Description	Checked	Approved
		For Bidding		

Powered by Gulf Electric

Approved	R.Soonthorn	
Checked	R.Soonthorn	
Designed		
Drawn	T.Nuntavut	

Description
DETAIL FOUNDATION

Project. Installation Pump Station			
Scale 1:75	Sheet	Rev.	
Dwg. no. A-05	05-XX	00	
File Name 05-XX			

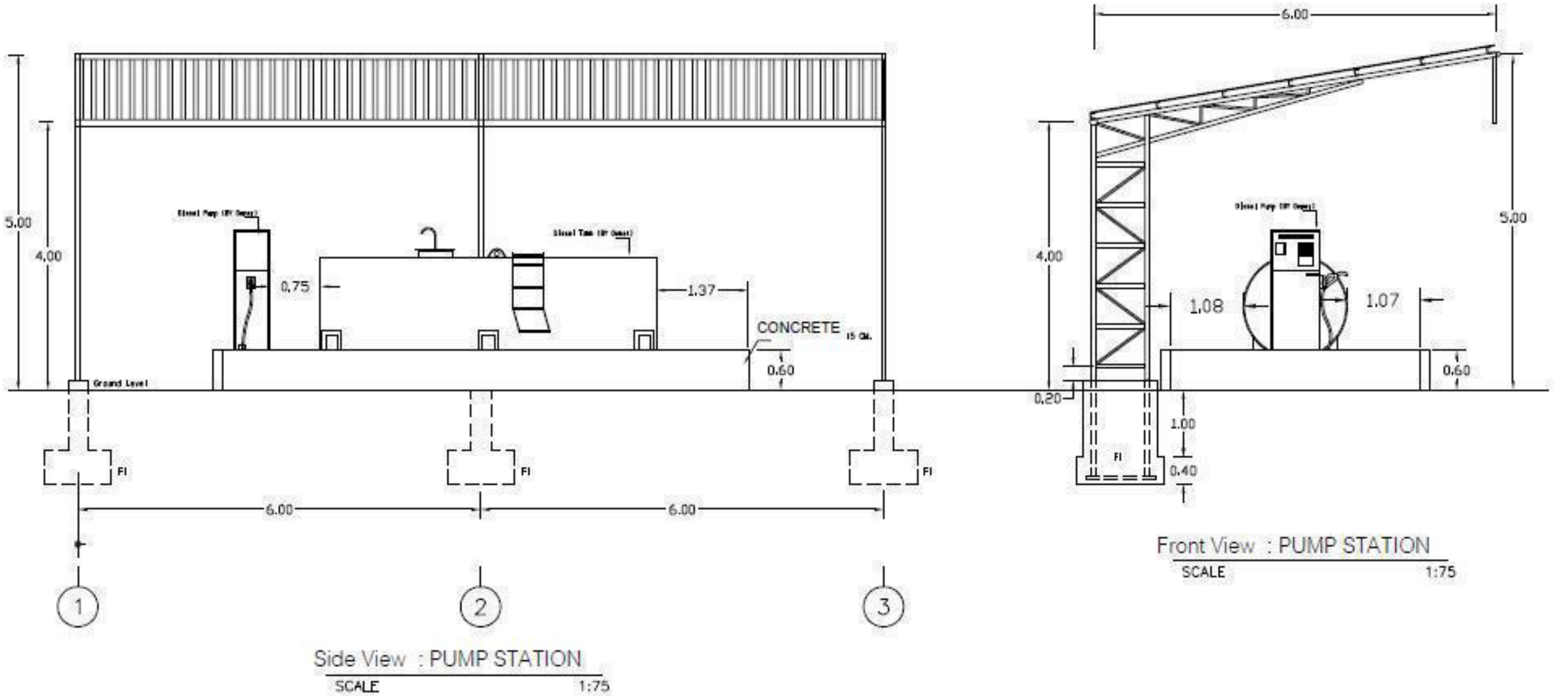


Figure 3.3.2-1 (Cont) Cross Section for Diesel Tank

Approved	Description	Project. Installation Pump Station
Checked	SECTION VIEW	Scale 1:75 Sheet Rev.

Table 3.3.3-1

Details of Chemical Uses

Chemicals	Source	Quatity (T/Y)	Storage Area	Usage
1. Foric Chloride	Domestic	175.25	Warehouse and Nearby Using Area	- Water Treatment Plant
2. Sodium hypochlorite (NaOCl)	Domestic	18.84		- Demineralized Water Plant
3. Lime	Domestic	42.73		- Water Treatment Plant
4. Polymer	Domestic	1.73		- Water Treatment Plant
5. Sulfuric acid		23.03		- Boiler Feed Water
6. Sodium hydroxide	Domestic	8.89		- Water Treatment Plant
7. RO Anti-scale	Domestic	0.89		- Water Treatment Plant

Source : Chana Green Company Limited, 2017

(2) Transport of chemicals

The Project will contact chemical supplier before transport to confirm date and time. This is to be prepared and reduce the risk of transportation vehicle to wait. The Project forecasted that the chemical transport is 2 times/month maximum. The chemicals will be stored in a chemical storage building with an area of approximately 24 square meters (3 meters width and 8 meters length).

(3) Management of chemical storage building

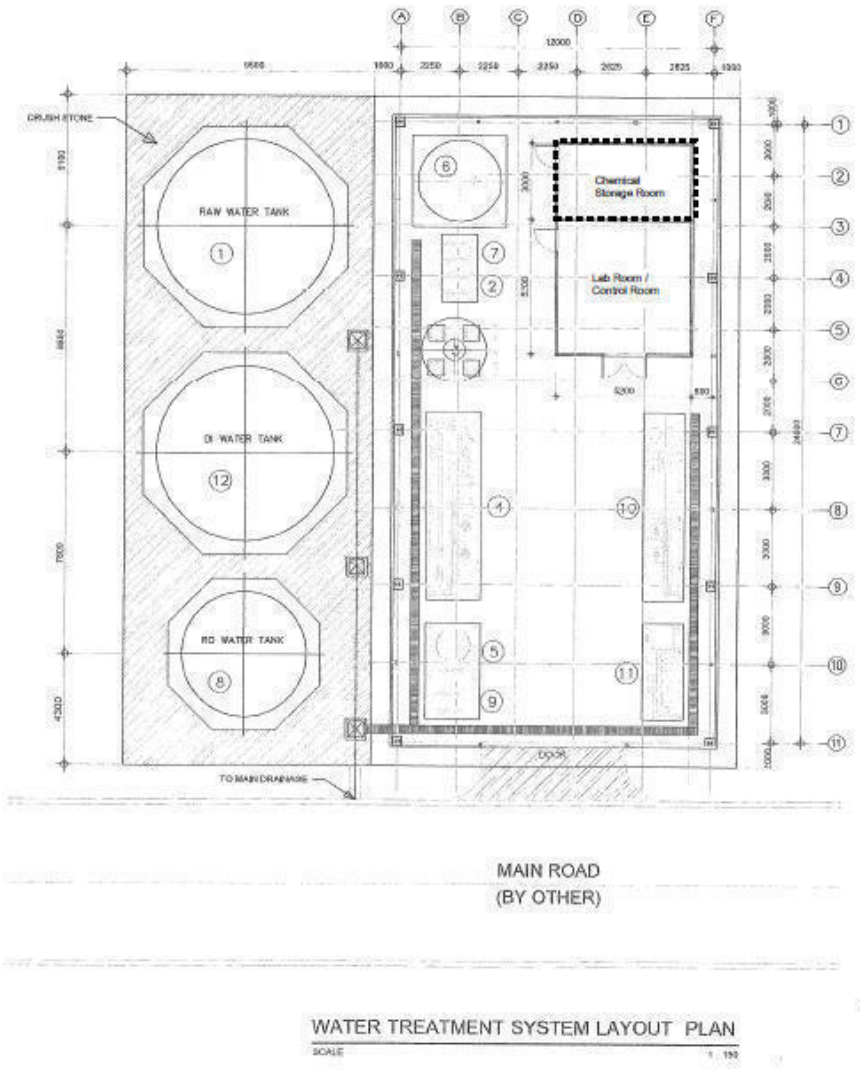
The chemical storage building will be equipped with a concrete gutter to receive leaked chemical to a sump prior sending to Neutralization pond. Chemicals used in the project are stored in a building storing chemicals. The storage of chemicals will continue to publish industrial activities, Subject Guide to maintain the chemicals and hazardous materials, B.E. 2550. For ventilation, the building is designed for ease of air flow in which comply with Ministerial Regulation issued under Building Act B.E.2522. Moreover, the Regulation of Labor Ministry on safety and environmental management of a confined space B.E. 2547 was applied. According to the regulation, the ventilation must be suitable, oxygen must not be less than 19.5 percent by volume. For fire system in the chemical storage building, (chemical storage building is shown in **Figure 3.3.3-1**), the Project will provide a fire extinguisher. This complies with the Notification of Ministry of Industry on fire prevention and suppression in factory B.E.2552. Moreover, the Project will construct a rainwater drainage gutter surrounding the building to collect rainwater from the roof of the chemical storage building. Principles of chemical storage are as follows:

1) Provide safety data of every chemical used in the Project at the chemical storage area as well as label on every chemical container

2) Chemicals that can be reacted with another will be stored separately such as acid-base or incompatible chemicals such as flammable chemical

(4) Management of used chemical container

Used chemical containers will be sent back to suppliers for repacking. For chemical storage bags, which is non reusable, it will be disposed of. The Project will collect the bags and send to waste disposer that is authorized by the Department of Industrial Works.



PLAN LAY OUT

ITEM	DESCRIPTION	QTY	DIMENSION
①	RO WATER TANK	1	ø6.80 x Ht. 6.00 (m.)
②	RAW WATER SUPPLY PUMP UNIT	1	-
③	MULTIMEDIA FILTER	1	ø2.50 x Ht. 2.08 (m.)
④	1ST PASS RO UNIT	1	W1.6 x L7.0 xH2.0 (m.)
⑤	CIP UNIT	1	W1.7 x L2.0 xH1.6 (m.)
⑥	RO REJECT WATER TANK	1	ø3.20 x Ht. 4.50 (m.)
⑦	MMF BACKWASH WATER PUMP UNIT	1	-
⑧	RO WATER TANK	1	ø4.80 x Ht. 6.00 (m.)
⑨	2ND PASS RO FEED PUMP UNIT	1	-
⑩	2ND PASS RO UNIT	1	W1.3 x L7.0 xH2.0 (m.)
⑪	EDI UNIT	1	W1.5 x L2.9 xH2.0 (m.)
⑫	DI WATER STORAGE TANK	1	ø6.80 x Ht. 6.00 (m.)

Figure 2.3.3-1 Chemicals Storage Area

(5) Leakage management

1) Small leakage (less than 5 liters)

(a) In the case of solid chemicals, clear the area by sweeping. For liquid chemical, use sand to absorb the chemical.

(b) Spread sand over the leakage to prevent spreading of the chemical.

(c) Collect the sand and put in a black bag, put a label on the bag prior prior to sending to a waste disposer that is authorized by the Department of Industrial Works.

(d) Wash the chemical contaminated area with clean water and collect the washed water to be disposed of by a waste disposer that is authorized by the Department of Industrial Works

(e) Monitor the containers for leak and also check if container is dilapidated which may cause leakage, if found, change the container or fix the container to normal conditions before using it again.

(f) Conduct a leak test before using again by filling water and retain for 30 minutes to check for leakage.

(g) Person assigned to manage the spill must wear personal protective equipment such as rubber gloves, safety glasses, and mask

2) Heavy leakage (over 5 liters)

(a) Prevent the leakage not to spread wider by providing a wall or other materials

(b) Scooping out or pump out the chemical into a prepared container to contained it.

(c) Spread sand over the leakage and collect the sand then put in a black bag, put a label on the bag prior sending to a waste disposer that is authorized by the Department of Industrial Works

(d) Wash the chemical contaminated area with clean water and collect the washed water to be disposed of by a waste disposer that is authorized by the Department of Industrial Works

(e) Monitor the containers for leak and dilapidated which may cause leakage, if found, change the container or fix the container to normal conditions before using again

(f) Conduct a leak test before using again by filling water and retain for 30 minutes to check for leakage

(g) In case a leak found, fix the leak and follow (f) again

(h) After tested, clean the container and close before use

(i) The leaked chemical can be kept unchanged by scooping, for the leaked chemical that sand was used, put in a black bag.

3.4 Product

According to the design, the Project has a total capacity of 25 MW. Data of power generation and steam production of the Project by mode of operation can be described as follows.

(1) High production (100%), 24 MW, the Project will send 20.622 MW to the grid of Electricity Generating Authority of Thailand and about 2.4 MW will be used internally

(2) Moderate production (65%), 15.6 MW, the Project will send 13.2 MW to the grid of Electricity Generating Authority of Thailand and about 2.4 MW will be used internally

(3) Low production (30%), 7.2 MW, the Project will send 4.8 MW to the grid of Electricity Generating Authority of Thailand and about 2.4 MW will be used internally

3.5 Production process

3.5.1 Technology and technical process

The Project's boiler has a capacity of 98 tons/hour. It is a moving grate stoker system type (cross-sectional drawing of the boiler and air pollution treatment system of the Project is shown in **Figure 3.5.1-1**). The process diagram of the Project is illustrated in **Figure 3.5.1-2**. The design criteria of the main machinery are summarized in **Table 3.5.1-1**.

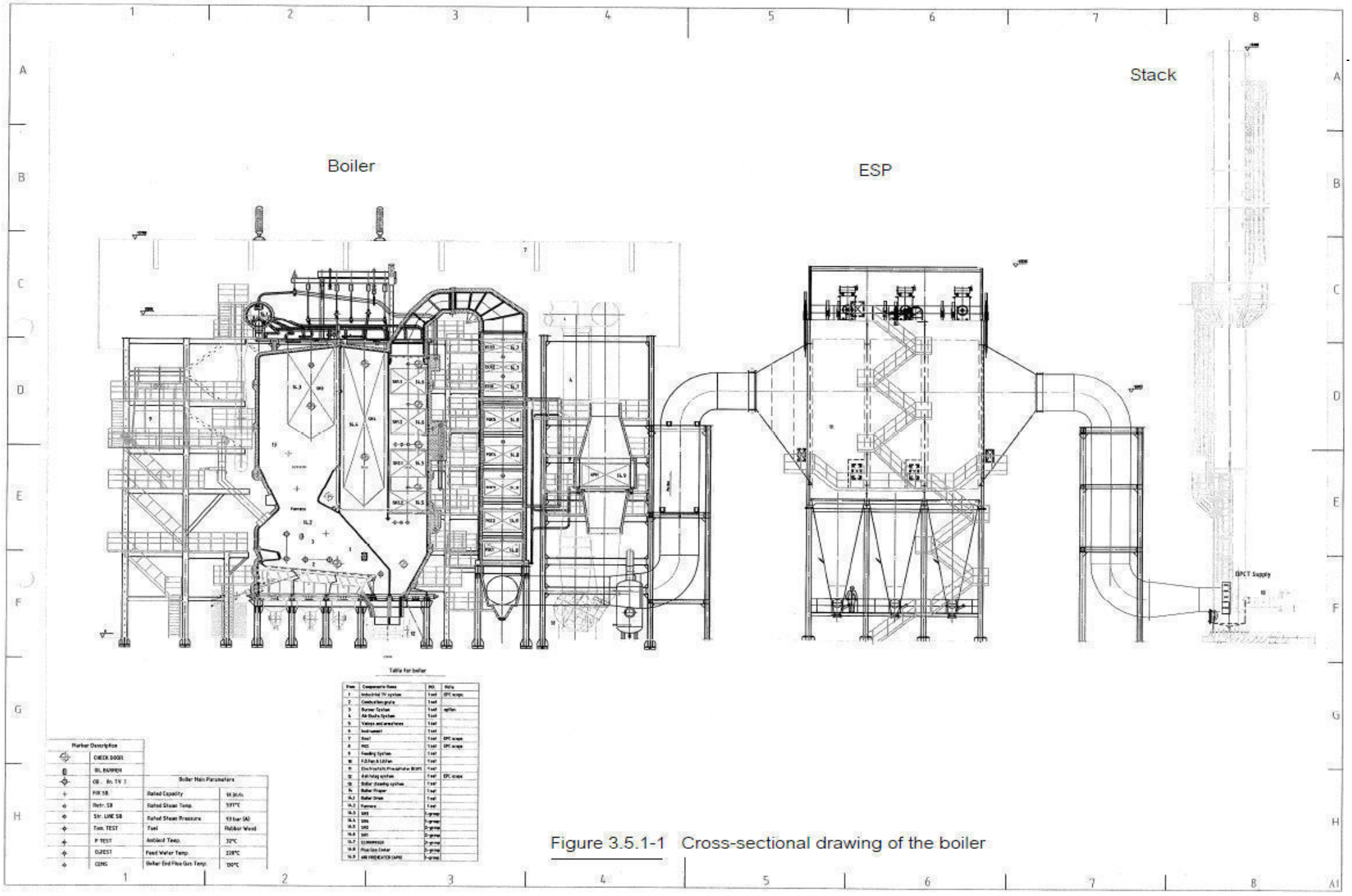


Figure 3.5.1-1 Cross-sectional drawing of the boiler

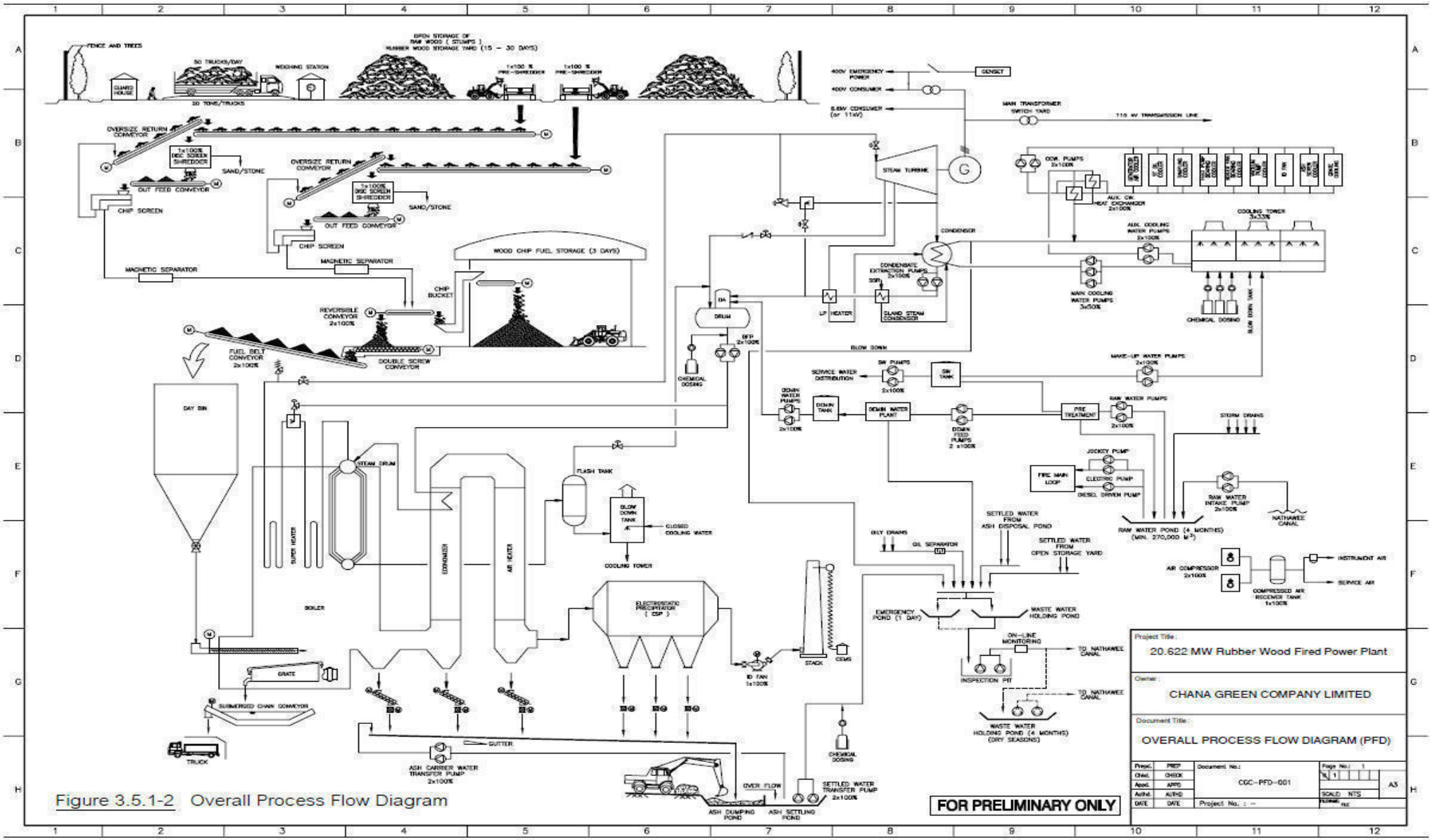


Figure 3.5.1-2 Overall Process Flow Diagram

Table 3.5.1-1

Important design criteria

Criteria	Value
Plant Performance	
Gross Plant Efficiency (%)	27.0
Net Plant Efficiency (%)	22.35
Boiler	
Maximum Continuous Rating (ton/hr)	98
Operating Live Steam Flow rate (ton/hr)	97.8
Operating Live Steam Temperature (^{o}C)	507
Operating Live Steam Pressure (Bar(a))	67
Steam Turbine Generator	
Type	Turbogeneration
Rated Steam Pressure (Bar(a))	65
Rated Steam Temperature (^{o}C)	505
Criteria	**Value**
Electricity	
Gross Output (kW)	24,915
Electricity export (kW)	20,622
Plant self-consumption (kW)	4,293
Transformer	
Step-up Generator Transformer capacity 6.6 /115 kV	1 set
Step-down Generator Transformer capacity 115 kV /400 V	1 set
Cooling Tower	
Return cooling water temperature (^{o}C)	43
Return cooling water flow rate (ton/hr)	4,167
Forward cooling water temperature (^{o}C)	34
Forward cooling water flow rate (ton/hr)	4,167

Source: Chana Green Company Limited, 2016

3.5.2 Production pattern of the Project

The Project's power generation was design to use the co-generation system by using a steam turbine. The principle of the steam turbine is the expansion of steam at high pressure and temperature through a steam turbine this axis that connects the turbine to a power generator. The extraction condensing steam turbine has been selected to be used in the Project.

Heat balance by mode of operation of the Project is shown in **Figure 3.5.2-1**.

3.5.3 Steps of production

Simplify diagram of power and steam production of the Project (**Figure 3.5.3-1**) can be described by step by step as follows:

(1) Fuel distribution to the boiler combustion chamber

After passing through the strainer, the fuel will be sent through a closed conveyor to a tank for one day (**Figure 3.5.1-2**) prior feeding to the Project's boiler. In case that the shredder is on maintenance or lack of fuel, the fuel from the fuel storage building will be used. There is a loader that will push the fuel to the closed conveyor. The conveyor has a capacity of 34 tons/hour. It will directly feed the fuel to the boiler. The stored fuel in the building can be used continuously for three days. Nevertheless, the fuel feeding to the boiler's combustion chamber will be done automatically by distributed control system from the control room.

The fuel distribution diagram is shown in **Figure 3.5.3-2**.

(2) Production of steam

1) Startup

The start-up begins by igniting the burner of the combustion chamber. Later, switch on the blower to blow the air to the chamber follows by a switch on the ventilator. After that, feed the fuel that mixed with diesel to the chamber. This is to accelerate and have a faster combustion of the fuel.

In order to control the quality of the fuel, the main factor affecting the complete combustion efficiency is moisture. Normally, the fuel storage area and feeding area are under roofs. Thus, in the case of rain, there is no impact on the fuel's moisture. Moreover, the first in-first out approach will be used to manage the fuel stock. Therefore, the Project will able to control the fuel quality to the control level and will not have an impact on air emission from the boiler.

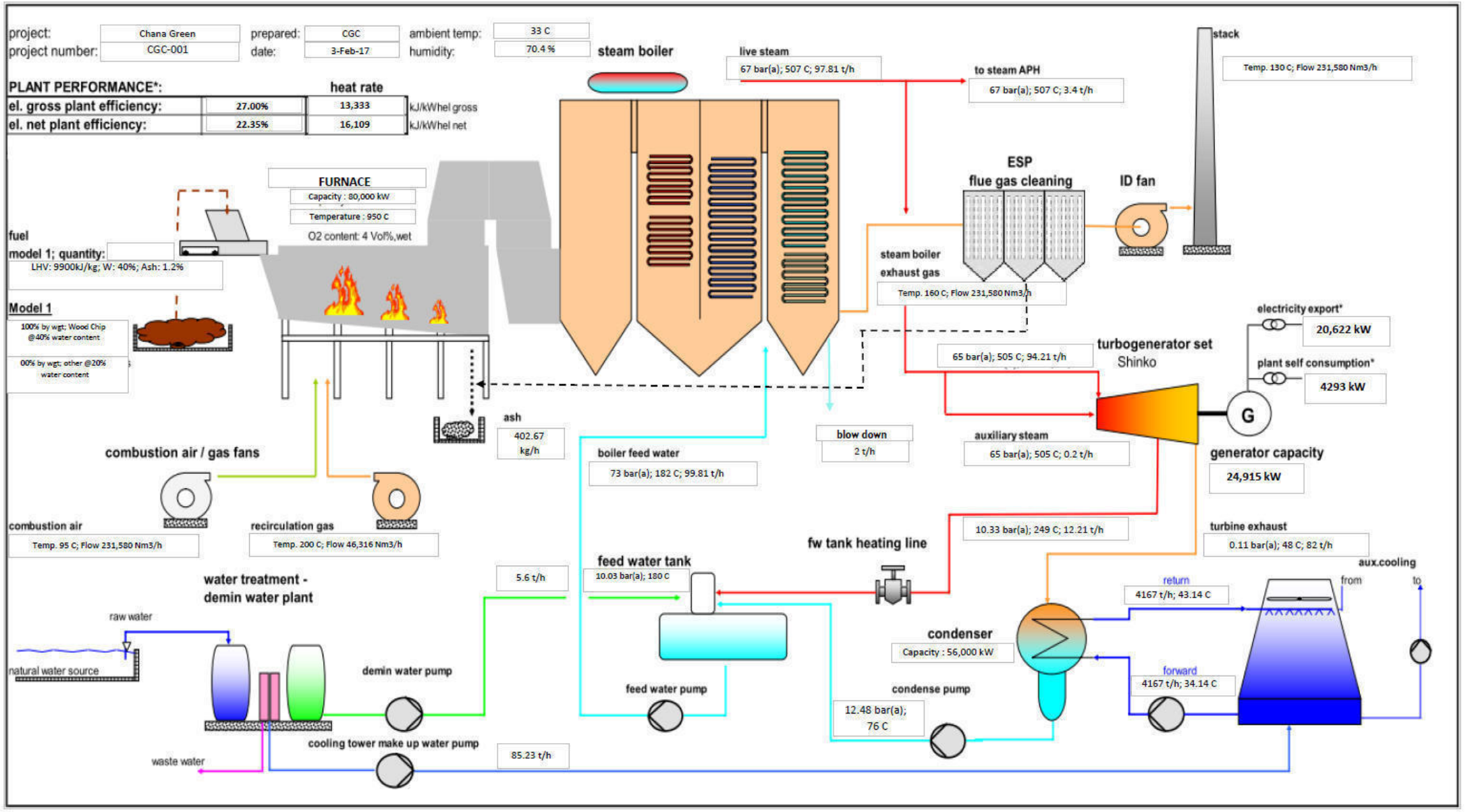


Figure 3.5.2-1 Heat Balance (High production (100%))

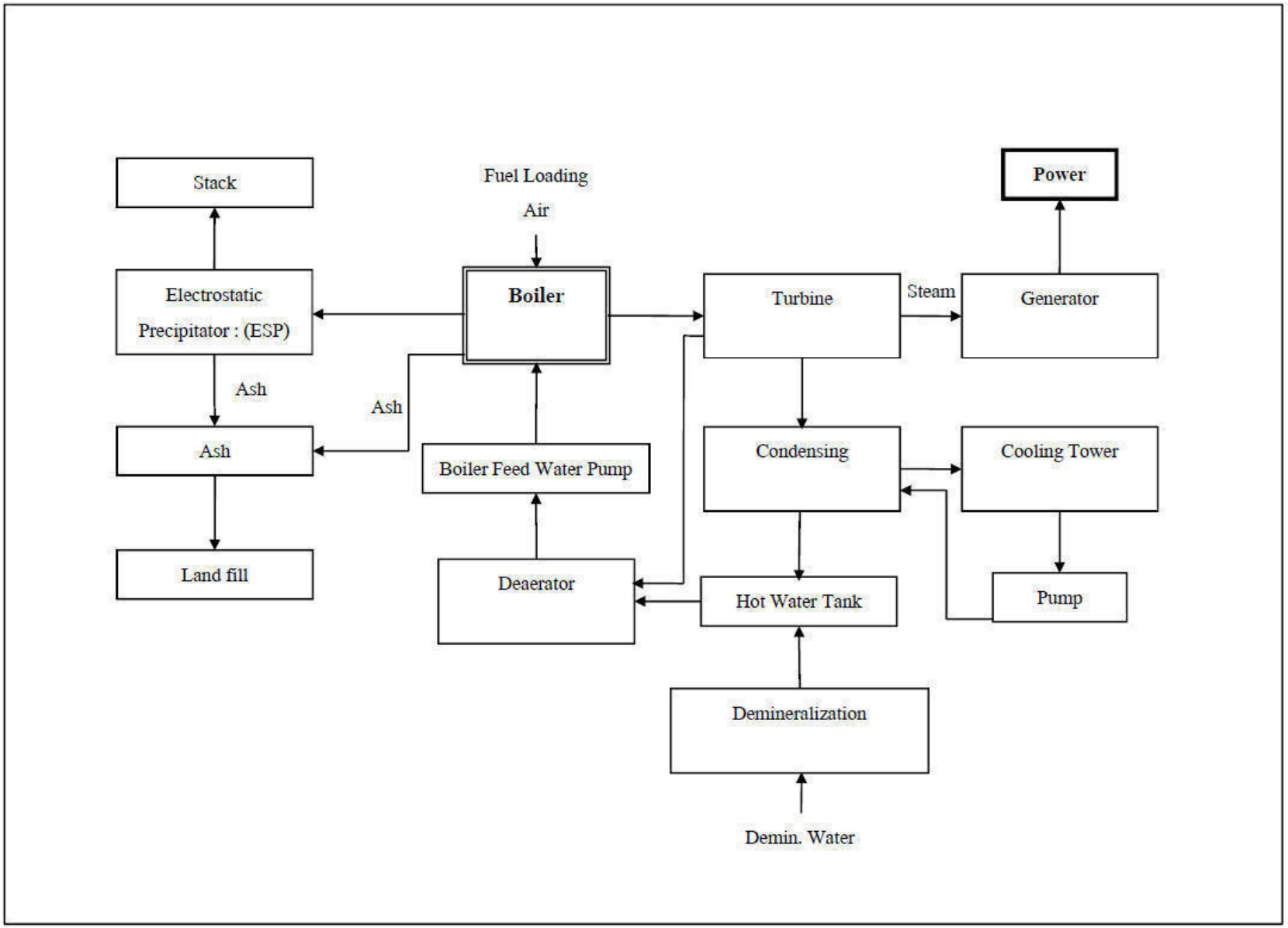


Figure 3.5.3-1 Simplify diagram of power and steam production

S.NO	DESCRIPTION	CAPACITY	TAG	QTY
12	BELT CONVEYOR 800 B/W LINE 1 (Woodchip) L89 M.	25 TPH	BC-3 L- 2	1
11	BELT CONVEYOR 800 B/W LINE 1 (Woodchip) L89 M.	25 TPH	BC-3 L- 1	1
10	MOVING FLOOR LINE 2	25 TPH	MVF-2	1
9	MOVING FLOOR LINE 1	25 TPH	MVF-1	1
8	DOUBLE SCREW CONVEYOR (Woodchip) L10.0M.	25 TPH	SC-2	1
7	DOUBLE SCREW CONVEYOR (Woodchip) L10.0M.	25 TPH	SC-1	1
6	BELT CONVEYOR TIPPER 800 B/W. (Woodchip) L 54.0 M.	25 TPH	BCTP-2	1
5	BELT CONVEYOR TIPPER 800 B/W. (Woodchip) L54.00 M.	25 TPH	BCTP-1	1
4	BELT CONVEYOR 800 B/W LINE 1 (Woodchip) L9.3 M.	25 TPH	BC-2 L- 2	1
3	BELT CONVEYOR 800 B/W LINE 1 (Woodchip) L9.3 M.	25 TPH	BC-2 L- 1	1
2	BELT CONVEYOR 800 B/W LINE 2 (Woodchip) L40.7 M.	25 TPH	BC-1 L- 2	1
1	BELT CONVEYOR 800 B/W LINE 1 (Woodchip) L40.7 M.	25 TPH	BC-1 L- 1	1

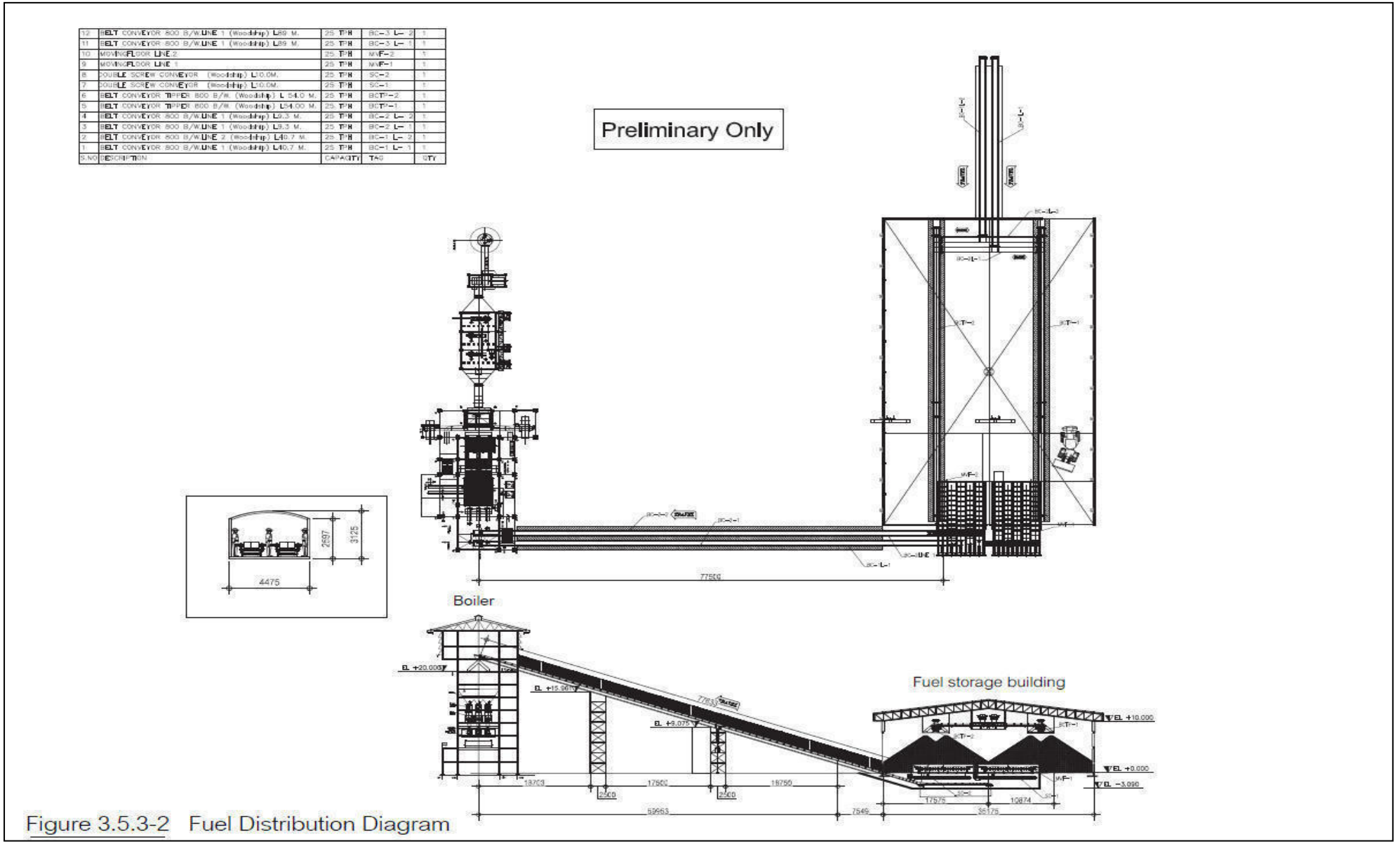


Figure 3.5.3-2 Fuel Distribution Diagram

2) Combustion system in the combustion chamber

Equipment in the moving grate stoker combustion system is a steel grate that is made to have many holes for the air to flow through the rubber wood. The rubber wood that will be fed by the air will flow into the combustion chamber during the combustion. The combustion will last until complete combustion and the residue will fall on the grate. Water will be used for cooling.

Nevertheless, temperature and excess air in the combustion chamber will be controlled as designed. During combustion, air will be blown into the chamber through the compressed air channel at the bottom by using a force draft fan. The fan will suck the air from outside and blow through the air preheater that is installed in the off-gas channel to heat up the air. The heated air will be compressed through the compressed air channel. The air volume will be more than the requirement. Besides using for the combustion, the air is also used to cool down the grate to prevent melting. Moreover, the air will be heated up at the same time which will be resulting in combustion efficiency. This air is called “primary air”. Another part of air called “secondary air”, or over fire air that blows through secondary forced draft fan to the combustion chamber. This is to increase the excess air to burn the organic residue in the grate. Carbon dioxide generated from incomplete combustion of volatile matter and fixed carbon will also be burned. These will incur complete combustion during flowing up high again in the combustion chamber.

Ash generated from the combustion that is left on the moving grate stoker will be washed out by steam jet onto the conveyor at front of the chamber. It is a conveyor that soaks in a closed water basin. This is to prevent cold air from getting in the chamber. When the ash called bottom ash is sunk in the water, it will be distributed out by a conveyor. This bottom is including of heavy smoky. For light weight ash, after combusted, it will be mixed in the off gas and flowed out of the chamber through off gas channel. It is called “fly ash”. The fly ash will be trapped by the air pollution treatment system prior discharging to the atmosphere.

All the ash will be discharged to the ash dumping pond through wet ash conveying system as shown in **Figure 3.5.3-3** and **Figure 3.5.3-4**. There are two ponds with a capacity of 23 cubic meters each. At the ponds, there is a bund and a pump to pump out the water that is separated from the ash back to the wet ash conveying system. The proposed ash pond is about 350 m from the canal. The company will follow the Thailand PCD regulation (http://infofile.pcd.go.th/waste/waste_sanitaryLandfill.pdf) that requires 100 m from surface water and 1.5 mm thick HDPE. The Plant will be having ground monitoring well to monitor any leakage. It will also provide a spare empty disposal pond which will be available all the time. If any leakage occur the ash pond, it will be removed and transferred to the spare disposal pond and the leakage will be fixed accordingly.

The wood burned ash is one kind of for Non-hazardous effluence from burning process not like MSW or industrial waste then we not need to control like IFC EHS Waste Management Facilities for Infrastructure business.

3) Steam production system

The Project's boiler is a water tube boiler. Based on the principle of heat exchange between the water in the tube and hot gas from the combustion in another tube. The steam production begins with the feeding of water through deaerator to the boiler. The boiler feed water pump will pump water to economizer for preheating prior sending to steam drum. Water will be

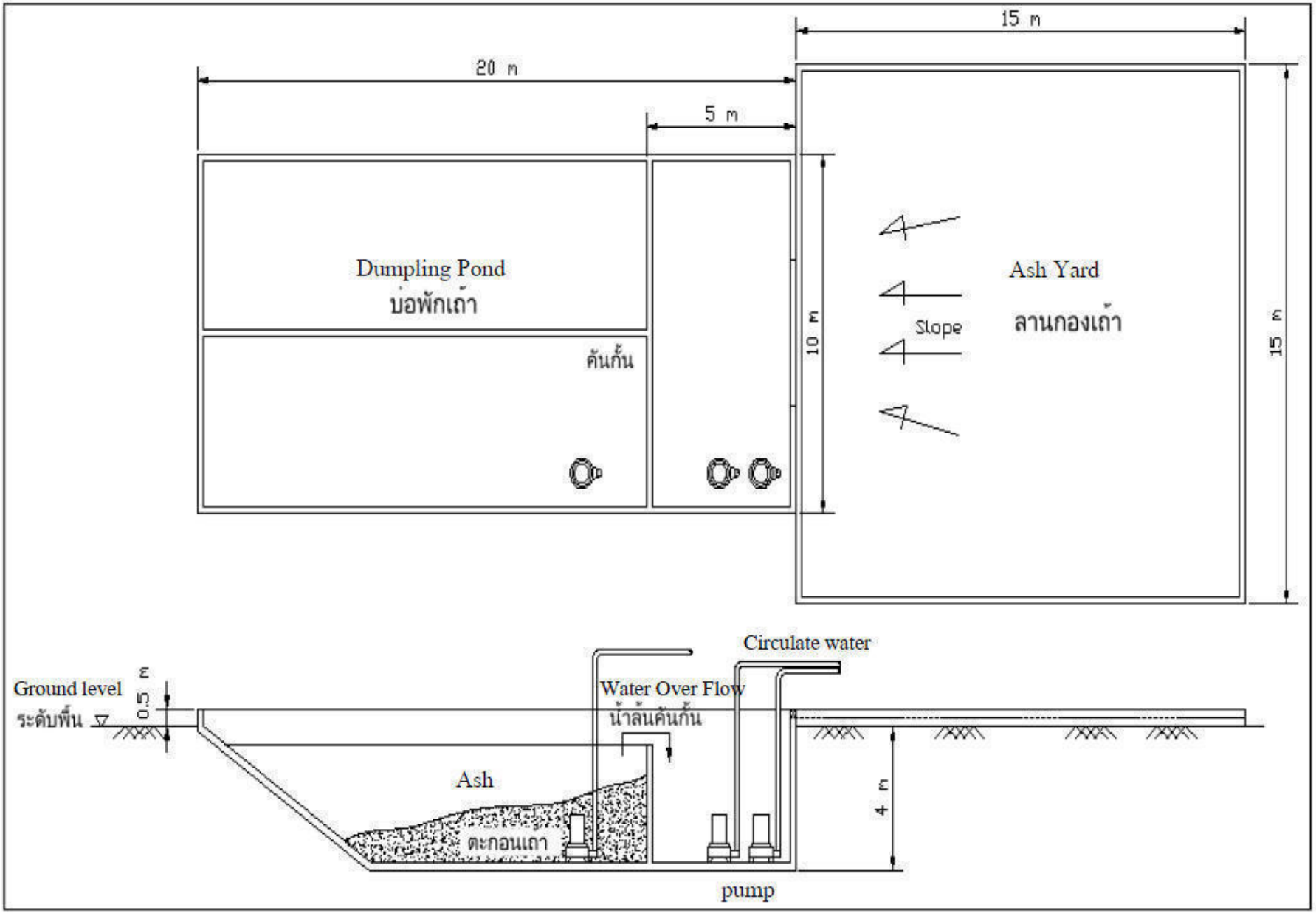


Figure 3.5.3-3 Cross-section of Ash Dumpling Pond

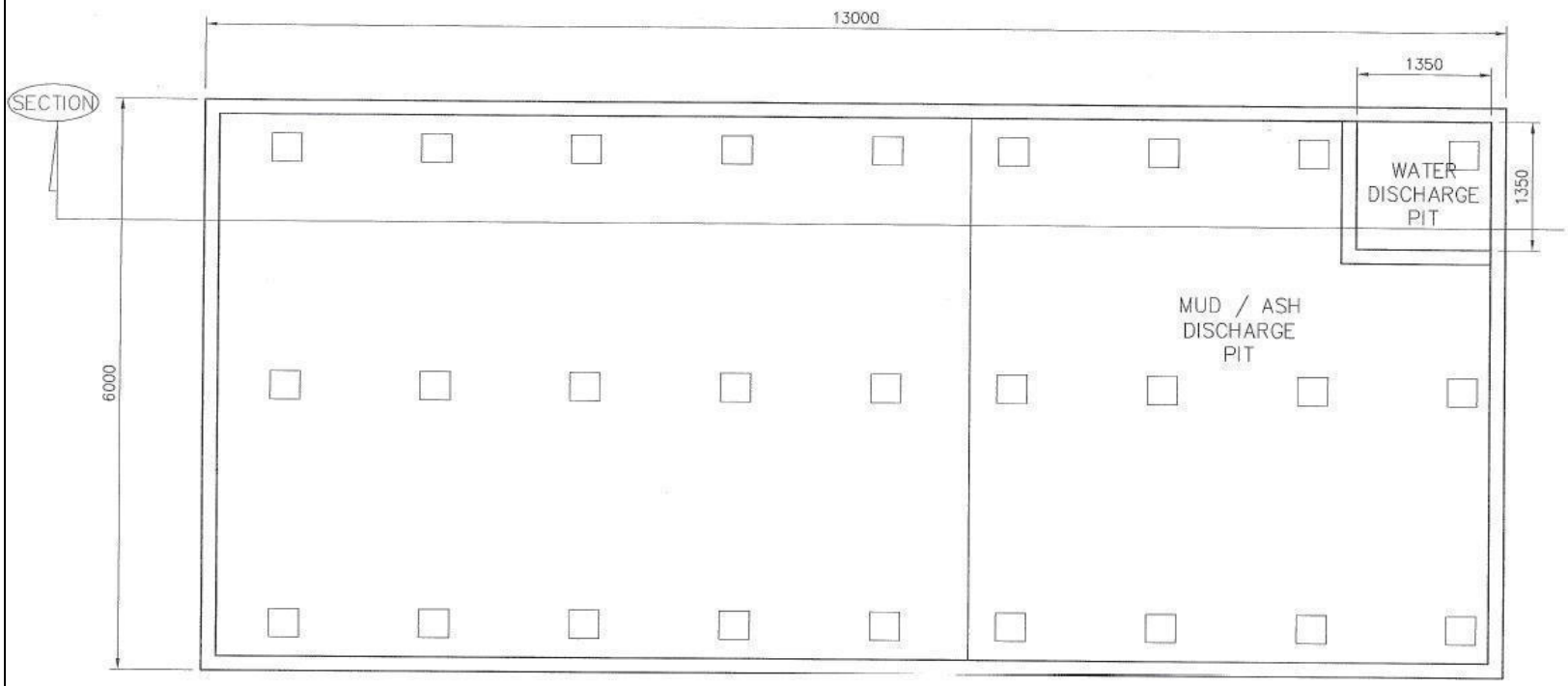
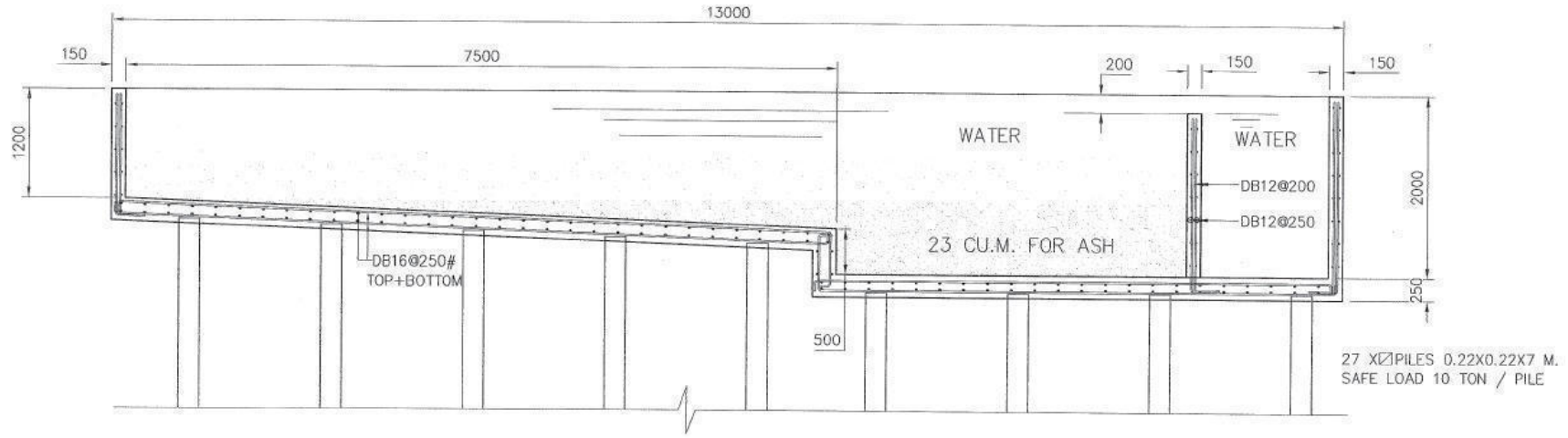


Figure 3.5.3-4 Cross-section of Ash Dumpling



separated out from saturated steam at the steam drum. Water will be sent to pipe wall for heat exchanging with the hot gas from the combustion. Water will be turned to saturated steam before sending back to the steam drum. Later, saturated steam will be sent through vapor separator in the drum prior sending to super heater. After that, saturated steam will be converted to superheat steam to be used as high-pressure steam.

In the case of running at the full capacity, the boiler will generate steam and send to the steam turbine that has an axis which connects to a power generator.

(4) Power generation

Superheated steam that generated from the boiler will be sent to the condensing steam turbine through a control valve to control the steam volume. When the steam passes through the turbine, it will spin the 25 MW power generator.

(5) Cooling system and condensing

The steam that passed through the steam turbine will be sent to a condenser for heat exchanging by using the cooling tower. Condensate will be generated and it will be sent back to the boiler. The cooling water will exchange the heat at the condenser.

The Project's three units of the cooling system are counter flow type. The total maximum water requirement is approximately 4,500 tons/hour.

(6) Linkage and transmission

The pressure of the power generated from the generator will be increased by a step-up transformer (11 KV/115 KV) which is cooled by oil prior sending to the grid of Electricity Generating Authority of Thailand.

3.5.4 Operation by mode of production

The Project's operation can be described as follows:

(1) Start up phase: The Project will ignite the burner and pre-heat the combustion chamber by using biomass fuel that mixed with diesel until ignited. Later, increase the ratio of the biomass fuel up to 100% and blow excess air to the chamber at the same time. This operation will help to prevent incomplete combustion of the fuel because there is a fuel feeding system that able to spread the fuel all over the chamber together with excess air. This will lead to complete combustion.

(2) Non-production phase: The Project will reduce the production capacity together with reducing the fuel feeding to the chamber until the fuel that left in the chamber is combusted and the combustion stops itself. Every fan will still be run until the fuel is fully combusted. This operation will help to prevent incomplete combustion because the combustion chamber will not be suddenly stopped when there is fuel left in the chamber.

(3) The case of malfunction/abnormality can occur in two cases as follows:

Case 1: Turbine trip In this case, the Project will immediately use the electricity from the Electricity Generating Authority of Thailand. The air pollutants will remain in the system. After receiving power from the grid, the system will capable to treat the pollutants that left in the system.

Case 2: Failure of dust trapping equipment In the case of failure of the equipment and resulting in higher value than the control level, the Project will stop the power production and fix immediately to bring the situation back to normal. Moreover, the Project provides a preventive maintenance plan to prevent such problems. Furthermore, the Project provides important spare parts of the dust trapping system in order to get it fixed quickly.

3.6 Infrastructure and utility

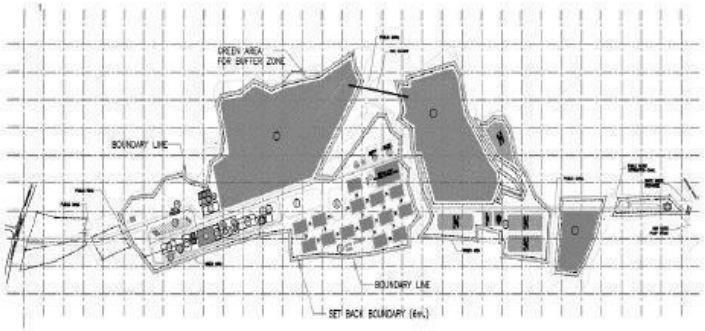
3.6.1 Water

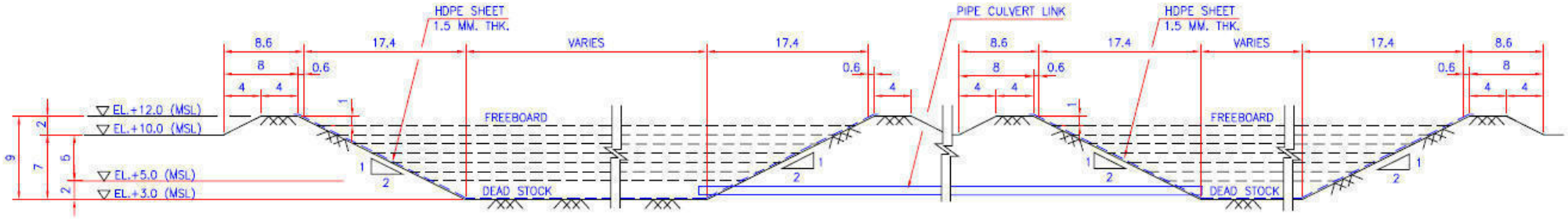
(1) Water source

There are two main water sources as follows:

1) Rainwater in the reservoir with the quantity of approximately 29,226.6 cubic meters/year. The Project has a water reservoir with a capacity of approximately 370,000 cubic meters. Cross-sectional drawing of the water reservoir is illustrated in **Figure 3.6.1-1**.

2) Water from Nathawee canal, the water will be stored in the raw water reservoir (370,000 cubic meters). The permit is shown in **Appendix 3-5**. Cross-sectional of Nathawee canal and water pumping level of 0.15 meter from the bottom of the canal is shown in **Figure 3.6.1-2**.





LEVEL	DESCRIPTION	ELEVATION FROM M.S.L. (M)	BOTTOM AREA (SQ.M)	TOP AREA (SQ.M)	TOTAL STORAGE VOLUME (CU.M)	EFFECTIVE STORAGE VOLUME EXCLUDING DEAD STOCK (CU.M)
1	VOLUME AT HEIGHT	EL.+5.0	47,614.1	53,661.4	101,275 (DEAD STOCK)	0
2	VOLUME AT HEIGHT	EL.+6.0	47,614.1	56,779.4	156,590	55,315
3	VOLUME AT HEIGHT	EL.+7.0	47,614.1	59,960.5	215,149	113,874
4	VOLUME AT HEIGHT	EL.+8.0	47,614.1	63,206.1	277,050	175,775
5	VOLUME AT HEIGHT	EL.+9.0	47,614.1	66,516.7	342,392	241,117
6	VOLUME AT HEIGHT	EL.+10.0	47,614.1	69,891.6	411,270	309,994
7	VOLUME AT HEIGHT	EL.+11.0	47,614.1	73,330.1	471,275	370,000

RAW WATER POND DETAILS

Figure 3.6.1-1 Cross-section of Raw Water Pond

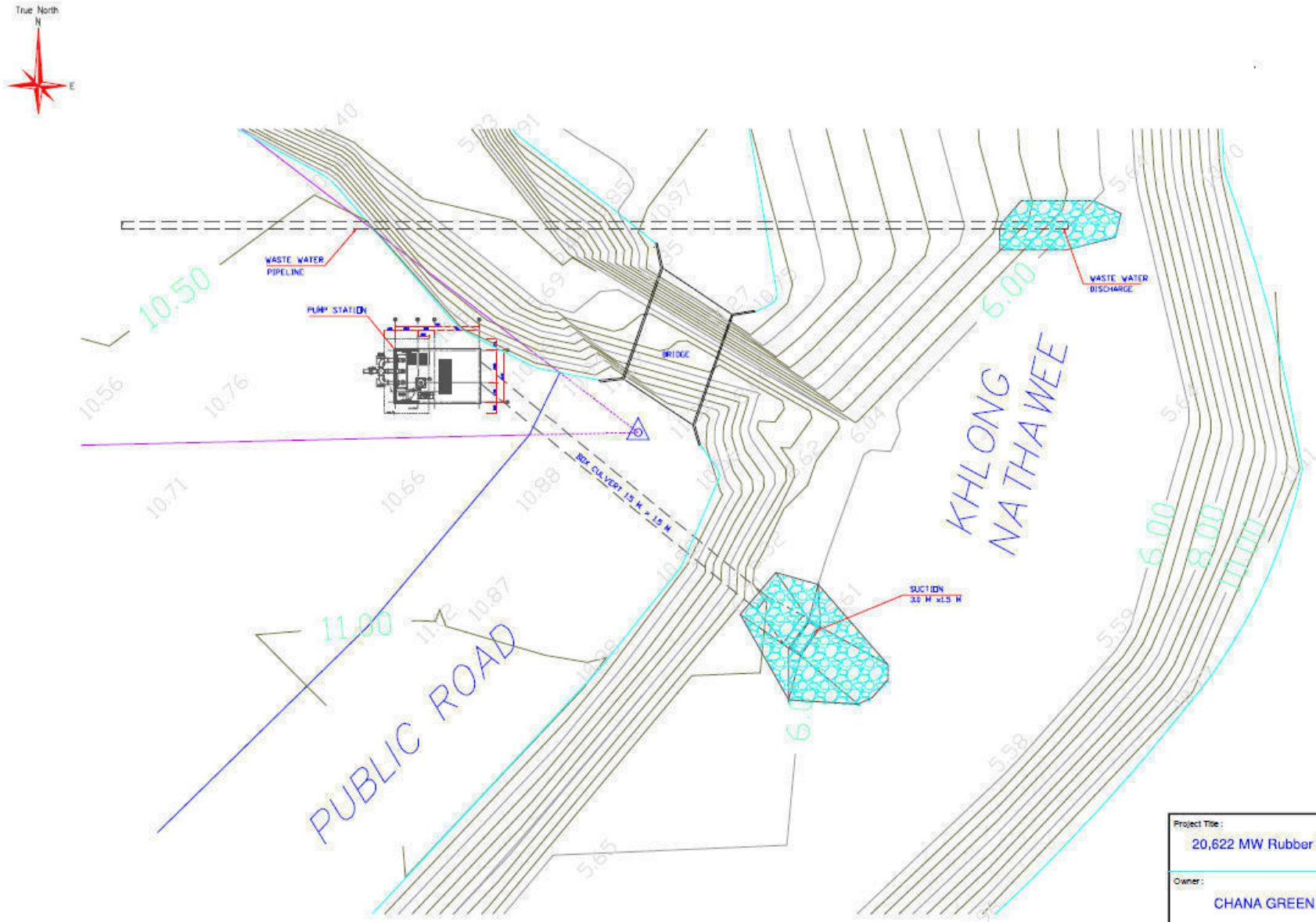


Figure 3.6.1-2 Cross-sectional of Nathawee canal and water pumping level

Project Title :
20,622 MW Rubber Wood Fired Power Plant

Owner :
CHANA GREEN COMPANY LIMITED

Document Title :
PUMP STATIOIN

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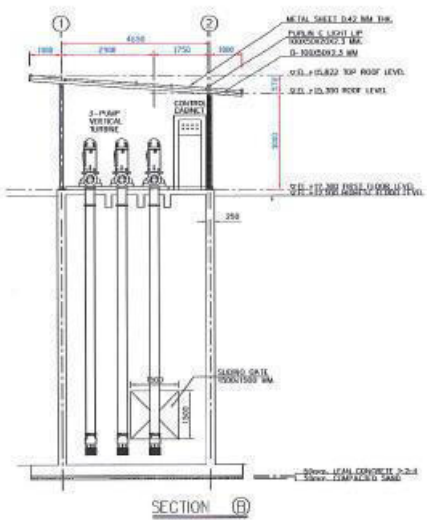

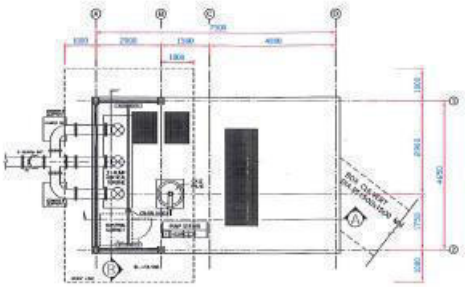

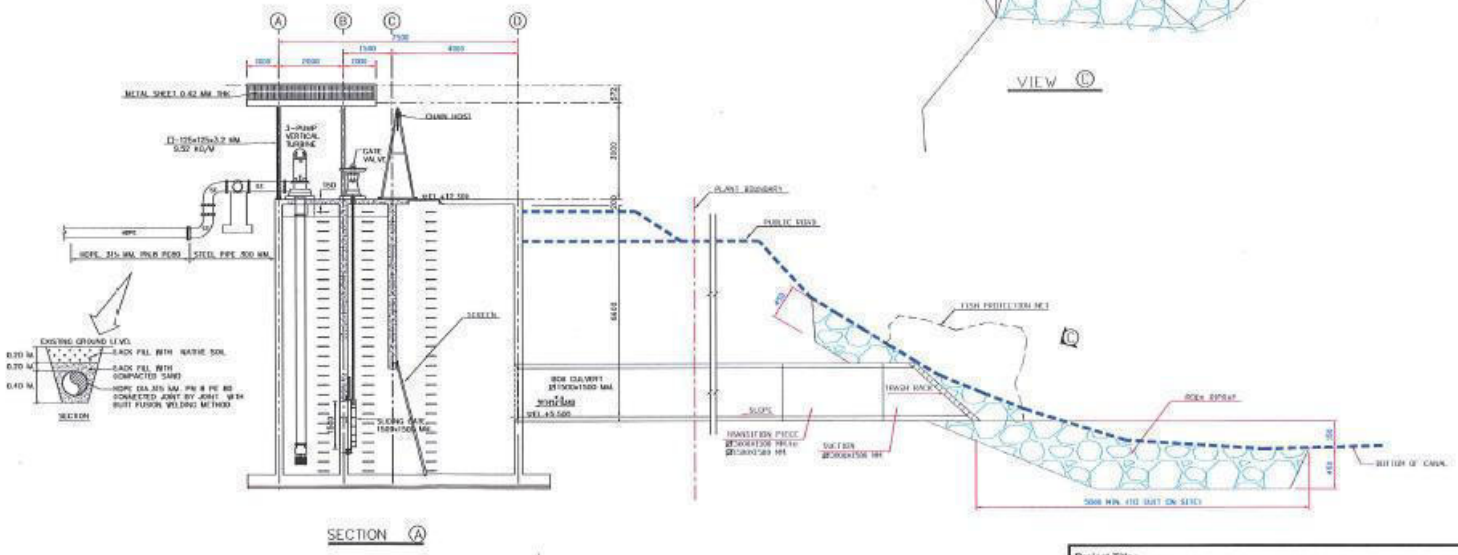

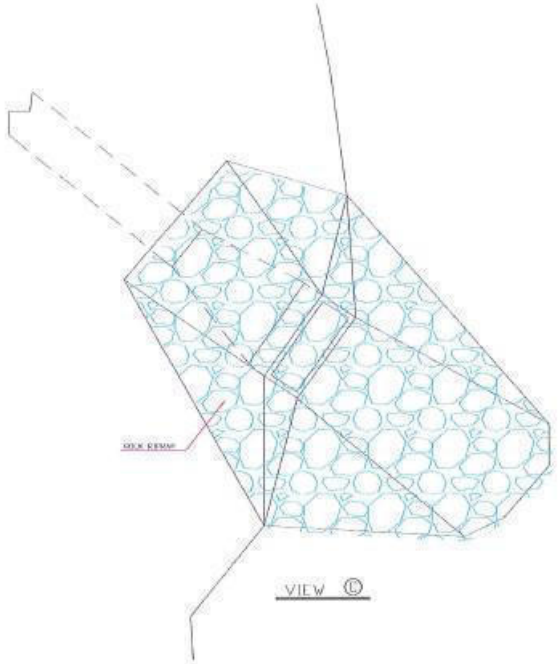

Figure 3.6.1-2 (Cont) Cross-sectional of Nathawee canal and water pumping level

FOR PRELIMINARY ONLY

Project Title:	20.622 MW Rubber Wood Fired Power Plant
Owner:	CHANA GREEN COMPANY LIMITED
Document Title:	PUMP STATIOIN

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(2) Water treatment

The Project's water treatment flowcharts are shown in **Figure 3.6.1-3** and **Figure 3.6.1-4** (water treatment process diagram is shown in **Figure 3.6.1-5**) and can be summarized as follows:

1) Water treatment process

The water treatment process begins with the pumping of water from the reservoir to the clarifier with a capacity of 100 cubic meter/hour and store in a clear water tank with a capacity of 1,800 cubic meters (sludge from the clarifier will be sent to the filter press system). Later, the water will be sent to the two sets of the multimedia filter with the rate of 15 cubic meters/hour each, the total capacity of 30 cubic meters/hour (600 cubic meters/day, calculated from 20 hours continuously). After that, it will be stored in the filtrated water tank with a capacity of 100 cubic meters to be used for general activities. Part of it will be sent to carbon filtration system to produce demineralized water.

2) Demineralization water process

Water from the filtrated water tank will be sent to two sets of carbon filtration system with a capacity of 15 cubic meter/hour prior sending to the two set reverse osmosis (RO) step one system with a capacity of 10 cubic meters/hour each (20 cubic meters/hour). Later it will be retained in an RO buffer tank with a capacity of one cubic meter prior sending to the two sets of RO system step two with a capacity of eight cubic meters/hour each (16 cubic meters/hour). After that, it will be sent to the two sets of degas system prior store in an RO water tank with a capacity of 20 cubic meters before sending to the two sets of EDI (Electro De-Ionization) system. Cation and anion will be trapped out. Demineralized water will be stored in a demineralized water tank with a capacity of 20 cubic meters. It will be used in the laboratory and the boiler of the Project.

(3) Water consumption

Water balance of the Project is shown in **Figure 3.6.1-6** and can be summarized as **Table 3.6.1-1**

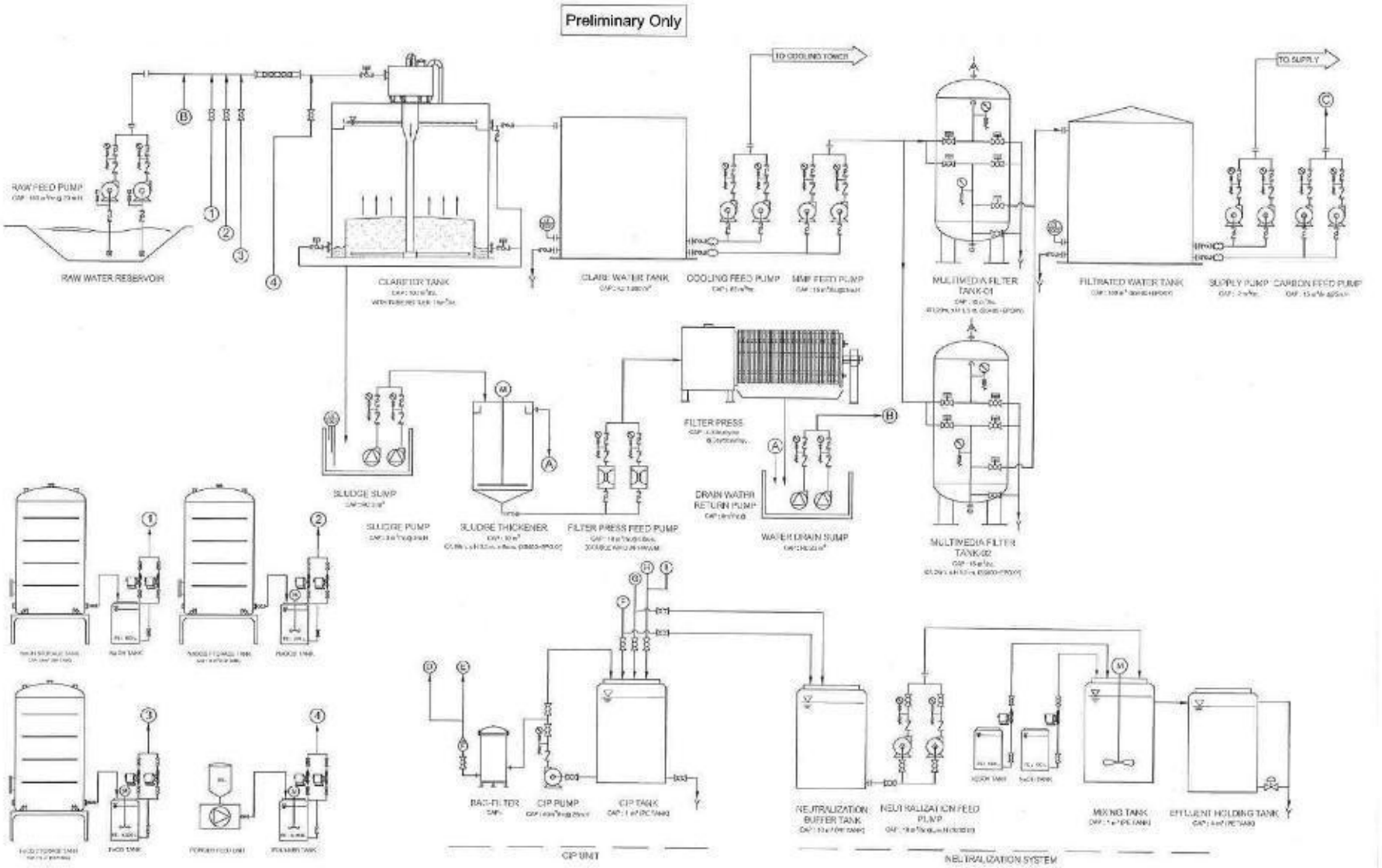


Figure 3.6.1-3 Water Treatment Process Flow Diagram

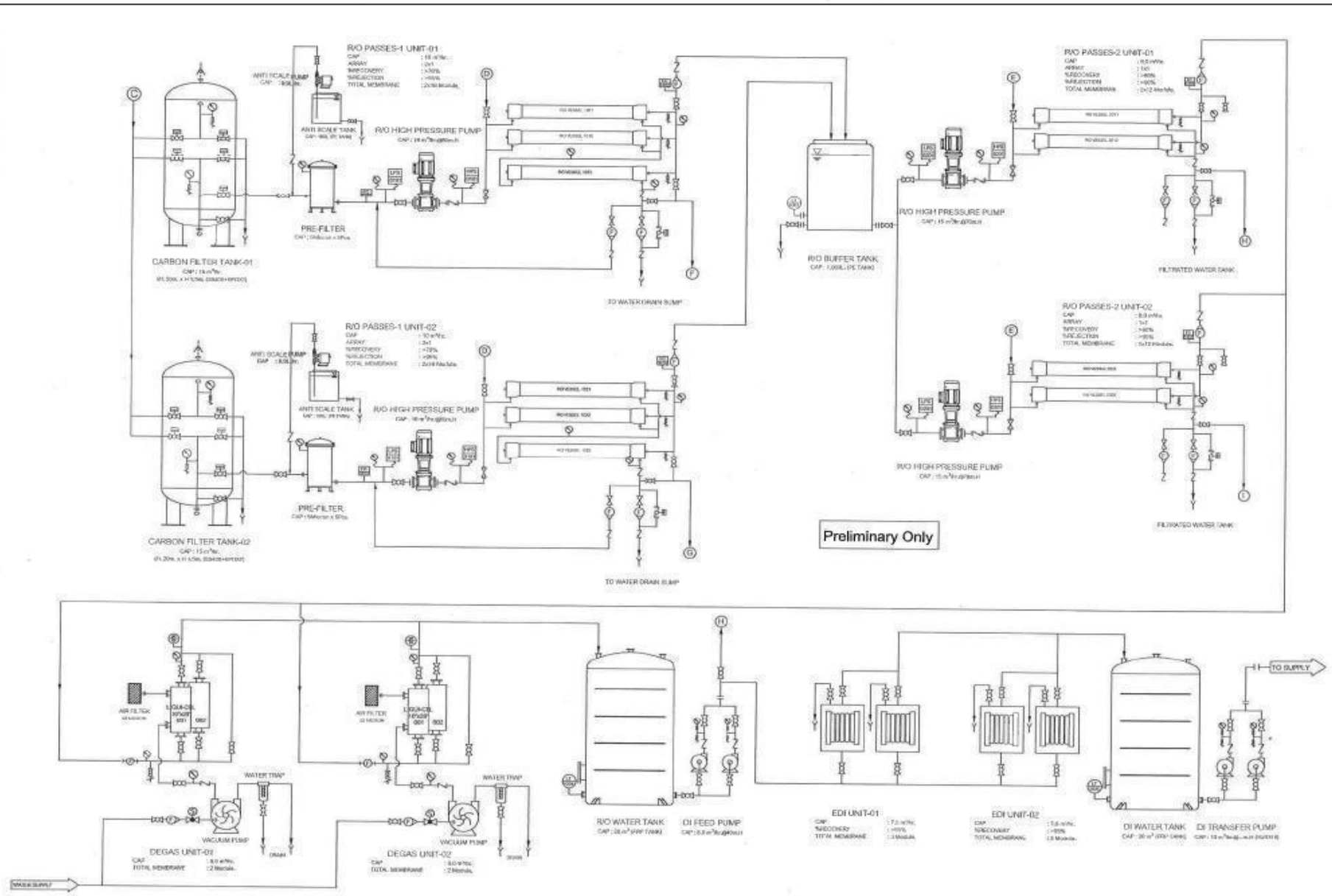
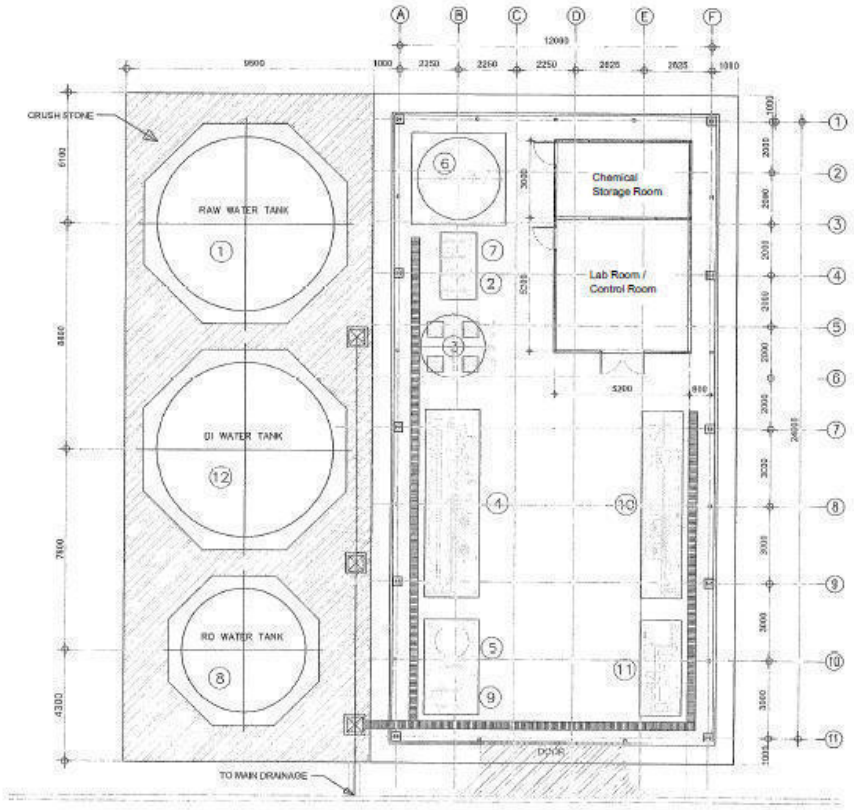


Figure 3.6.1-4 Process Flow Diagram of DI Water



PLAN LAY OUT

ITEM	DESCRIPTION	QTY	DIMENSION
①	RO WATER TANK	1	ø6.60 x HL 9.00 (m.)
②	RAW WATER SUPPLY PUMP UNIT	1	–
③	MULTIMEDIA FILTER	1	ø2.50 x HL 2.00 (m.)
④	1ST PASS RO UNIT	1	W1.8 x L7.0 xH2.0 (m.)
⑤	CIP UNIT	1	W1.7 x L2.0 xH1.6 (m.)
⑥	RO REJECT WATER TANK	1	ø3.20 x HL 4.50 (m.)
⑦	MMF BACKWASH WATER PUMP UNIT	1	–
⑧	RO WATER TANK	1	ø4.80 x HL 6.00 (m.)
⑨	2ND PASS RO FEED PUMP UNIT	1	–
⑩	2ND PASS RO UNIT	1	W1.2 x L7.0 xH2.0 (m.)
⑪	EDI UNIT	1	W1.5 x L2.9 xH2.0 (m.)
⑫	DI WATER STORAGE TANK	1	ø6.60 x HL 9.00 (m.)

WATER TREATMENT SYSTEM LAYOUT PLAN

SCALE 1 : 150

Figure 3.6.1-5 Water Treatment System Layout Plan

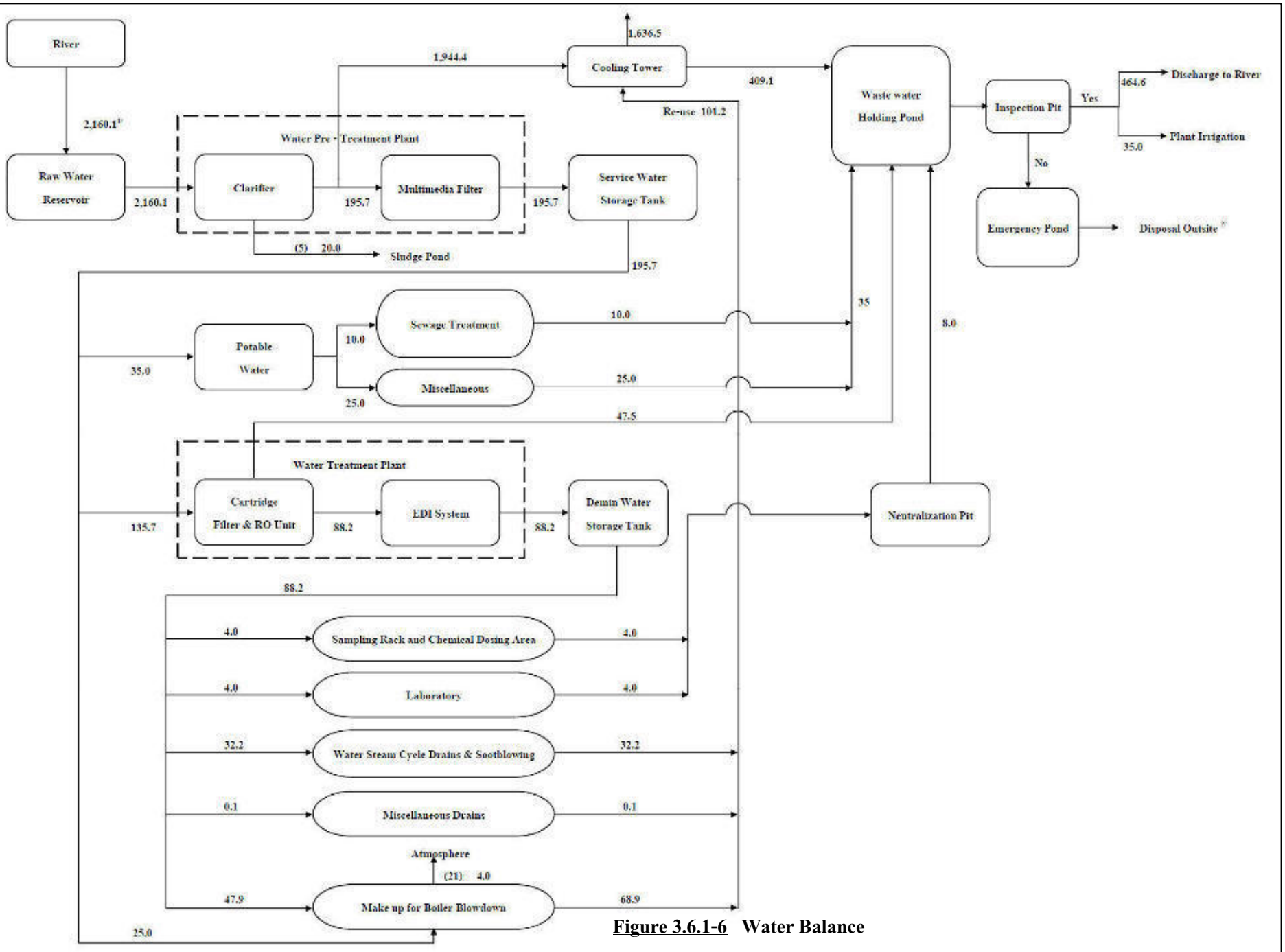


Figure 3.6.1-6 Water Balance

Table 3.6.1-1

Water consumption

Purpose	Type of water	Consumption rate (cubic meter/day)
(1) Office/canteen	Sand filtered water	35
(2) Cleaning of floor/equipment	Tap water	35
(3) Laboratory	Tap water	40.3
(4) Make up water at the cooling tower	Sand filtered water	2,045.6
(5) Make up water at the boiler	Demineralized water	120

3.6.2 Study of adequacy and security of water

Chana Green Power Plant is located at Ku Subdistrict, Chana District, Songkhla Province. The Project covers the area of approximately 0.28 square kilometers of Nathawee canal water basin which is part of southeast water basin as shown in **Figure 3.6.2-1**. Nathawee canal water basin is part of the southeast water basin in which covers about 1,571.28 square kilometers of land. The water basin covers most of the area of Nathawee District, Chana District, and part of Muang District, Thapha District, Namom District, Sadao District, Hatyai District, and Sabayoi District of Songkhla Province.

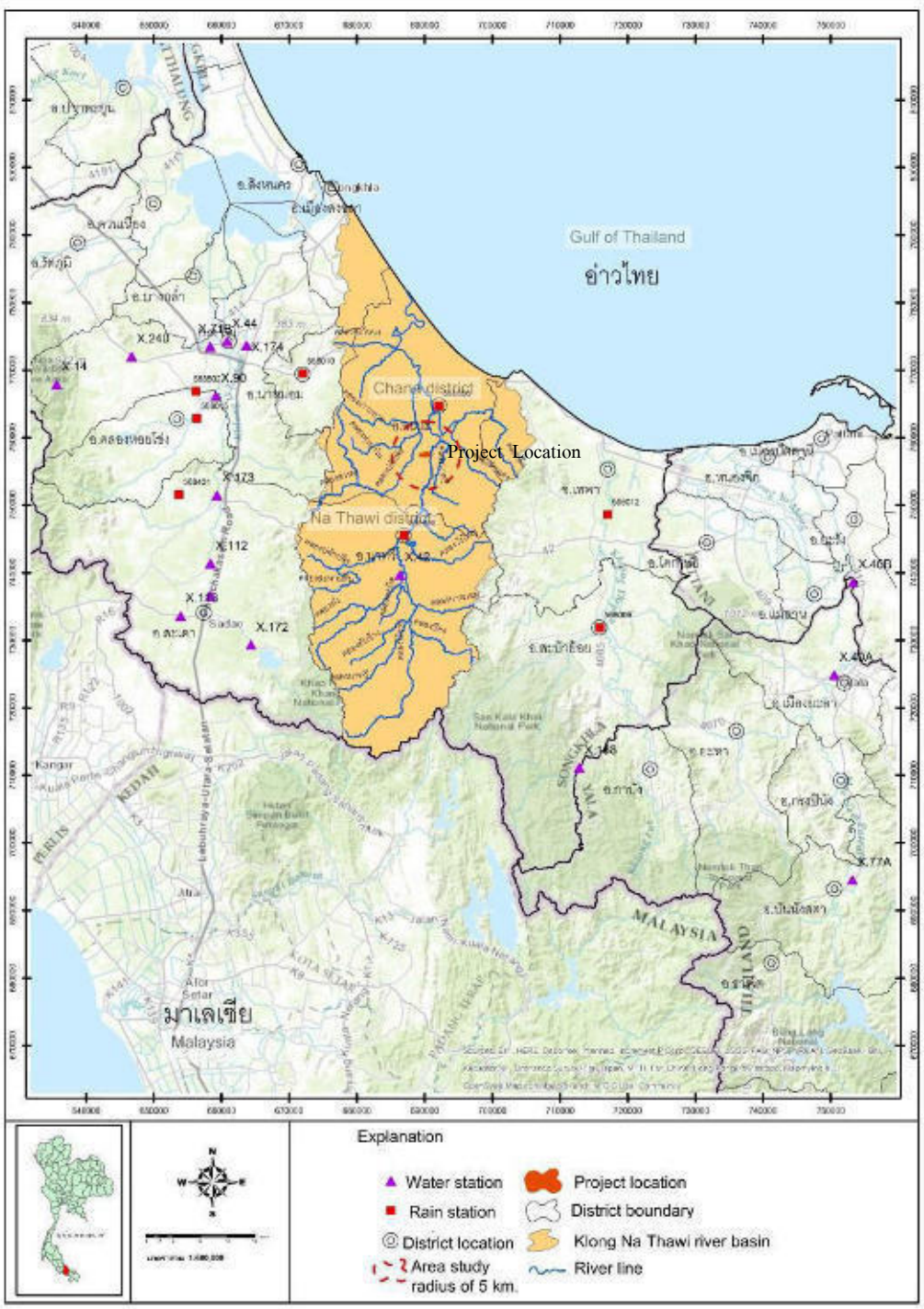


Figure 3.6.2-1 Location of the Project

From the Project's water balance, the analysis and prc District boundary Nathawee canal water basin Water line rity of water throughout a year over the period of 25 years can be done, detail

(1) Water usage

The Consultant used the following criteria for the forecasting of situation and trend of water usage in the area of Nathawee Subdistrict and Chana District.

(2) Water balance analysis

The results of runoff water analysis were used in the analysis of water balance of Nathawee canal from upstream at X.42 station to the Gulf of Thailand. The demand of water for various purposes was taken into account. The water demand in the area of Nathawee water basin over the period of the next 30 years are demand for water supply production of Nathawee Provincial Waterworks of 1.63 million cubic meters/year, water demand for consumption of the population in the area of Nathawee District of 3.35 million cubic meters/year, water demand for agricultural purposes of 98.89 million cubic meters/year, water demand for consumption of the population in the area of Chana District of 4.98 million cubic meters/year, and water demand for downstream ecosystem conservation for Nathawee water basin of 47.28 million cubic meters/year.

1) Analysis of the lowest water level that can be pumped

The data obtained from the survey of cross-sectional of Nathawee canal were used in the preparation of rating curve to estimate the lowest water level that can be pumped. The demands of water for downstream ecosystem conservation, irrigation of Chana floodgate during the dry season, and Chana District community water supply were also taken into account. Consideration of the rating curve found that the lowest water level that can be pumped at a confidence level of 80 percent at various depths are shown in **Figure 3.6.2-6**. It was found that the water level that can be pumped after deducting by water demands and enough for the Project to pump (15,365 cubic meter/day) starts at +5.35 msl or 0.15 meter from the bottom of the canal.

2) Summary of the lowest water level that can be pumped

From the study results, the conclusion can be drawn that the lowest water level that the project can pump in consideration of ecosystem and downstream water demand is 0.15 meter from the bottom of Nathawee canal. The water quantity is over 22,000 cubic meter. The pumping will be done during the rainy season, October-December, and during the dry season, April-May, five months in total. The Project will stop pumping in case that the water level is lower than the specified lowest level.

The pumped water will be retained in the water reservoir in the Project that is planned to store water to be sufficient for four months continuously. The results of the highest water quantity that the project can pump are described in the next section.

(3) Analysis of the highest rate and period that can be pumped

Consideration of the net water runoff that the Project can pump over the period of the past 30 years found that the lowest water runoff level left from other activities that the Project can use

is approximately 65.90 million cubic meter/year. The lowest water runoff in the rainy season (May – December) is approximately 62.51 million cubic meters while the lowest water runoff in the dry season (January - April) is approximately 1.35 million cubic meters. Nevertheless, the monthly lowest water runoff data were used in the designing of the water reservoir of the Project as well as pumping rate. The water shortage in Nathawee canal at the Project area over a period of four months continuously was also considered.

3.6.2.3 Conclusion and recommendation

From the study results above, conclusion and recommendation for the water management are providing of a water reservoir and pumping of water from Nathawee canal with the period and pumping rate as follows:

(1) The four months water reservoir

1) Area 57,600 square meters (36 rai)
2) Capacity 345,600 cubic meters
3) Depth 6 meters

(2) Highest pumping rate

1) During April – May, pumping rate of 6,600 cubic meters/day
(Use water pump with capacity of 3,600 cubic meters/day for three pumps)
2) During October - December, pumping rate of 4,000 – 11,160 cubic meters/day
(Use water pump with capacity of 3,600 cubic meters/day for three pumps)

(3) Lowest pumping rate

The lowest quantity of water that can be pumped without an impact on the ecosystem at 20 percent of the confidence level of 80 percent is 460 cubic meter/day and the lowest water level is +5.35 msl (0.15 meter from the bottom of Nathawee canal).

3.6.3 Backup power system

In the worst case that the boiler stops running and the Project has to restart the system, the Project will contact the Provincial Electricity Authority and ask to use electricity for the system start up. However, the chance is less.

3.7 Pollution and control

3.7.1 Air pollution

(1) Source of air pollution from combustion

1) Boiler

The Project will install a boiler with a capacity of 98 tons/hour (locations of boiler and air pollution treatment system are shown in **Figure 3.5.1-1**). The boiler was designed in accordance with the Notification of Ministry of Industry B.E.2547 on the standard of air emission from biomass power plant (case of a new plant that the is approved after 1 October 2004). The Project also considered the Notification of Ministry of Natural Resources and Environment on the standard of air emission from new power plants B.E.2010. The design of the air pollution treatment system was done coherently with the maximum capacity of the boiler. Thus, it can be ensured that the air pollution treatment system of the Project will capable of supporting the maximum emission rate.

2) Design criteria of the air pollution treatment system

The emission rates shown in **Table 3.7.1-1** have the concentrations that cover the normal operation and the soot blow cases which are lower than the emission standard according to Notification of the Ministry of Industry B.E.2547 on standard of air emission from biomass power plant (case of new plant that the is approved after 1 October B.E.2547) and the Notification of Ministry of Natural Resources and Environment on standard of air emission from new power plants B.E.2553.

3) Principle of the air pollution treatment system

The Project will design electrostatic precipitator or ESP to trap dust. Three ponds of ESP will be connected in series. Two ponds will be operated at the same time while one pond will be stopped to knock the dust. Thus, in the case of an emergency that one pond stop, the rest still working during fixing.

Table 3.7.1-1

Emission Loading in Varies Operation modes

Source		Stack		Emission Data			Concentation			Emission Loading		
		High	Diameter	Temp	Velocity	Flow Rate	TSP	SO_2	NO_X	TSP	SO_2	NO_X
		(m)	(m)	(K°)	(m/s)	(Nm^3/s)[1/]	(mg/Nm^3)	(ppm)	(ppm)	(g/s)	(g/s)	(g/s)
1.	**Stump 100%**											
1.1	Normal	40	2.20	403.15	20.74	74.28	85.73	53.49(ppm)[1/] / 163.97(mg/m^3)[3,4/]	171.4(ppm)[1/] / 163.97(mg/m^3)[3,4/]	4.710	7.690	17.710
1.2	Soot blow						107.17[1/]/125.39[4/]			5.880		
2.	**Slab 100%**											
2.1	Normal	40	2.20	403.15	18.76	69.57	71.19	42.30	42.30	3.66	5.69	4.090
2.2	Soot blow						88.99			4.58		
3.	**Stump 50% Slab 50%**											
3.	Normal	40	2.20	403.15	19.20	71.26	71.26	48.33	118.00	3.750	6.660	11.690
3.2	Soot blow						89.08			4.690		
Standard[2/]							**120**	**60**	**200**	-	-	
Standard[3/]							**50 or up to 150 mg/m^3**	**2000 mg/m^3**	**650 mg/m^3**	-	-	-

Remarks :
[1/] Reference to dry condition, 25°C, 1 atm., and 7% Excess Oxygen
[2/] Notification of the Ministry of Industry B.E.2547. (at 1 atm, 25 degC, 7% O_2)
[3/] IFC EHS General Guidelines: Small Combustion Facilities Emissions Guidelines (3MWth – 50MWth) (at 1 atm, 0 degC, 6% O_2)
[4/] Reference to dry condition, 0°C, 1 atm., and 6% Excess Oxygen

The principle of the electrostatic precipitator or ESP is that it will be operated all the time and one pond will be stopped to knock off the dust. Each pond has electrode to spread electric charge to the dust. When the dust passes through the dust collecting plate which has opposite charge, dust will be trapped on the plate. After dust knocking off to the hopper, the electric field will be cut. Later, dust will be sent out on a conveyer while another two ponds are still working. This will be automatically operated. In case that one pond is a malfunction, there are more ponds still running all the time.

4) Soot blow from boiler

Soot will be blown out during boiler running because soot from combustion will adhere on the surface of the gas pipe. When the thick soot accumulated on the pipe causes decreasing of heat exchange efficiency. Therefore, to maintain the boiler efficiency, soot must be blow out by using steam. The blown soot will go with off gas, resulting in higher dust concentration. The soot blow assumption is twice a day for approximately ten minutes/set. There are eight sets of soot blow which will be alternate work in the case of air pollution treatment system failure**.** The pressure of steam used for sort blow is approximately 15 bar.

5) Safely shutdown of boiler

In the case of the problem of the air pollution treatment system during operation, the operator will shut down the system to investigate and fix the problem according to the working procedure. Reduction or shutdown of the system will be done under the approval of an engineer who controls the boiler. When the system is ready, the Project will restart the process.

In the operation, if it is necessary to stop the system, the operation will turn to boiler interlock bypass mode at DCS（Distributed Control Systems） system in the control room. The boiler will be stopped to investigate and fix the problem. The following are steps of boiler shutdown.

(a) Stop fuel feeding to the combustion chamber, it can be done in less than one minute after the command to stop the boiler

(b) Stop boiler feed water pump

(c) Stop spreader fan, primary FDF (Forced Draft Fan), secondary FDF, and IDF (Induced Draft Fan), respectively

Nevertheless, the whole system of the Project can be stopped within five minutes. However, the fuel will be left in the combustion chamber and combustion will last for a period of time until there is no fuel which will take approximately 30 minutes.

6) Preventive measure of the air pollution treatment system

The Project provided an operational manual of the boiler in order to prevent problems on the ESP. Details are as follows:

(a) To reduce risk to the process and environmental impacts due to malfunction of equipment, the Project provided a preventive maintenance program for the boiler, air pollution treatment system, and related equipment. The preventive maintenance program consists of routine inspection and annual inspection plans.

The Project will also provide necessary spare parts of the ESP for the case of fixing of the ESP. All parts will be installed at the ESP. They are consisted of the following:

a) Rapping Cam Roller 3 sets
b) Rapping Bellows 3 sets
c) Fuse for Lamp 3 sets

(b) The Project will provide a staff with knowledge and experience on controlling of air pollution treatment system in complying with the Notification of the Department of Industrial Works

(c) Inspection and solving practices will be set for the operation of the boiler coherent with the designer recommendations

(2) Source of air pollution other than combustion

Other than the main source of air pollution from combustion mentioned above, there are other activities that may cause air pollution namely, fuel storage, distribution of fuel to the boiler combustion chamber, distribution of ash from the combustion chamber, distribution of ash from the ash dumping pond, and ash disposal pond.

1) Fuel storage

The fuel will be stored in an open yard. After shredded to small pieces, they will be kept in a storage building prior feeding to the combustion chamber. Nevertheless, the fuels kept on the yard are big lumber. Thus, there is no dispersion of dust from the fuel storage.

2) Distribution of fuel to the boiler combustion chamber

The Project will provide a close system over the conveyor. It will help reducing the dispersion of dust during the distribution of fuel to the combustion chamber. Moreover, the Project will set an operational practice to reduce dispersion of dust at the boiler building area as follows:

(a) Operator whose control the conveyor shall inspect the system in the good conditions all the times

(b) Clean by sweeping of fuel residue every day to prevent accumulation and spread of the fuel

3) Distribution of ash from the combustion chamber and distribution of ash to the disposal pond and farmers

Ash is generated from the boiler can be classified into two types, bottom ash and fly ash. Ash from the combustion chamber is not classified as hazardous waste under Thai Law. The project has developed Guideline for Ash utilization of Chana project (refer to the attached file).

(a) Fly ash from the ESP that is knocked to the hopper will go to the rotary to prevent the ash from mixing with the off gas. Later, the ash will be distributed by the wet ash conveying system to go with the bottom ash.

(b) Bottom ash is generated from the combustion of the boiler and fall to the bottom of the chamber and flows to wet ash conveying system and then into the ash dumping pond with a capacity of 23 cubic meters (**Figure 3.5.3-4**). The water that the ash is separated out will circulate to the wet ash conveying system. The separated ash from the ash dumping pond will be sent to ash disposal pond in the Project. The pond has a capacity of approximately 10,000 cubic meters. Each pond is able to dispose of the ash for two years. Details are described in waste management section, section 3.7.3.

Ash from the combustion chamber is not classified as Hazardous waste follow Thai Law. The generated ash will be sampled and tested to confirm its suitability prior to use as soil conditioner.

(3) Management of odor from the fuel yard

In order to prevent odor from the fuel yard, the Project has set preventive measures as follows:

1) The Project will construct a drainage gutter around the fuel yard to prevent accumulation of moisture in the fuel pile. The floor is designed to have a slope to let water flow to the settling pond with a capacity of 5,365 cubic meters. The water will be reused.

2) The fuel residue in the gutter around the fuel storage yard will be collected to prevent blocking.

3) The Project will plant trees to serve as buffer zone to prevent dispersion of odor and dust that possibly will have impacts on the surrounding communities.

3.7.2 Wastewater and control

Wastewater from the Project can be classified into 5 types, wastewater from consumption of the workers, wastewater from the process and support system, contaminated rainwater, runoff from the fuel yard, and leachate from the ash disposal pond. Details are shown in **Table 3.7.2-1** and can be described as follows:

(1) Source and quantity of wastewater

1) Wastewater from consumption of workers

Wastewater from buildings which are an administration building, a control building, a water treatment control building, a workshop and warehouse building, and a guard house is approximately 35 cubic meters/day maximum. This wastewater will be treated in the septic tank until Biological Oxygen Demand (BOD) concentration is below 20 milligrams/liter prior discharging to the low concentration wastewater treatment system. The management is described in the wastewater management section.

2) Wastewater from the process and support system

(a) Wastewater from the water treatment plant is approximately 47.5 cubic meters/day. It will be sent to waste water holding pond. The management is described in the wastewater management section.

(b) Blowdown from the boiler of 101.2 cubic meters/day will be sent to use as raw water in the Project.

(c) Cooling tower blowdown of 409.1 cubic meters/day in cooling tower basin will be waste water holding pond. The management is described in the wastewater management section.

Table 3.7.2-1

Waste Water

Source	Quantity (m^3/day)	Treatment method
1. Wastewater from consumption of workers	35.0	This wastewater will be treated in the septic tank until BOD concentration is below 20 milligrams/liter sending to Waste water Holding Pond
2. Wastewater from the process and support system		
- Wastewater from the water treatment plant	47.5	sent to wastewater treatment system
- Blowdown	101.2	sent to use as raw water in the Project
- Cooling tower blowdown	409.1	sent low concentration wastewater treatment system
- Wastewater from the laboratory and wastewater from chemicals mixing area	8.0	sent to neutralization pit prior sending to the low concentration wastewater treatment system
- Wastewater from root washing, trucks cleaning, and fuel yard cleaning	250.0	sent to the wastewater treatment system prior sending to the waste water holding pond
3. Oil contaminated wastewater Rainwater in the area of the first 15 minutes and fire water used in the area Power generator, steam generator, big water pump of cooling tower, small water pump, and maintenance building areas	80.00 (m^3/first 15 minutes)	To trap oil out of the water. Oil on the surface will be collected in a closed 200 liters container in thewaste storage building. It will be disposed of by a waste disposer that is approved by Department of Industrial Works. The wastewater that contains less than five milligrams/liter of oil

Table 3.7.2-1 (Cont)

Source	Quantity (m^3/day)	Treatment method
4. Fuel yard runoff	4,538.55	Rainwater will flow to the gutter and the settling pond with a
	m^3/3 hr	capacity of 5,365 cubic meters. In the pond, floating
		surface aeration will beused to aerate prior recirculate to wash
		trucks and fuel yard floor.
5. Ash disposal pond leachate		
- Leachate from the disposal pond	831.83	The Project also designed water a retention pond with a capacity
	m^3/3 hr	of 4,842 cubic meters equip with a floating surface aeration system
		prior recirculate to wash trucks and fuel yard floor.

Source : Chana Green Company Limited, 2016

(d) Wastewater from the laboratory and wastewater from chemicals mixing area of 8.0 cubic meters/day will be sent to equalizing pond prior sending to waste water holding pond. The management is described in the wastewater management section.

(e) Wastewater from root washing, trucks cleaning, and fuel yard cleaning of 250.0 cubic meters/day will be sent to wastewater treatment system. The management is described in the wastewater management section.

3) Oil-contaminated water

Oil contaminated wastewater is generated from many areas which are transformer, power generator, steam generator, big water pump of cooling tower, small water pump, and maintenance building areas. Oil contaminated wastewater is generated by two cases, rainwater in the area of the first 15 minutes and fire water used in the area. The Project will separate oil-contaminated wastewater prior sending to central oil separator which is designed to separate oil out of water until the concentration is less than five milligrams/liter to comply with the Notification of the Ministry of Natural Resources and Environment (B.E.2559) on industrial effluent standard for industry, industrial estate, and industrial zone and Notification of Ministry of Industry No.2 (B.E.2539) on industrial effluent standard.

From the calculation of oil-contaminated wastewater by area (**Appendix 2-6**) as shown in **Table 3.7.2-2** and **Table 3.7.2-3**, it was found that the oil-contaminated wastewater of 78.26 cubic meters will be collected in an oil trap with a capacity of 100 cubic meters to trap oil out of the water. Oil on the surface will be collected in a closed 200 liters container in the waste storage building. It will be disposed of by a waste disposer that is approved by Department of Industrial Works. The wastewater that contains less than five milligrams/liter of oil will be sent to Waste Water Holding Pond.

4) Fuel yard runoff

Runoff at the fuel yard (32,300) has a quantity of 4,538.55 cubic meter/three hours. The Project designed a settling pond that is able to separate dust from the water continuously over the period of three hours (**Figure 3.7.2-1**). Rainwater will flow to the gutter and the settling pond with a capacity of 5,365 cubic meters. (The design is small compared to the water volume) In the pond, floating surface aeration will be used to aerate (data of the aerator and detail of the design are needed, due to wastewater treatment system calculation sheet, this wastewater will not be treated by other means, so, need to prove that treated wastewater is met with standard) prior recirculate to wash trucks and fuel yard floor.

Table 3.7.2-2

Oil contaminated rainfall: Calculate by area

	Source	Drainage area (m^2)	Coefficient	Rain intensity (mm/hr)	Oil contaminated rainfall from Equation 1 (m^3/hr)	Oil contaminated rainfall first 15 minutes (m^3)
1.	Power Block Area					
	Power Transfermer	72	0.9	117	7.58	1.9
	Auxiliry Transfermer	65	0.9	117	6.84	1.71
2.	Generator and Steam Generator area					
	Boiler combusion area	93	0.9	117	9.79	2.45
	Boiler feed water pump A/B	120	0.9	117	12.64	3.16
3.	Main Cooling tower and Pump					
	Main coolling water pumps	186	0.9	117	19.59	4.9
4.	Treated water pump area					
	Treated water pump	75	0.9	117	7.90	1.97
	Fire water pump	20	0.9	117	2.11	0.53
5.	Workshop and Warehouse					
	Lubrication Oil Storage Area	25	0.9	117	2.63	0.66
	Diesel tank for mobile Truck & Forklift	120	0.9	117	12.64	3.16
Total		**776**	**-**	**-**	**81.72**	**20.44**

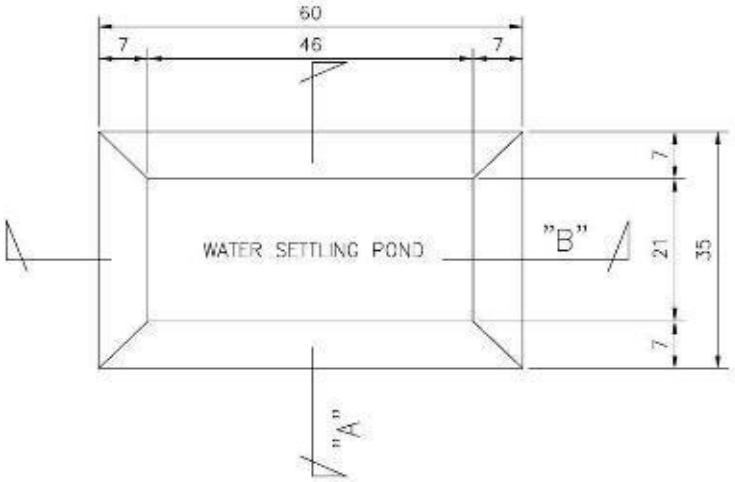
Source : Chana Green Company Limited, 2016

Table 3.7.2-3

Fire water used at the transformer area (oil contaminate) : calculate by area for Deluge System

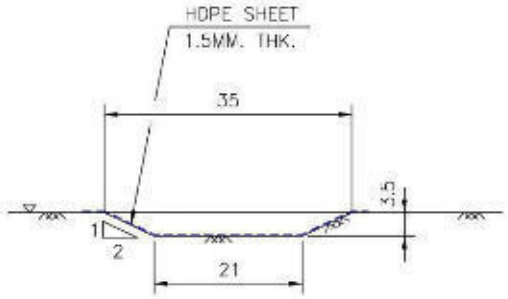
	Source	The amount of water used for firefighting From NFPA15 standard ($m^3/hr/m^2$)	Area (m^2)	Amount of fire water (oil contaminate) 30 minutes (m^3)
1.	Power Block Area			
	Power Transfermer	0.612	22	6.732
	Auxiliry Transfermer	0.612	25	7.65
	Diesel engine generator oil storage tank	0.612		
2.	Generator and Steam Generator area			
	STG lube oil containment	0.612	29	8.874
	Boiler feed water pump A/B	0.612	93	28.458
3.	Treated water pump area			
	Fire water pump	0.612	20	6.12
รวม		-	-	**57.834**

Source : Chana Green Company Limited, 2016

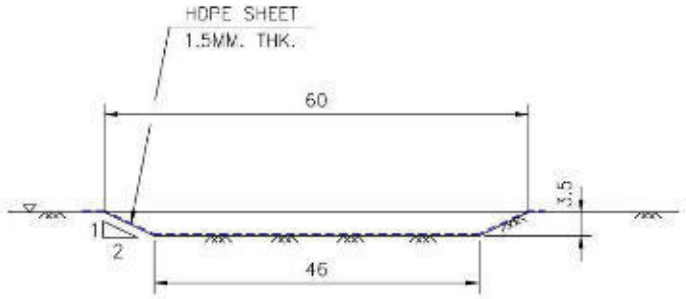


SETTLING POND AT WOOD STORAGE YARD DETAILS

MAXIMUM CAPACITY = ((A1 + A2) / 2) x H
= ((2,100 + 966) / 2) x 3.5
= 5,365.5 CU.M



SECTION "A"



SECTION "B"

2559/405918 5122(v-

Figure 3.7.2-1 Water Setting Pond

5) Ash disposal pond leachate

Leachate from the disposal pond of the Project (33,600 square meters) can be divided into two categories, rainwater on the disposal pond and rainwater on another area of the disposal pond of 831.83 cubic meters/three hours each (calculated from the same size of the area). The Project designed a water retention pond with a capacity of 4,842 cubic meters as shown in **Figure 3.7.2-2.** The Project also designed an ash settling pond with a capacity of 4,842 cubic meters equip with a floating surface aeration system as shown in **Figure 3.7.2-3** prior recirculate to wash trucks and fuel yard floor.

(2) Wastewater treatment system

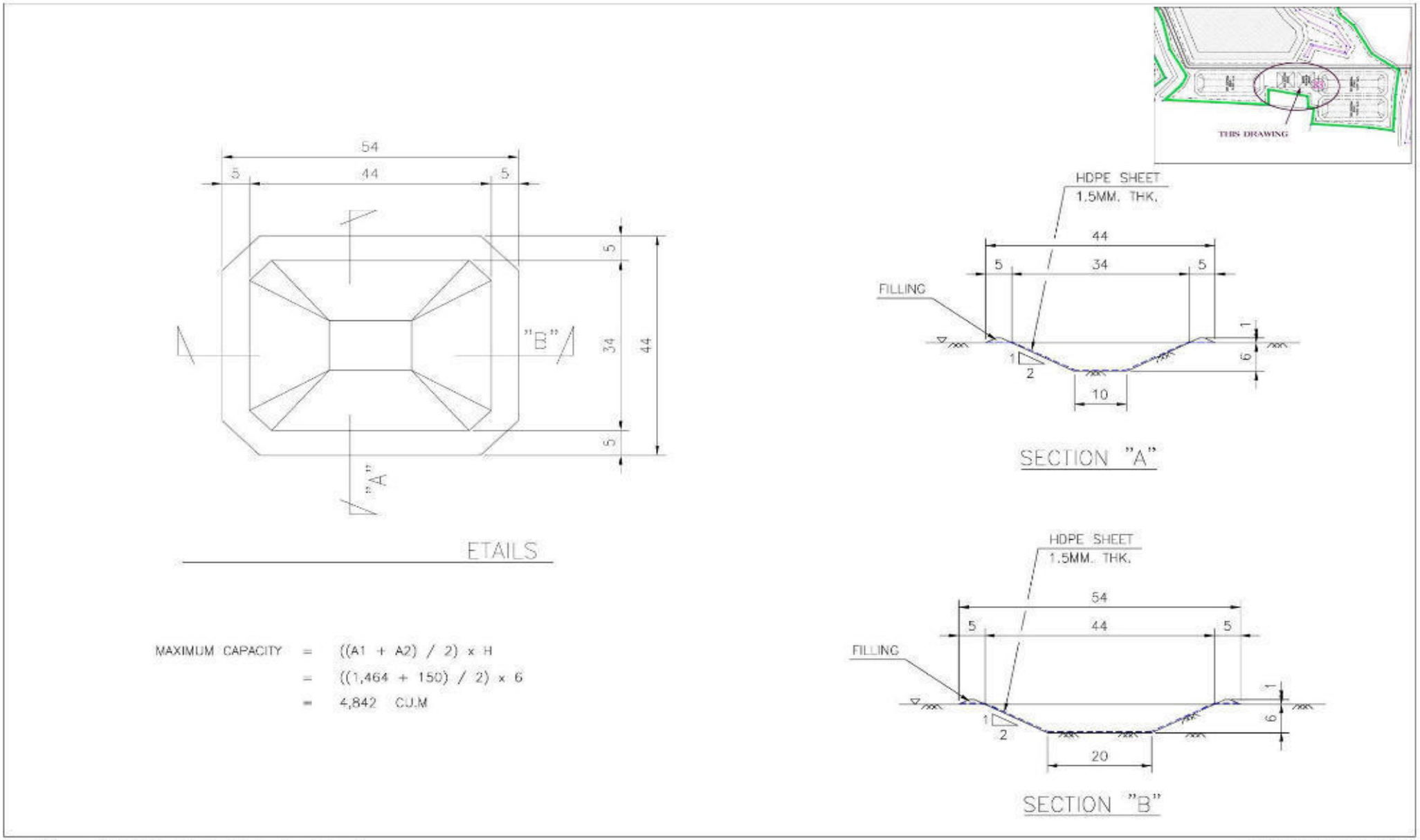
1) Septic tank

The Project will provide bathrooms and toilets in various places namely administration building, control building, water treatment control building, workshop and warehouse building, and guard house. Septic tanks will be installed to pre-treat wastewater generated from these buildings. According to the Ministerial Regulation issued under Building Act B.E.2552, the wastewater must be pre-treated before sending to low concentration wastewater treatment. The assumption used in the designing of the septic tanks was that BOD concentration in the influent is 260 milligrams/liter and effluent is below 20 milligrams/liter.

2) Oil trap system

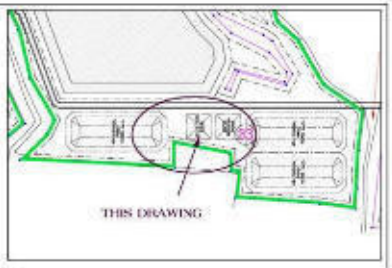
Oil-contaminated water will be generated from rain over the contaminated area for the period of 15 minutes and fire water used at the transformer area, power generator area, steam generator area, big water pump area at cooling tower, small pump area, and maintenance building area. Oil contaminated wastewater with the quantity of 78.26 cubic meters will be collected and sent to the central oil separator with a capacity of 100 cubic meters. Oil will be trapped by the barriers in the pond. According to the design, concentration of oil in the effluent is less than five milligrams/liter which comply with the Notification of the Ministry of Natural Resources and Environment (B.E.2559) on industrial effluent standard for industry, industrial estate, and industrial zone and Notification of Ministry of Industry No.2 (B.E.2539) on industrial effluent standard (efficiency calculation sheet is shown in **Appendix 2-9)**.

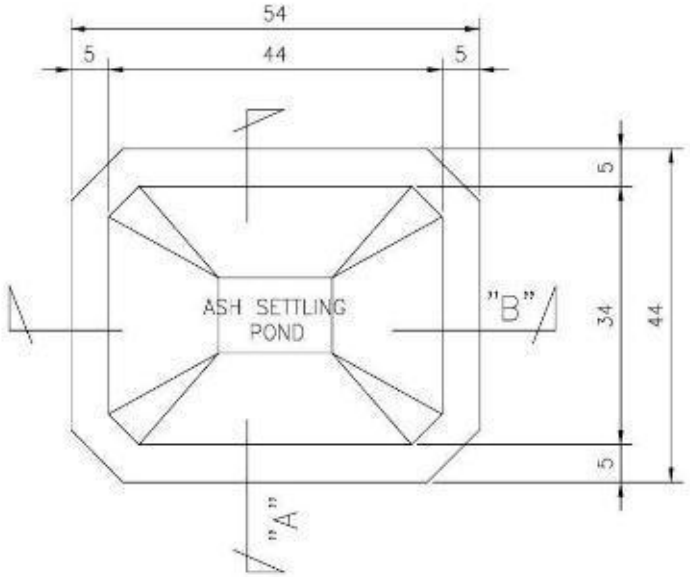
The trapped oil will be collected in a close 200 liters container in the waste storage building prior sending to dispose of by waste disposer with approval from the Department of Industrial Works.



MAXIMUM CAPACITY = ((A1 + A2) / 2) x H
= ((1,464 + 150) / 2) x 6
= 4,842 CU.M

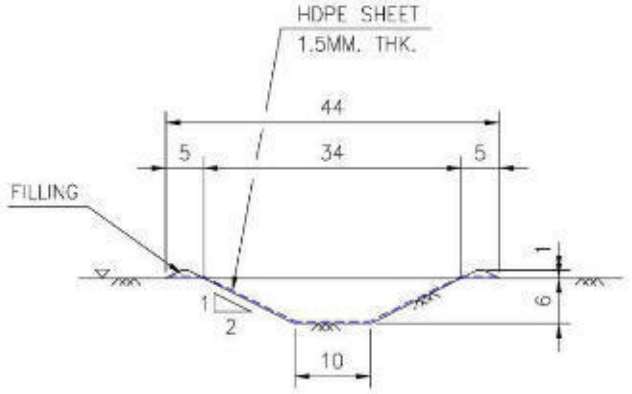
Figure 3.7.2-2 Water Retention Pond



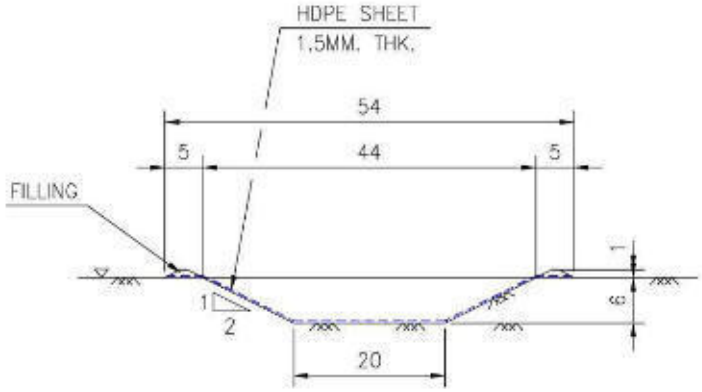


ASH SETTLING POND DETAILS

MAXIMUM CAPACITY = ((A1 + A2) / 2) x H
= ((1,464 + 150) / 2) x 6
= 4,842 CU.M



SECTION "A"



SECTION "B"

2559/405918 5122/x-02/02

Figure 3.7.2-3 Ash Setting Pond

2) Wastewater treatment system for Wastewater from root washing, trucks cleaning, and fuel yard cleaning

Waste water from root and truck washing and wastewater from fuel yard washing. It will be collected in high BOD EQ pond with a capacity of 260 cubic meters. Later, it will be treated in an upflow anaerobic filter tank follow by aeration tank.

Wastewater management diagram is shown in **Figure 3.7.2-4**. Location of the high-concentration wastewater treatment system is shown in **Figure 3.2.1-1** (No.23) and **Figure 3.4.2-5**.

Assumptions used in the design of the wastewater treatment system are as follows:

- Wastewater quantity 250 cubic meters/day
- Influent COD 300 milligrams/liter
- Effluent COD less than 120 milligrams/liter
- Influent BOD 80 milligrams/liter
- Effluent BOD less than 20 milligrams/liter

The wastewater will be collected to the EQ pond which able to retain for one day (260 cubic meters). Later, it will be sent to an upflow anaerobic filter tank. The dimension of the tank is six meters width, ten meters length, and three meters height. There is a media filter with a thickness of one meter and 2.6 meters height for water. The total water volume in the tank is 156 cubic meters. Microorganisms in the tank will digest organic materials resulting in reducing BOD concentration from 80 milligrams/liter to 32 milligrams/liter. After that, it will be sent to an aeration lagoon with a capacity of 217 cubic meters equip with an aerator with a capacity of 2.07 cubic meter/hour. After aerated, BOD concentration will be reduced to below 20 milligrams/liter. Then it will be sent to wastewater holding pond.

3) Wastewater Collection System

Wastewater will be collected to wastewater holding pond with a capacity of 900 cubic meters (**Figure 3.7.2-6**). Later, it will be sent to an inspection tank where pH, temperature, and conductivity will be automatically measured. Treated wastewater will be discharged to the Nathawee Canal, unless water quality of those treated wastewater is not follow the wastewater quality standard. Poor quality wastewater will be pumped to emergency pond (capacity of 900 cubic meters **Figure 3.7.2-7**) will has capacity to collect wastewater for 1 day to find a proper solution such as neutralized pH in the emergency pond, temperature adjustment, or resending those wastewater to fresh water reservoir for

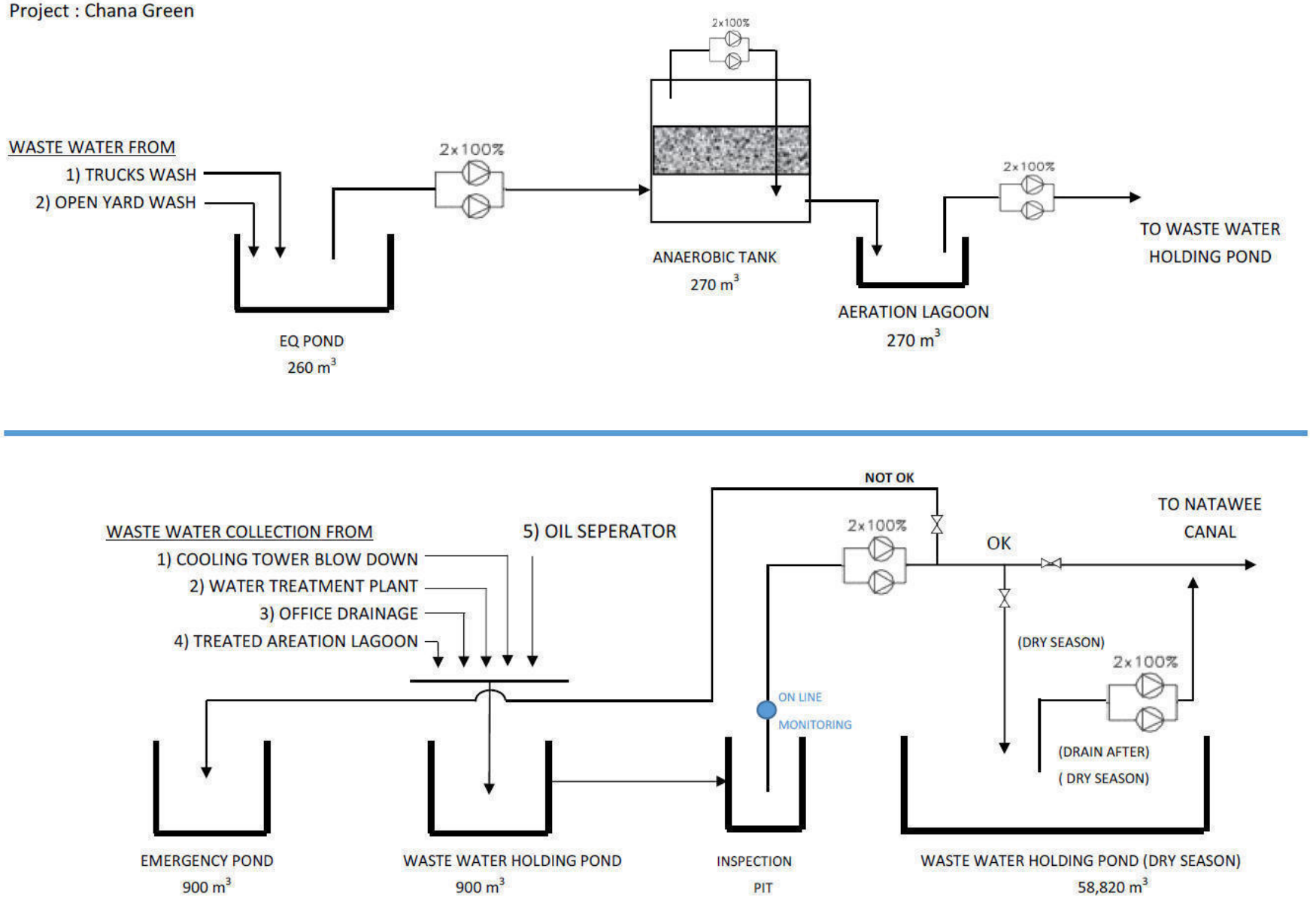


Figure 2.7.2-4 Process Diagram for Wastewater Treatment

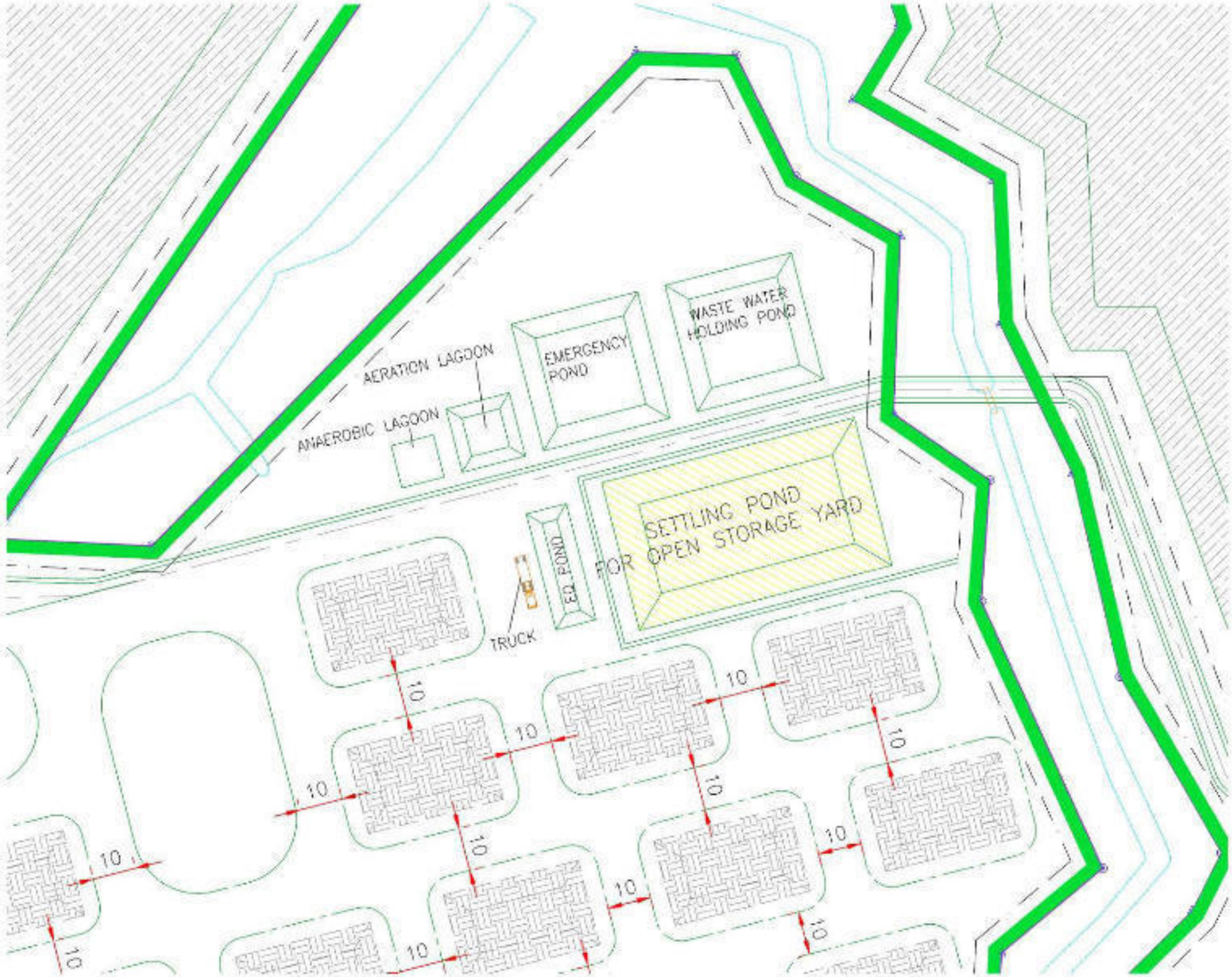


Figure 3.7.2-5 Wastewater Treatment for Wastewater From Root Washing Truck Clean And Fuel Yard Cleaning

FOR PRELIMINARY ONLY

Project Title : 20.622 MW Rubber Wood Fired Power Plant

Owner : CHANA GREEN COMPANY LIMITED

Document Title :

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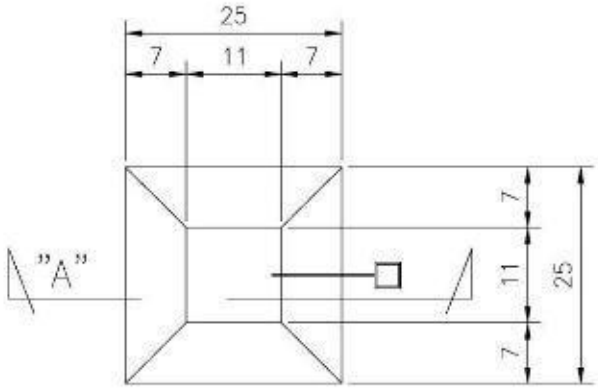
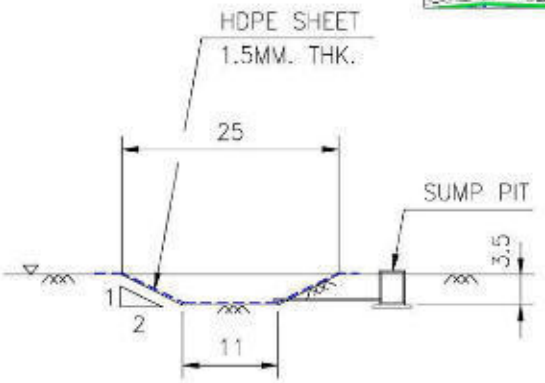




SECTION "A" & "B"

WASTE WATER POND DETAILS

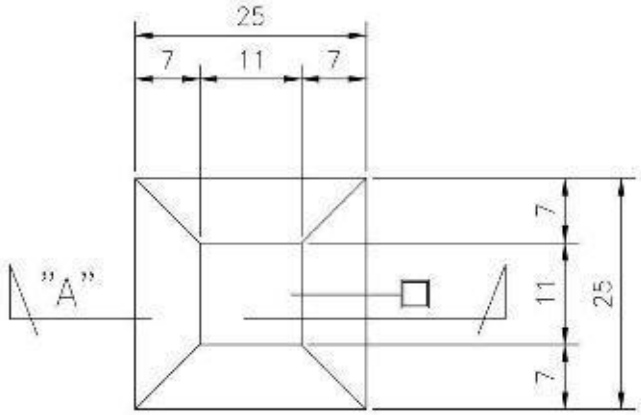
MAXIMUM CAPACITY = ((A1 − A2) / 2) x H

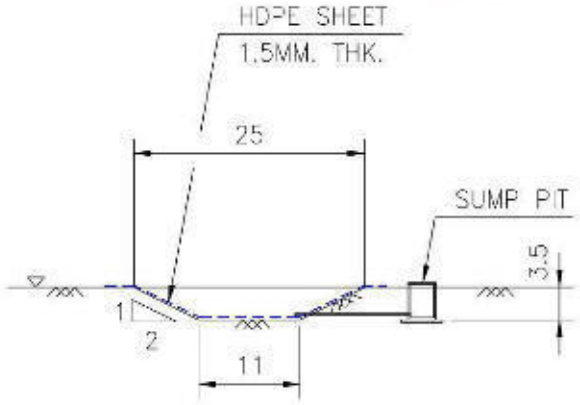
= ((625 + 121) / 2) x 3.5

= 1,305.5 CU.M

= 900 CU.M (EFFECTIVE)

Figure 3.7.2-6 Waste Water Holding Pond





SECTION "A" & "B"

EMERGENCY POND DETAILS

MAXIMUM CAPACITY = ((A1 + A2) / 2) x H

= ((625 + 121) / 2) x 3.5

= 1,305.5 CU.M

= 900 CU.M (EFFECTIVE)

Figure 3.7.2-7 Emergency Pond

sedimentation and maintaining conductivity before reuse as recycling wastewater. In case of untreated wastewater over 1 day, the project will ask for wastewater treatment from authorized organizations.

During the dry season the water level in Nathawee Canal a little. The sewerage treatment may affect water resources. The project was designed Watse Water Holding Pond Dry Season paved with HDPE capacity of 58,820 cubic meters (**Figure 2.7.2-8**).

3.7.3 Waste and management

(1) Concept of 3R

The Project applied the 3R concept to the Project waste management. It gives benefit to the Project due to reducing the burden of waste management. It also response to the government policy.The concept can be described as follows:

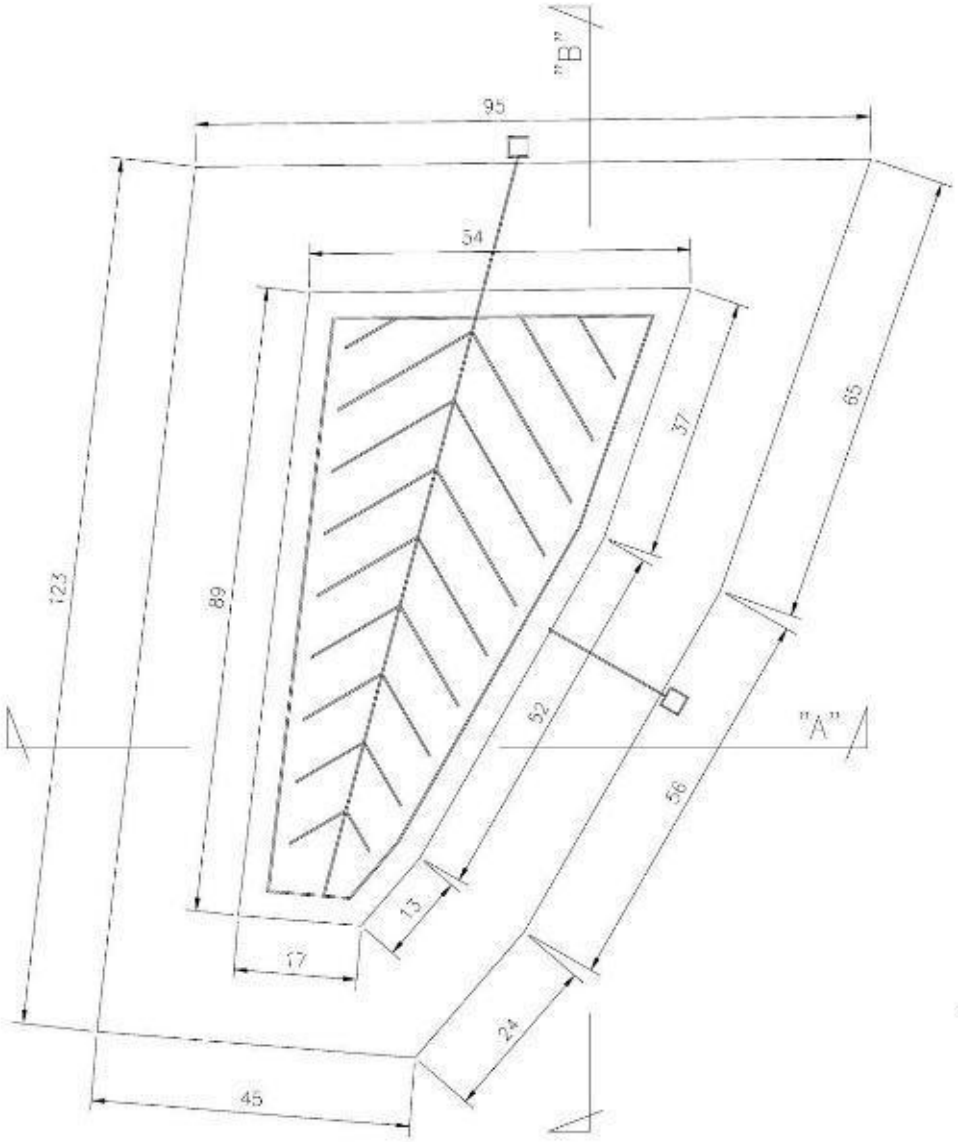
1) REUSE: It is the use of waste from sorting process that is cleaned, fixed, or using other similar activities that the materials can be used for the same purpose. The examples are using two sides of a paper prior discard, using of used envelope, the use of recirculated water in the production process, and using of treated wastewater for gardening.

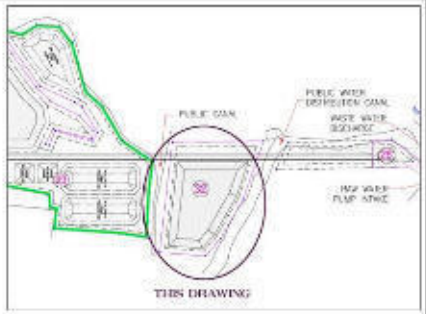
2) RECYCLE: It is the use of waste from sorting process that passes through a process or an activity to utilize that waste as a raw material to produce a new product. In the case of the Project, there is no concrete operation on recycling. However, the Project has a policy that supports this concept such as training the workers about recycling and sort the waste before donate or sale to be recycled.

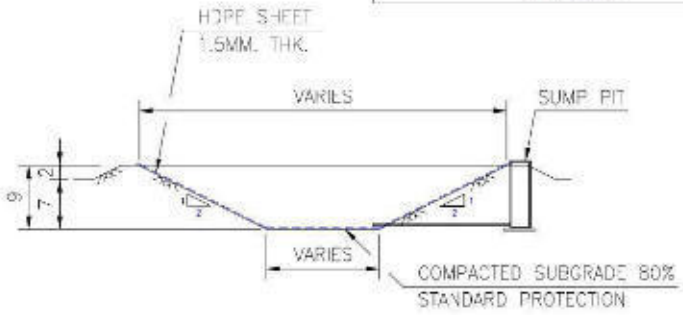
3) REDUCE: It is to control, prevent, or reduce the generation of waste by using appropriate and effective process, steps, technique, and technology which are generally accepted that will not cause impacts on the environment and health. The examples are rejected the use of foam material in the office, managing of the document by a central document section to reduce copying of document which resulting in reducing the use of ink and paper, the use od rechargeable battery, and the use of refill packaging for floor and toilet cleaning agent.

(2) Type, quantity, and management

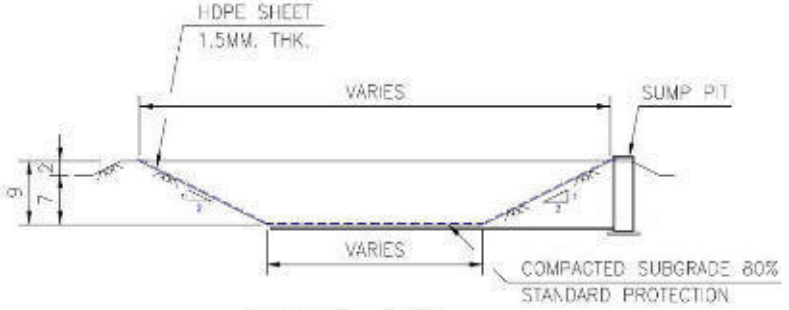
Types of waste based on the Notification of the Department of Industrial Works on waste or unused material disposal B.E.2548 and Public Health Act (No.2) B.E.2550 can be summarized in **Table 3.7.3-1** and can be described as follows:







SECTION "A"



SECTION "B"

WASTE WATER POND (DRY SEASONS) DETAILS

MAXIMUM CAPACITY = ((A1 + A2) / 2) x H

= ((9,550.3 + 3,520.8) / 2) x 9

= 58,820 CU.M

Figure 3.7.2-8 Waste Water Holding Pond Dry Season

Table 3.7.3-1

Waste Management

Source	Type of solid waste from Notification of Ministry of Industryonwaste or unused material disposal B.E.2548	Quantity	% Recycle/Reused/ Reduce	Container	Storage Area	Disposal method
1.Waste from consumption of worker	not required to follow the Notification of Ministry of Industryonwaste or unused material disposal B.E.2548 but must comply with the Public Health Act (No.2) B.E.2550	65 kilograms/day	10% Reuse 10% Recycle 10% Reduce	sorting at the generating source of waste container	waste containers	sending to Baan Na Municipality to dispose
2. Industrial waste						
2.1 HA (Hazardous Waste-Absolute entry)						
(1) Used lubricant oil from maintenance (including of container) and oil from oil separator	13 02 08 (waste engine, gear, and lubricating oils) and 13 05 06 (oil from oil/water separators)	3 tons/year	100 % External Recycle	closed 200 liters containers	waste storage building	sending to dispose of by waste disposers with an approval by the Department of Industrial Works
(2) Used chemical containers	15 01 (packaging) 15 01 05 (composite packaging)	0.2 tons/year	-	hazardous waste containers	waste storage building	sending to dispose of by waste disposers with an approval by the Department of Industrial Works
2.2 Non-hazardous waste						
(1) Ash from the boiler combustion chamber	10 01 01 (bottom ash, slag and boiler dust (excluding boiler dust mentioned in 10 01 04)) and 19 80 02 (solid wastes, such as particulates collected from air pollution controlsystem)	5,000 tons/year	100 % External Recycle	ash disposal pond	ash disposal pond ash dumping pond	given to farmers for soil conditioning or can be used to produce fertilizer or bricks
(2) Deteriorated membrane and activated carbon from water treatment system	19 09 05 (saturated or spent ion exchange resins)	1,200 liters/year	-	closed 200 liters containers	waste storage building	sending to dispose of by waste disposers with an approval by the Department of Industrial Works
(3) Sludge from water treatment system	19 09 02 (sludges from water clarification)	1 m^3/year	-	closed 200 liters containers	water treatement plant area	sending to dispose of by waste disposers with an approval by the Department of Industrial Works

1) Waste from consumption of worker

General waste generated from the office building and routine activities of workers. The majority of waste are paper, unused material, and food residue with the quantity of approximately 65 kilograms/day or 21 tons/year (calculated from waste generate of 1.0 kilogram/person/day x number of workers of 65 persons). This category of waste is not required to follow the Notification of Ministry of Industry on waste or unused material disposal B.E.2548 but must comply with the Public Health Act (No.2) B.E.2550. The Project has the policy to recycle this category of waste as must as possible. Waste from sorting at the generating source will be collected in waste containers provided in the area. The containers have a capacity of 200 liters each. There is three type of waste containers, wet waste, dry waste, and hazardous waste. In this step, waste will be sorted again prior sending to Baan Na Municipality to dispose. (**Appendix 2-9**).

2) Industrial waste

Industrial waste generated from the Project can be classified into two categories as follows:

(a) Hazardous waste-absolute entry

a) Used lubricant oil from maintenance (including of container) and oil from oil separator are hazardous wastes in the waste code 13 02 08 (waste engine, gear, and lubricating oils) and 13 05 06 (oil from oil/water separators) in according to the Notification of Ministry of Industry on waste or unused material disposal B.E.2548 issued under Factory Act B.E.2535. The quantity of hazardous waste is approximately 3 ton/year. It will be collected in closed 200 liters containers in waste storage building before sending to dispose of by waste disposers with an approval by the Department of Industrial Works.

b) Used chemical containers are classified as hazardous waste with the waste code 15 01 (packaging) 15 01 05 (composite packaging) in according to the Notification of Ministry of Industry on waste or unused material disposal B.E.2548. The quantity of the hazardous waste is approximately 0.2 ton/year. It will be collected in hazardous waste containers in waste storage building before sending to dispose of by waste disposers with an approval by the Department of Industrial Works.

(b) Non-hazardous waste

a) Ash from the boiler combustion chamber can be categorized into two types, fly ash and bottom ash. It is a waste of the waste code 10 01 01 (bottom ash, slag and boiler dust (excluding boiler dust mentioned in 10 01 04)) and 19 80 02 (solid wastes, such as particulates collected from air pollution control system) in according to the Notification of Ministry of Industry on waste or unused material disposal B.E.2548 issued under Factory Act B.E.2535. It is a non-hazardous waste with a quantity of approximately 5,000 tons/year. Ash is generated from the combustion of the boiler and fall to the bottom of the chamber and flows to wet ash conveying system and ash dumping pond with a capacity of 23 cubic meters (**Figure 3.5.3-4**). The water that is separated out from the water will circulate to the wet ash conveying system. The collected ash will be disposed of in the ash disposal pond in the Project with a capacity of approximately 10,000 cubic meters each pond. One pond can serve for two years. The ash disposal pond will be lined with HDPE as shown in **Figure 3.7.3-1**. The generated ash will be given to farmers for soil conditioning or can be used to produce fertilizer or bricks. Trucks will be used to transport the ash, the wheels will be cleaned prior to leaving the Project.

Nevertheless, the Project will construct two ponds of the disposal pond at a time (one pond is a spare pond). In case that the pond is filled up and no utilization of the ash, the Project will close the pond with HDPE, fill up with soil, and plant grass over the pond as shown in **Figure 3.7.3-2**. The Project's ash disposal pond covers an area of 33,600 square meters or 21 rai that can dispose of ash for more than 5 years.

b) Deteriorated membrane and activated carbon from water treatment system are classified as non-hazardous waste in a group of 19 09, wastes from the preparation of water intended for human consumption or water for industrial use. It is a waste of the waste code 19 09 05 (saturated or spent ion exchange resins) in according to the Notification of Ministry of Industry on waste or unused material disposal B.E.2548. It is a non-hazardous waste with a quantity of approximately 1,200 liters/year. It will be collected in closed 200 liters containers in waste storage building before sending to dispose of by waste disposers with an approval by the Department of Industrial Works.

c) Sludge from water treatment system is classified as non-hazardous waste in a group of 19 09, wastes from the preparation of water intended for human consumption or water for industrial use. It is a waste of the waste code 19 09 02 (sludge from water clarification) in according to the Notification of Ministry of Industry on waste or unused material disposal

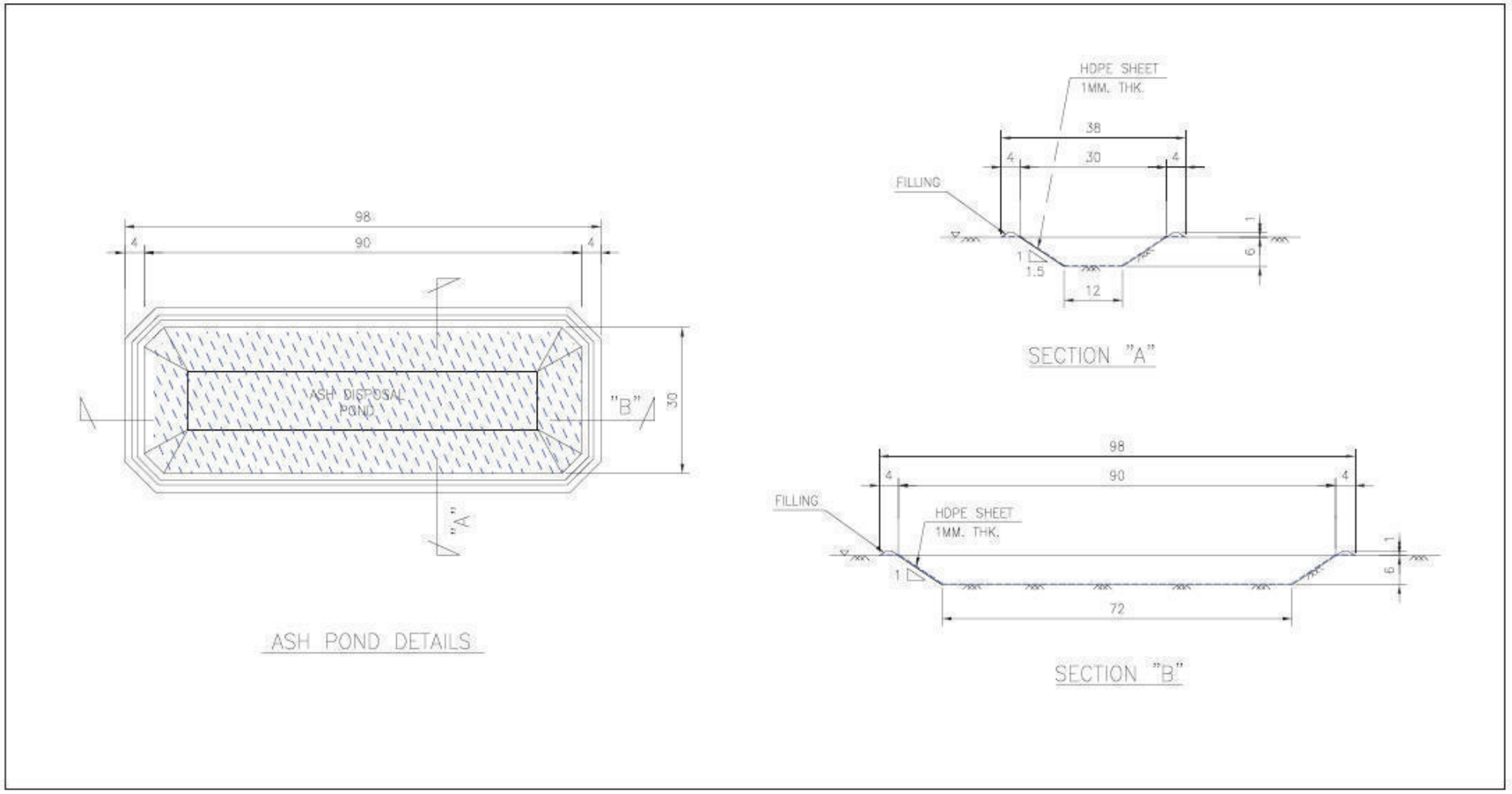


Figure 3.7.3-1 Ash Disposal Pond

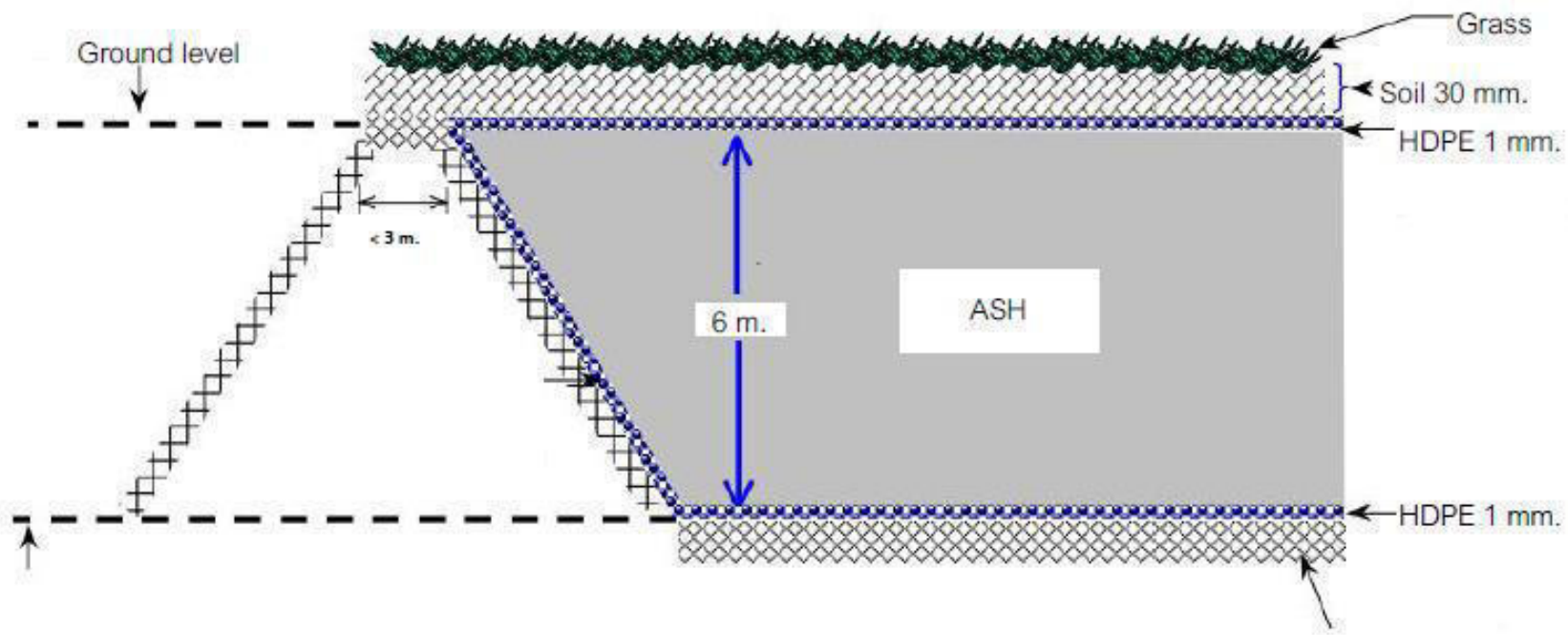


Figure 3.7.3-2 Ash Disposal

B.E.2548. It is a non-hazardous waste with a quantity of approximately one cubic meter/year. It will be disposed of by a waste disposer with an approval by the Department of Industrial Works.

(2) Waste storage building

The waste storage building will be constructed on an area of 112 square meters (**Figure 3.7.3-3**). It is an open building with a roof to store wastes for less than 90 days before sending out to dispose of. Wastes will be stored separately by type. Labels will be provided. The operation will comply with the Notification of the Ministry of Industry on hazardous waste manifest system B.E.2547. The building will be weekly monitored. The Project will provide a fire extinguisher to be prepared in case of fire. Furthermore, a sump will be provided to collect washed water in case of leakage. However, the waste transfer will not be at the same time for all wastes. normally, the Project will contact the waste disposer to bring the waste out immediately after the transfer. Wastes will be stored over a short period of time before the waste disposer to pick up waste. In addition, there are many waste disposers presently. Thus, the Project has more options to dispose of the wastes without keeping them in the Project for a long period of time.

3.7.4 Noise level

(1) Source of noise

Sources of noise from the Project are machinery and equipment which are a boiler with a capacity of 98 ton/hour, a power generator with a capacity of 25 MW, and a cooling tower. Each production unit was designed to generate noise during normal operation of not over 85 dB(A) at a distance of one meter from the machine. At the shredder building, it was designed to generate noise of not over 85 dB(A) at of one meter from outside of the shredder building.

(2) Management

In the area that generates loud noise, the Project will set a plan to put warning signs for the workers to be aware and use personal protective equipment for their own safety. Normally, the workers will work in the area for some time only for inspection and the process record. In the design phase, the Project set a preventive measure to prevent noise impacts by reducing the noise level at source by laying of machine and equipment according to engineering and safety principles.

Moreover, the Project will control the noise level at the distance of one meter from the Project fence not to higher than 70 dB(A) in accordance with the Notification of the Ministry of Industry on noise level and noise from industrial operation B.E.2548. As indicated earlier, mitigation measures detailed in

the EMP will be applied to comply with Thai law and IFC guidelines, as required, and strict monitoring activities will be done to check progress of EMP implementation.

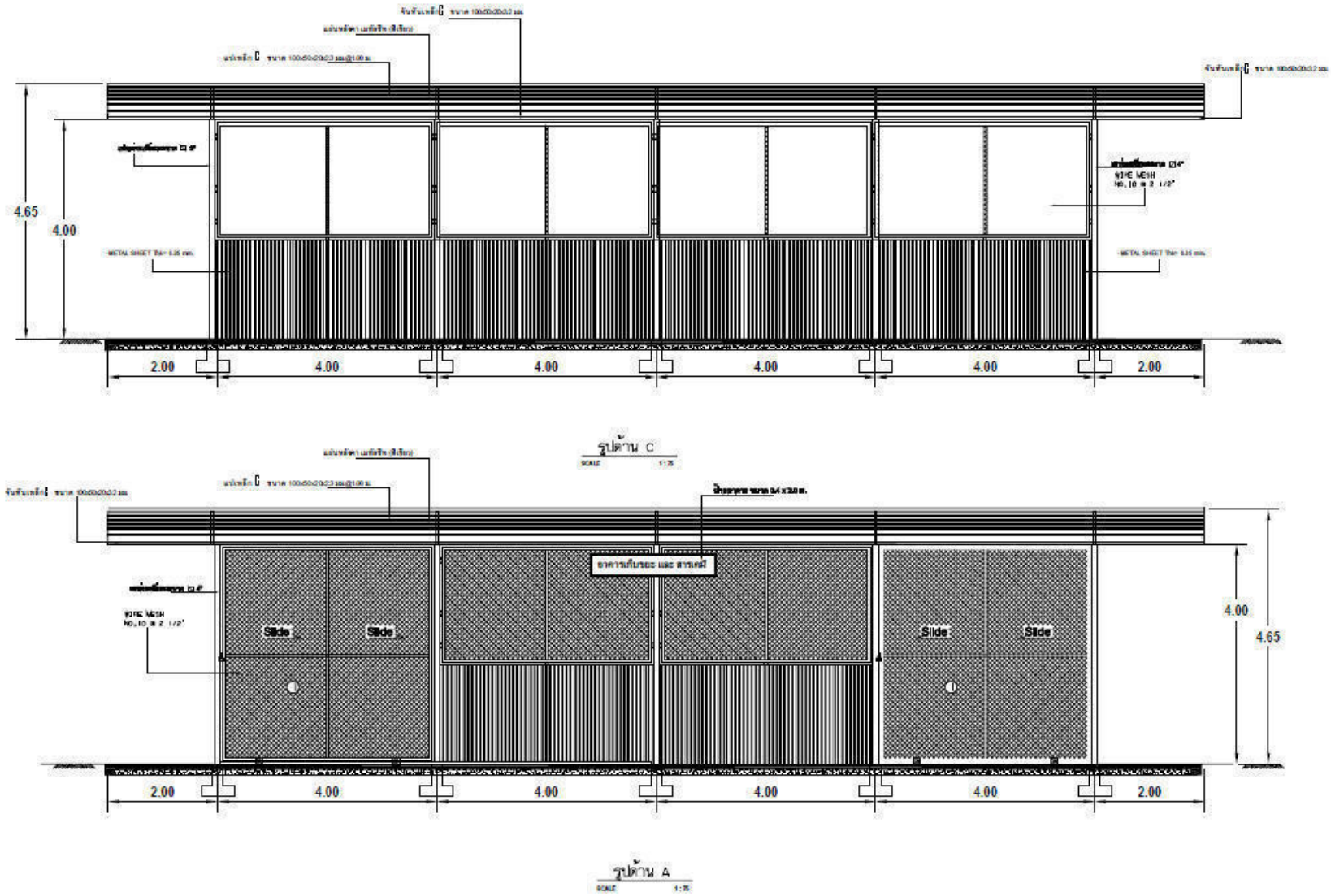


Figure 3.7.3-3 Waste storage building

Rev.	Date	Description	Checked	Approved
		For Bidding		

Powered by Gulf Electric

Approved	N.Yutapong	
Checked	R.Soonthorn	
Designed	T.Numtawut	
Drawn	T.Numtawut	

Description: รูปด้าน A,C

Project.	โครงการก่อสร้างอาคารเก็บขยะอันตราย		
Scale	1:75	Sheet	Rev.
Dwg. no.	AA-03	EE-XX	00
File Name	อาคารเก็บขยะอันตราย		

3.8 Water drainage system and flood prevention

3.8.1 Water drainage system

From the survey and contour line of the area that the Project considered in the design and construction of the Project (**Figure 3.8.1-1**). The water reservoir will be used to slow the water flow and unchanged from the existing. Moreover, the Project will construct water drainage system in the area that the flow direction complies with the terrain. It is a separate system that wastewater and rainwater will be collected separately as shown in **Figure 3.8.1-2**. Wastewater of the Project will flow through the wastewater gutter to the wastewater treatment system.

Nevertheless, the assessment to retain rainwater was done by considering the overall picture of the area. The Rational Method was used as follow:

$$Q = 0.278 \times 10^{-6} CIA$$

Q = Peak discharge (cubic meter/second)
C = Runoff coefficient
I = Rainfall intensity
A = Discharge area (square meter)

The discharge area was divided into three sub-areas, discharge area A, B, and C (**Figure 3.8.1-3**). From the calculation of rainwater retention of the Project (**Appendix 2-11**), it was found that the rainwater quantity to be retained is 35,937.57 cubic meters/three hours. The Project will use the reservoir with a capacity of 370,000 cubic meters for rainwater retention, it can be seen that the reservoir is capable of receiving the rainwater.

3.8.2 Flood prevention

The study of flood problems along the main water bodies of Nathawee canal water basin is a study of flood conditions in the past as well as in the future after the development of the Project. In this

study, a mathematical model was used as a tool. Data were collected and input in the prepared model. The model was modified for reliability before applying in this study of the flood. The mathematical model used in the flow direction of the flood in this study was MIKE11 which was developed by the Danish Hydraulic Institute (DHI), Denmark. MIKE11 consists of many modules. MIKE11-HD and MIKE11-NAM were used in this study.

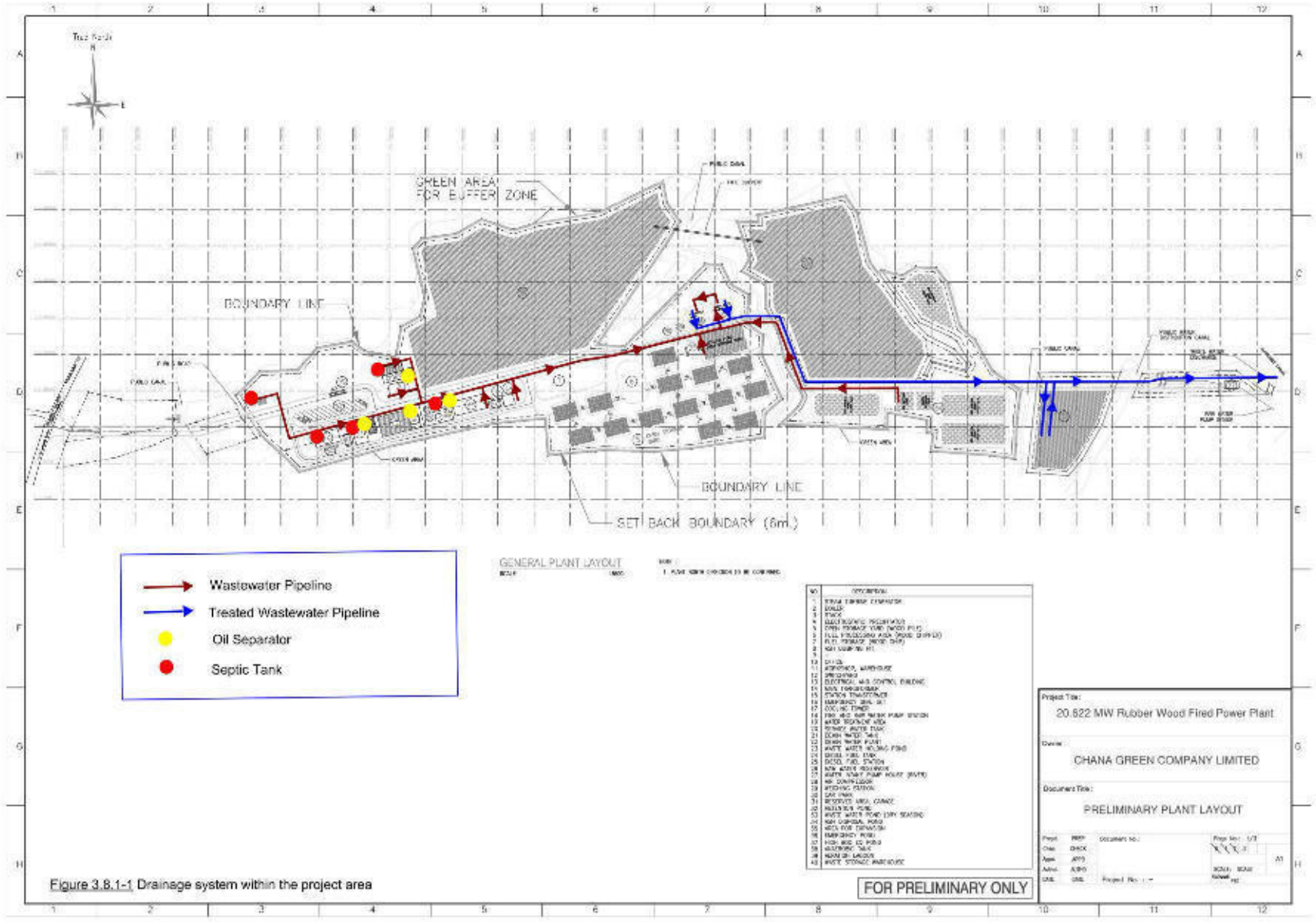


Figure 3.8.1-1 Drainage system within the project area

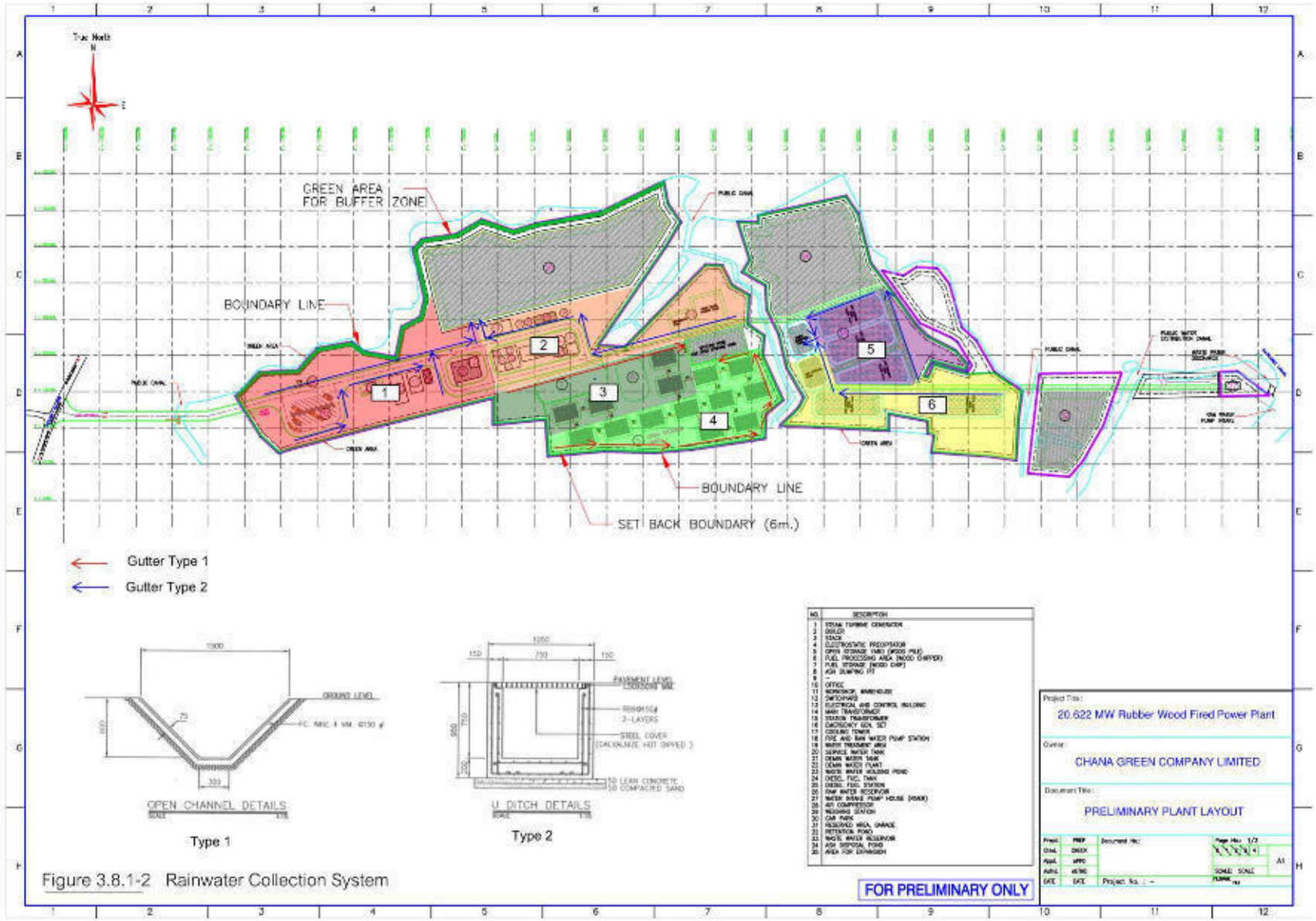


Figure 3.8.1-2 Rainwater Collection System

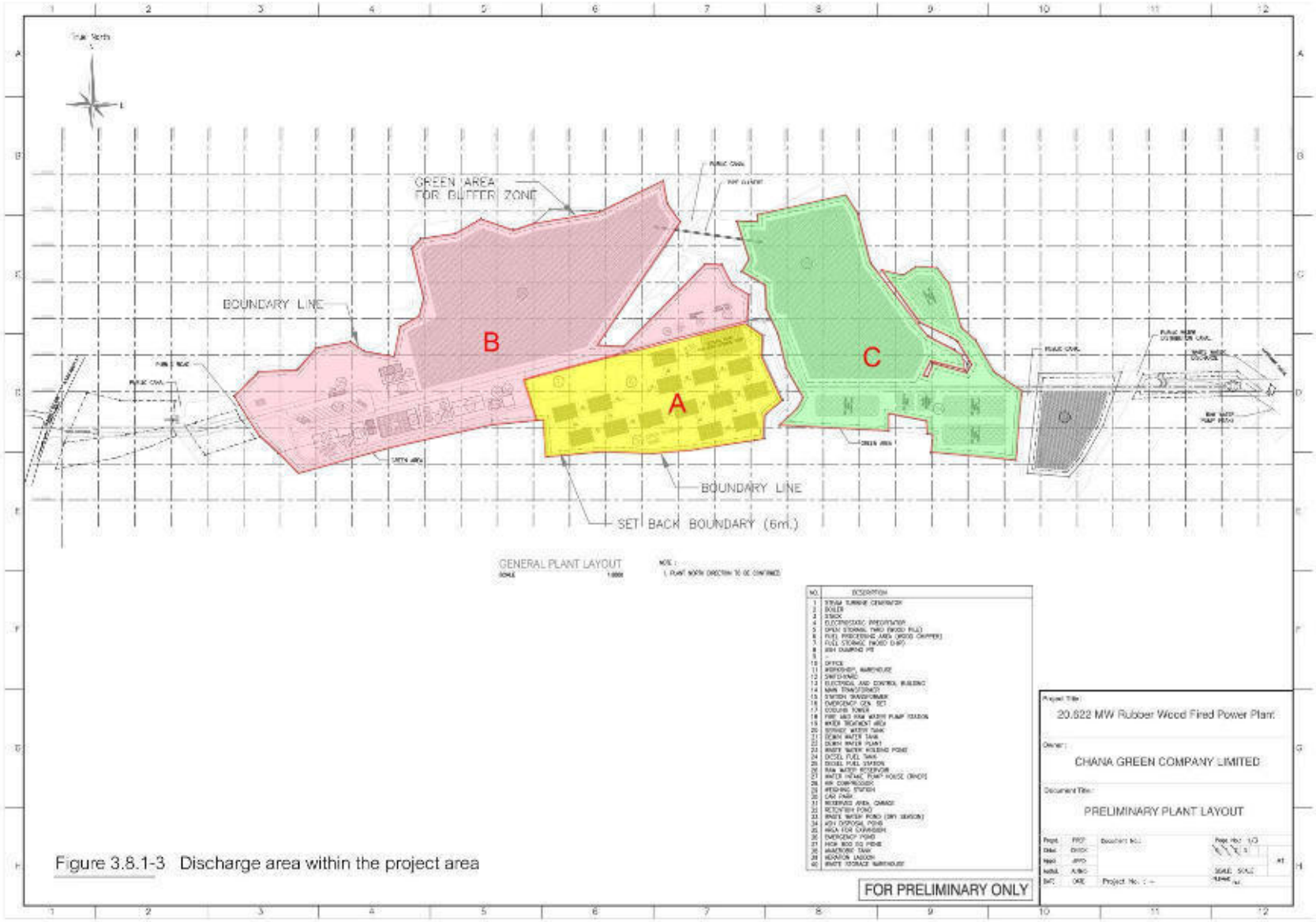


Figure 3.8.1-3 Discharge area within the project area

(1) Flood statistic

From the statistic of the flood in the southern region, it was found that the majority of southern province faces with a high frequency of flood in which occur every year. For the Project area, it was found that flood frequency was four-seven times in the past ten years or counted for 58.18 percent of the Project area as shown in **Figure 3.8.2-1**.

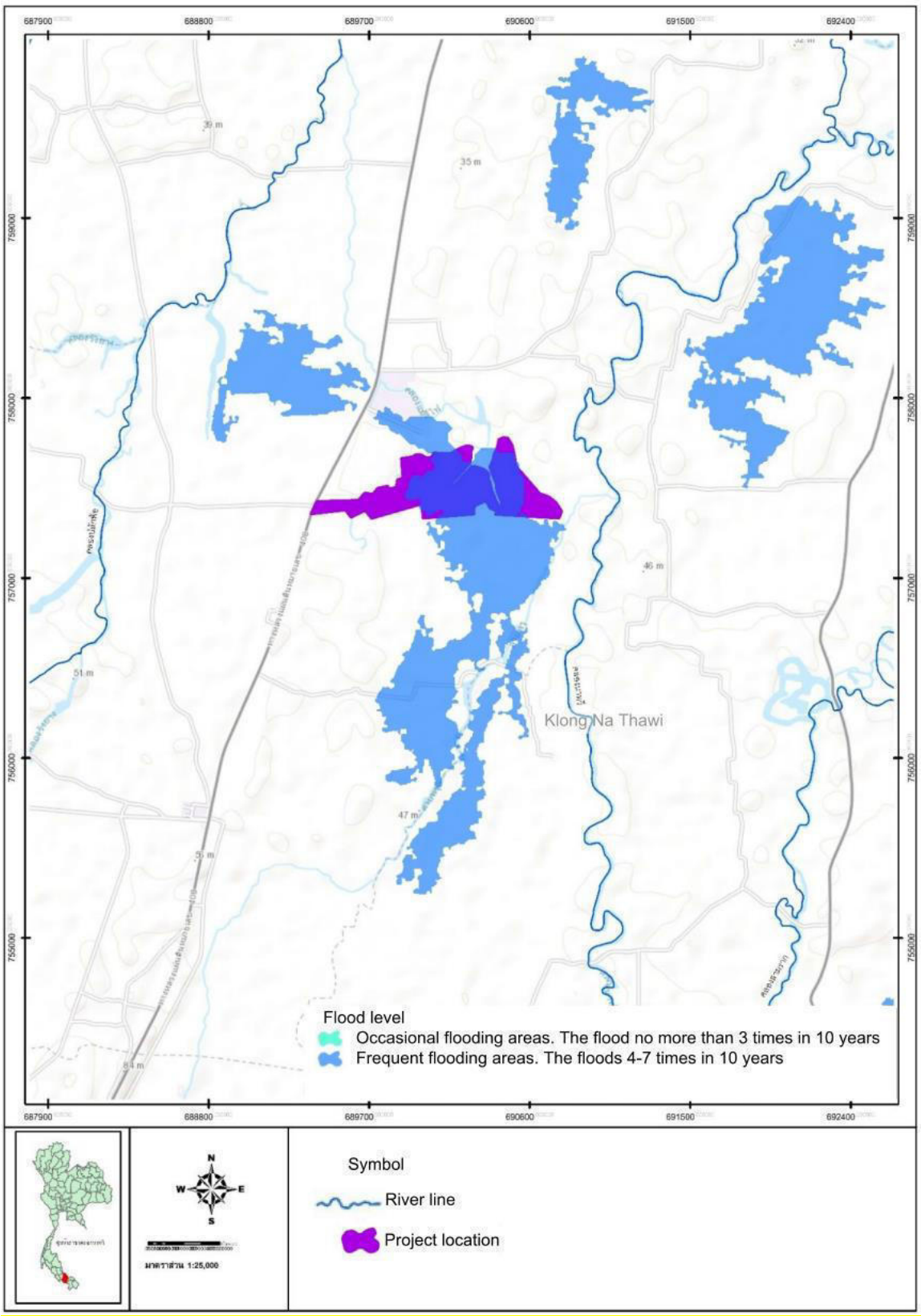
The results of the study are divided into three parts which are steady flow at recurrence year 50, 100, and 200 years. From the longitudinal cross-sectional of the canal that flows from left to right indicates the bottom level of the canal, the level of the left and right banks, and water level calculated by the model. It was found that flood begins at the lower bank (right) at the level of +11.31, +11.55, and 11.79 msl, respectively. Thus, flood prevention dyke that was designed at the level of +12.00 msl can prevent flood in the area. There are two recommendations as flows:

1) **Construction of dyke** around the Project area to prevent flood with the height of +12 msl (two meters) or about two meters from the ground

2) Construction of reservoir to receive runoff from rainfall in the Project area. The capacity must be appropriate and capable of receiving the rainfall in the Project area. The assessment of the runoff was done by using Rational Method. The Project will construct a water reservoir with a capacity of 370,000 cubic meters.

(2) Flow direction of local flood before development of the Project

The study of the Project area by using Geographic Information Systems (GIS) found that the flood flow direction before the Project development is accordance with the slope from south to north. Thus, the flow of local flood direction is from south to north as shown in **Figure 3.8.2-2**.



Source: Land Development Department (2013)

Figure 3.8.2-1 Flood area in the Project area

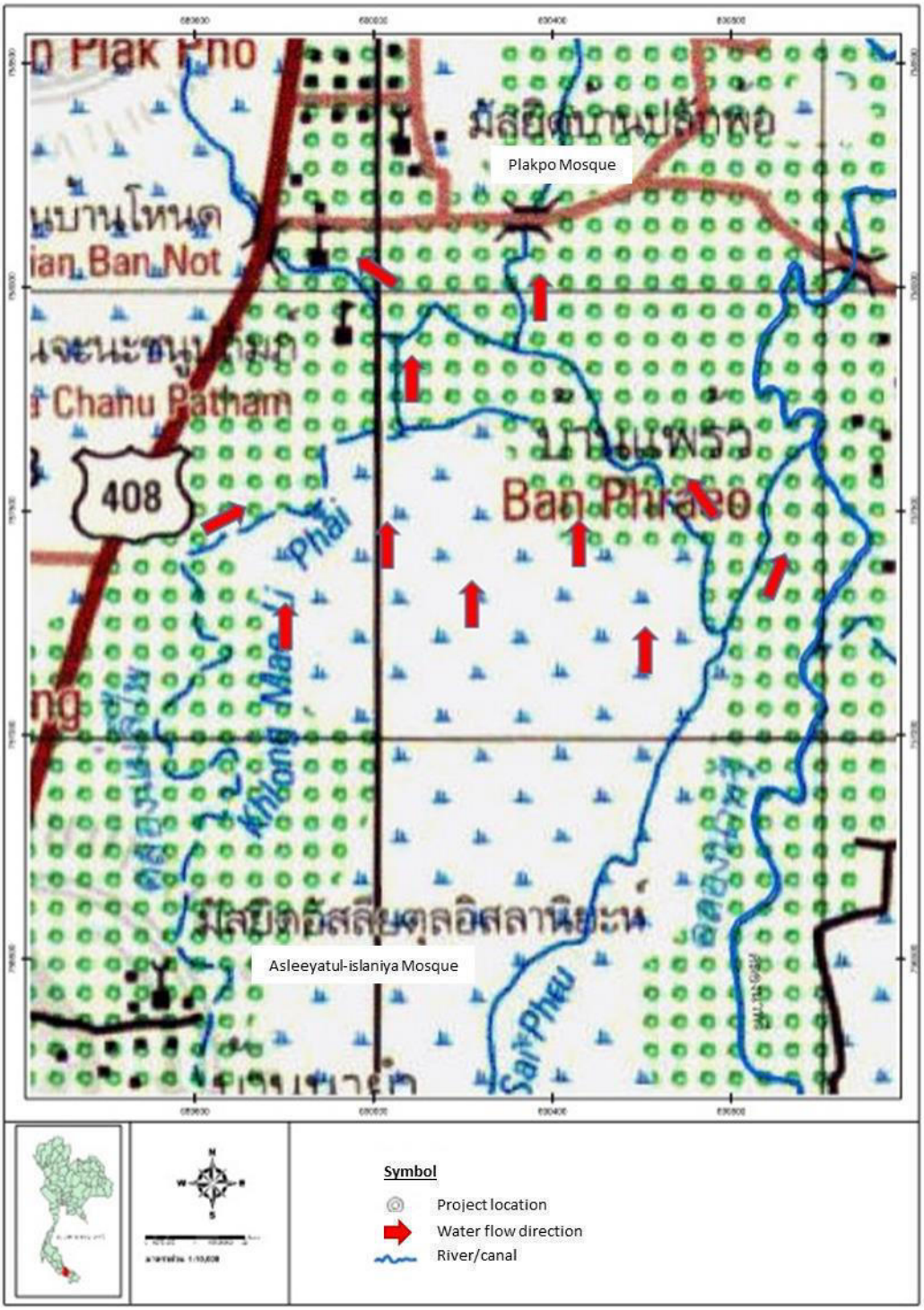
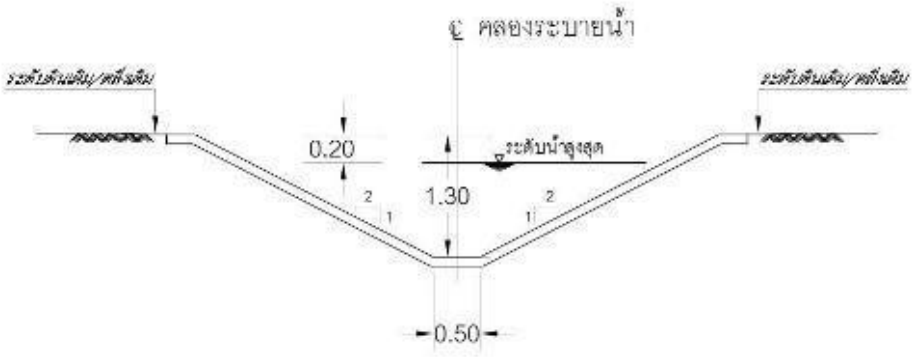


Figure 3.8.2-2 Flow direction of local flood be the Project development

(3) Flood protection other Area

From T_c that used recurrence of five years, the relationship of rain intensity-time period-recurrence year are I=74.88 mm/h, C=0.30. Thus, Q = 1.87 cubic meters/second. From the calculation Q = 1.99 cubic meters/second which is higher than 1.87 cubic meters/second. Thus, it is acceptable. Therefore, the cross-sectional of the drain canal can be obtained as shown in **Figure 3.8.2-3**.



Source: Analyzed by the Consultant

Figure 3.8.2-3 Cross-sectional of the drain canal to be improved

3.9 Project management

Organization chart of the Project is shown in **Figure 3.9-1**. The Project will employ 65 workers and the operation hours are divided into two shifts.

3.10 Occupational health and safety

3.10.1 Occupational health and safety and environmental policy

Chana Green Company Limited concerns on the live and health of the employees. Thus, the Company aims to provide occupational health and safety and environmental practice along with the working routine. The Company set the following policy.

(1) Safety at work is the first duty of the workers in all levels.

(2) The Company will support the improvement of the working environment and will provide appropriate and adequate personal protective equipment.

(3) The Company will support safety activities that will help encourage the safety concern of the employees such as safety training and promoting.

(4) The supervisor in all levels must be a good model and has a leadership to train the employee about safety working.

(5) All employees must concern about their own safety as well as colleagues and the Company's properties throughout the operation.

(6) Every employee must keep the working area clean.

(7) Every employee must cooperate in occupational health and safety projects and be able to give an opinion to improve the working conditions and operations.

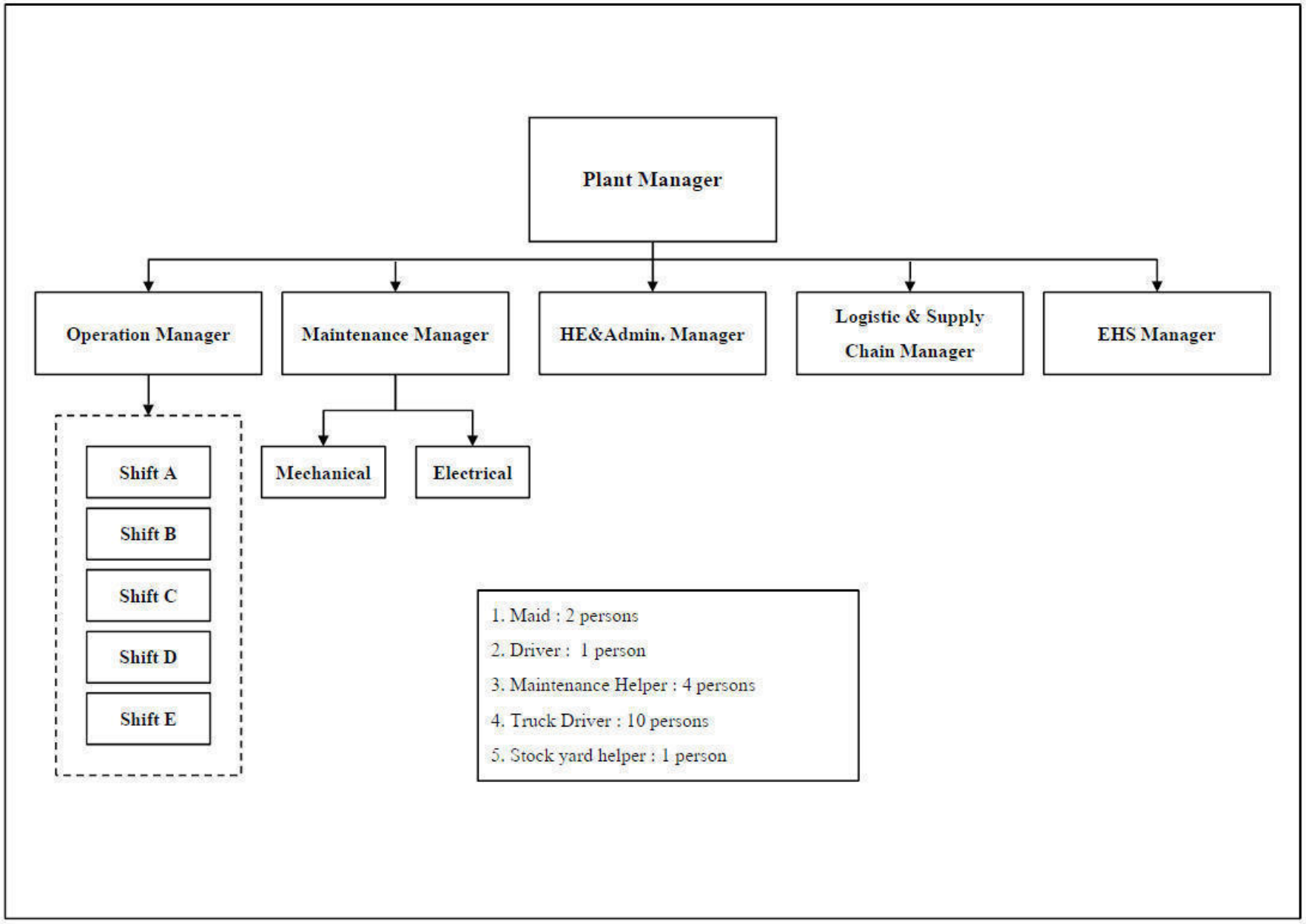


Figure 3.9-1 Organization Chart

(8) The Company will assess the risk of operational steps to prevent the danger that may incur as a result of the operation.

(9) The Company will evaluate the occupational health and safety and environmental operation according to the policy to achieve the highest efficiency of the operation.

3.10.2 Occupational health and safety and environmental committee

The Project will appoint an occupational health and safety and environmental committee in accordance with the Ministerial Regulation (Ministry of labor) on the standard of occupational health and safety and environmental management B.E.2549 (amended by the Ministerial Regulation (Ministry of Labor) on the standard of occupational health and safety and environmental management (No.2) B.E.2553. The regulations stated that a working place with higher than 50 employees must provide an occupational health and safety and environmental committee. Thus, the Project has set the responsibilities as follows:

(1) Consideration of policies and plans related to safety at work as well as safety practice beyond the work to prevent and reduce the chance of accident and illness or nuisance related to work or unsafe conditions

(2) Report and recommend about measures or corrections that lead to the operation that complies with safety laws and regulations to the employer to ensure safety of the employees, contractor, and visitors

(3) Support and promote safety activities in the work.

(4) Consider the safety rules and manual as well as safety standard of the workplace and report to the employer

(5) Survey on safety practices in the workplace and investigate the accident statistic for at least once a month

(6) Consider projects or plans related to safety training including of projects or plans related to responsibility of the employer, management, supervisor, and all levels of employees to report to the employer

(7) Set a reporting system for unsafe conditions to be a duty of all levels employees

(8) Keep tracking of the issues reported to the employer

(9) Report the annual operation to the employer which includes problems, obstacles, and recommendations of the committee

(10) Evaluate the safety operation of the workplace

(11) Work on safety related tasks assigned by the employer

The regulations specified that the occupational health and safety and environmental committee may vary depending on the size of the workplace. The project that will have about 65 employees must have a number of the committee of seven people at least. The committee consists of a president, two management representatives, three employee representatives, and a secretary (safety officer).

3.10.3 General rules

The safety office has set safety rules as follows:

(1) Wear helmet all the times in construction area
(2) Wear shoes (rubber or canvas), slippers are prohibited
(3) Wear safety goggles in welding, grinding, and concrete breaking work
(4) Wear mask in presence of dust or air pollution
(5) No smoking outside the designed area
(6) Wear gloves in risky work such as steel cutting, steel holding, and sling binding
(7) Wear protective equipment (earmuffs) when working in loud noise area
(8) Wear safety belt when working on a high
(9) Wear tight clothes and do not let shirt out of plants
(10) Playing during work is prohibited
(11) Keep equipment in place for safety reason
(12) Check tools and equipment every time before work to ensure safety
(13) Speed limit at 30 kilometers/hour in the Project area
(14) Strictly follow the warning signs
(15) Provide work permit system

To work in the Project, the safety division has set a list of work that works permit is required, as follows:

(1) Work at high
(2) Hot work such as welding, cutting, grinding, and drilling that causes sparks
(3) Confine space (confine space entry permit)

3.10.4 Safety annual plan

(1) Notify the name of safety officer in accordance with the Notification of Department of Labor Protection and Welfare on rules and procedures to notify the name of safety officer and reporting in case of injury, illness, or loss

(2) Prepare a safety report of the safety officer and technical level safety officer (Jor Por. (Wor) and Jor Por. (Thor) forms)

(3) Prepare a chemical details report in accordance with the Regulation of Ministry of Labor on occupational health and safety and environmental management related to chemicals B.E.2556 article 2 (Sor Aor.1 form)

(4) Prepare a fire drill and firefighting report in accordance with the Regulation of Ministry of Labor on occupational health and safety and environmental management related fire prevention and suppression B.E.2555 article 30

(5) Provide training on following safety issues

1) Before work training for new employees and contractors
2) Personal protective equipment
3) Fundamental of the use of fire extinguishers and firefighting
4) Fundamental of fire drill and evacuation
5) Use of chemical and SDS

(6) Safety week

(7) Inspection of alarm and fire systems

(8) Investigation of accident, illness, or nuisance that has been reported and provide recommendation to prevent such case

(9) Collect and analyze safety statistic and prepare the report with recommendations related to hazard, illness, or nuisance

3.10.5 Personal protective equipment

(1) Providing of personal protective equipment

The Project has a policy related to personal protective equipment (**Table 3.10.5-1**). The selection of personal protective equipment will be done by conducting a survey of type and number of personal protective equipment required by the division. Personal protective equipment usage standard and warning signs will be promoted among the workers. The inspection and evaluation of the use will be done regularly.

(2) Training on personal protective equipment

1) New employees

The training course on the use and maintenance of personal protective equipment will be provided for new employees. The training will be provided to the employees again every year.

Table 3.10.5-1

Checklist for Personal Protective Equipment

	Type of devices	Department					Remark
		Production	Maintenance	Occupational Safety and Health	Supply Chain and Logistics	Human Resources and Administrative	
1	Safety Helmets	☆	☆	●	●	☆	
2	Glasses	☆	☆	☆	☆	☆	
3	Glasses Dimming	☆	☆	☆	☆	☐	
4	Dimming Mask	☆	☆	☆	☆	☐	
5	Earplugs reduce noise	●	●	●	●	☆	
6	Chemical Mask	☆	☆	☆	☆	☐	
7	Mask	●	☆	●	●	☆	
8	Leather gloves	☆	☆	●	●	☆	
9	Fabric gloves	☆	☆	☆	☆	☆	
10	Rubber glove	☆	☆	☆	☆	☆	
11	Rubber boots	☆	☆	☆	☆	☆	
12	Safety Shoes	●	●	●	●	☐	☐Don't need to use
13	Safety Belt & Lift Line	☆	☆	☆	☆	☆	
14	Chemical protective apron	☆	☆	☆	☆	☆	
15	Reflective vest	☐	☐	☆	☆	☆	

Source : Chana Green Company Limited, 2016

2) General employees

For general employees, the Project will provide a training related to the type of the personal protective equipment at the division that the equipment is used and will provide the same training if the division request. This is to raise awareness of the practice.

3.10.6 Occupational health and safety welfare

The Project will operate in accordance with the Ministerial Regulation (Ministry of labor) on welfare in workplace B.E.2548 which stated that a workplace with ten workers or higher must provide adequate medical supplies and medicines for at least 29 items.

Nevertheless, the Project will provide medical supplies and medicines in order to comply with the regulation above in the case of illness or injury. For severe injury, the Project will send the injury to Chana Hospital which is the nearest hospital locates about seven kilometers from the Project. It will take less than ten minutes to travel.

3.10.7 Health check

The Project will provide a health check for the new employees. For existing employees, the project will provide an annual health check. This complies with Ministerial Regulation (Ministry of labor) on rules and guideline on providing health check to workers B.E.2547 issued under Labor Protection Act B.E.2541. Details of the annual health check are as follows:

- Expose to dust: check lung function
- Expose to loud noise: check hearing ability
- Expose to heat: check kidney function (BUN)
- Detailed work that required to use eyes for long: check visual performance

Nevertheless, detail of the health check will be depending on an occupational medicine doctor or a doctor that qualified with the criteria specified by the General Director of Department of Labor Protection and Welfare.

Moreover, in order to prevent the health impacts of the employees, the Consultant has set measures for the Project to implement as follows:

(1) Check the health of the new employees before work and provide annual health check in accordance with the risk

(2) Check the health of employees in which the checking details are depending on an occupational medicine doctor or a doctor that qualified with the criteria specified by the General Director of Department of Labor Protection and Welfare

(3) Analyze the relationship of the checked results with the environmental conditions every year to find out cause of abnormal found whether or not relating to the working environment, if yes, fix the problem and appropriately help the affected employee in case by case basis

3.10.8 Installation and testing of fire equipment

(1) Installation of fire equipment

The design of the Project's alarm and fire system was done in accordance with the standards of Engineering Institute of Thailand under the H.M. the King's Patronage, Notification of the Ministry of Industry on fire prevention and suppression B.E.2552, NFPA, and Regulation of Ministry of Labor on occupational health and safety and environmental management related fire prevention and suppression B.E.2555.

The layout of fire pipes and fire equipment of the Project as well as firefighting radius are shown in **Figure 3.10.8-1** and **Figure 3.10.8-2**, respectively. The design of firefighting equipment is shown in **Table 3.10.8-1** and can be summarized as follows:

(2) Firewater

The quantity of fire water was considered based on a group of building and fire water pipe. It was used to calculate the quantity of fire water and size of the fire pump. The design was done to cover the whole Project area as follows:

1) Water source is the water reservoir with a capacity of 270,000 cubic meters
2) Install a set of diesel fire pump with a capacity of 1,250 gallons/minute with a pressure of nine bar, a set of electric fire pump with a capacity of 1,250 gallons/minute with a pressure of nine bar, and a set of electric jockey pump with a capacity of 50 gallons/minute with a pressure of ten bar

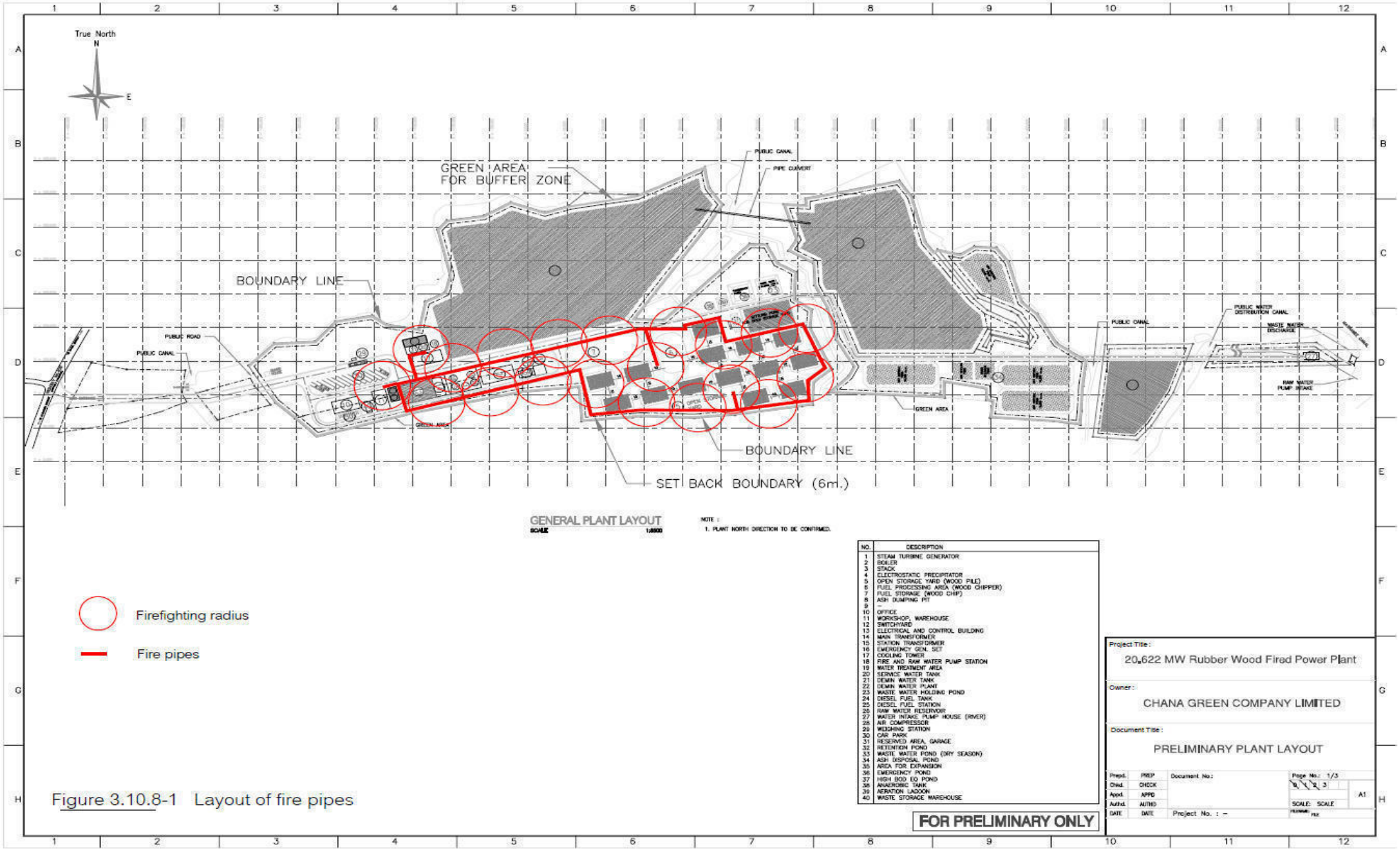
(3) Fire truck

The Project will provide a fire truck with a capacity of 6,000 cubic meters equipped with fire equipment.

Table 3.10.8-1

The installation of fire extinguishers for project

Type	Location	Quantity	Area (m^2)	Method	Standard design	
					Foreign	Thailand
1. Firefighting pump building	Water treatment plant					
2. Fire pump						
2.1 Diesel fire pump 1,250 gallons/minute	Water treatment plant	1	-	25-5,000 gallons/minute or	NFPA 20	standards of Engineering Institute of
with a pressure of 9 bar				4.5-1,134 m^3/hr		Thailandunder the H.M. the King's Patronage
2.2 Electric fire pump 1,250 gallons/minute				with a pressure of 6.8 bar		
with a pressure of 9 bar						
2.3 Electric jockey pump 50 gallons/minute		1	-			
with a pressure of 9 bar						
3. Fire Hose Cabinet	Power Block Area	3	3,500	safe distance between cabinet	NFPA 14	Notification of the Ministry of Industry on
(1) Nozzle Fire	Switchyard and Electric transformers	1	1,200	less than 64 meters		fire prevention and suppression B.E.2552
(2) Hose Station	Wood Shredder and Fuel Storage House	4	7,000			
	Open Storage Yard	6	32,300			
	Control Building	1	400			
4. Portable Dry chemical Fire Extinguisher (ABC)	Power Block	4	3,500			
	Switchyard and Electric transformers	2	1,200			
	Water Treatment and Waste Water Treatment Area	1	1,000			
	Cooling tower and Pump	2	1,600			
	Diesel tank	1	25	1,045 m^2/tank	NFPA 10	Notification of the Ministry of Industry on
	Wood Shredder and Fuel Storage House	7	7,000			fire prevention and suppression B.E.2552
	Control Building	1	400			
	Workshop and Warehouse	1	700			
	Administration and Guardhouse	2	1,900			
	Raw Water Pumping Station	1	30			



NO.	DESCRIPTION
1	STEAM TURBINE GENERATOR
2	BOILER
3	STACK
4	ELECTROSTATIC PRECIPITATOR
5	OPEN STORAGE YARD (WOOD PILE)
6	FUEL PROCESSING AREA (WOOD CHIPPER)
7	FUEL STORAGE (WOOD CHIP)
8	ASH DUMPING PIT
9	–
10	OFFICE
11	WORKSHOP, WAREHOUSE
12	SWITCHYARD
13	ELECTRICAL AND CONTROL BUILDING
14	MAIN TRANSFORMER
15	STATION TRANSFORMER
16	EMERGENCY GEN. SET
17	COOLING TOWER
18	FIRE AND RAW WATER PUMP STATION
19	WATER TREATMENT AREA
20	SERVICE WATER TANK
21	DEMIN WATER TANK
22	DEMIN WATER PLANT
23	WASTE WATER HOLDING POND
24	DIESEL FUEL TANK
25	DIESEL FUEL STATION
26	RAW WATER RESERVOIR
27	WATER INTAKE PUMP HOUSE (RIVER)
28	AIR COMPRESSOR
29	WEIGHING STATION
30	CAR PARK
31	RESERVED AREA, GARAGE
32	RETENTION POND
33	WASTE WATER POND (DRY SEASON)
34	ASH DISPOSAL POND
35	AREA FOR EXPANSION
36	EMERGENCY POND
37	HIGH BOD EQ POND
38	ANAEROBIC TANK
39	AERATION LAGOON
40	WASTE STORAGE WAREHOUSE

FOR PRELIMINARY ONLY

Project Title :
20.622 MW Rubber Wood Fired Power Plant

Owner :
CHANA GREEN COMPANY LIMITED

Document Title :
PRELIMINARY PLANT LAYOUT

Prepd.	PREP	Document No.:	Page No.: 1/3
Chkd.	CHECK		0 1 2 3
Appd.	APPD		A1
Authd.	AUTHD		SCALE: SCALE
DATE	DATE	Project No. : –	FILENAME: FILE

Figure 3.10.8-1 Layout of fire pipes

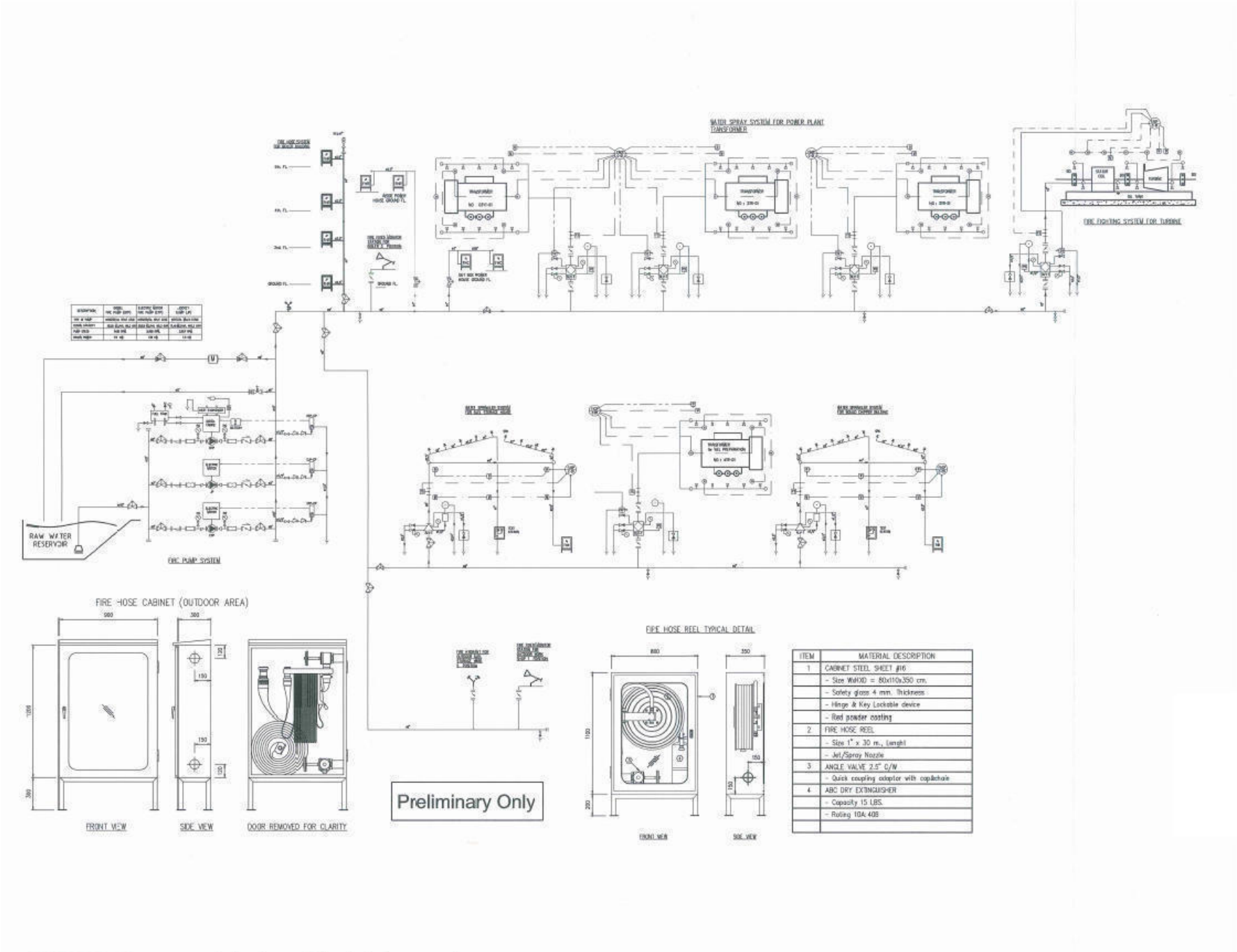


Figure 3.10.8-2 Conceptual design of firefighting equipment

Table 3.10.8-1 (cont.)

Type	Location	Quantity	Area (m^2)	Method	Standard design	
					Foreign	Thailand
5. Fire Alarm System	Power Block	1	3,500	All floor If there are 2 or more levels/ 300 m^2 or above	NFPA 72	Regulation of Ministry [1/]
	Switchyard and Electric transformers	1	1,200			
	Water Treatment and Waste Water Treatment Area	1	1,000			
	Cooling tower and Pump	1	1,600			
	Wood Shredder and Fuel Storage House	1	7,000			
	Control Building	1	400			
	Workshop and Warehouse	1	700			
	Administration and Guardhouse	1	1,900			
6. Smoke Detector	Administration	30	1,900	installed at a height	NFPA 72	standards of Engineering Institute of
	Control Building	10	400	less than 10.5 m		Thailandunder the H.M. the King's Patronage
				safe distance between detector		
				less than 9 m		
7. Heat Detector	Administration	35	1,900	installed at a height	NFPA 72	
	Control Building	15	400	less than 4 m		
				spacing between detectors		standards of Engineering Institute of
				for horizontal surface		Thailandunder the H.M. the King's Patronage
				less than 7.2 m		
				except walk distance		
				less than 9.5 m		

Note : [1/] Regulation of Ministry of Labor on occupational health and safety and environmental management related fire prevention and suppression B.E.2555

Source : Chana Green Company Limited, 2017

(4) Testing of the fire system

The Project will monitor and test the fire system and prepare a summary report of the results of the test which will be approved by a mechanical engineer and/or safety officer.

3.10.9 Emergency plan

The Project has set an emergency plan for possible cases with the main objective to reduce the harmful to the employees of Chana Green Power Plant and machinery as well as equipment of Chana Green Power Plant. Details are as follows:

(1) Emergency control

In normal working hours, the power plant manager is responsible for safety control of the employees which includes emergency cases. Other than working hours, a shift in charge is responsible for safety control of the employees which includes emergency cases until the situation backs to normal or the power plant manager backs to the power plant and being the coordinator. The emergency cases can be classified into three levels as follows:

1) Emergency level 1: It is an emergency that sub-organization/division can manage the case by using the prepared equipment or it can be clearly seen that the emergency will not get bigger or expand.

2) Emergency level 2: It is an emergency that sub-organization/division cannot deal with or it can be clearly seen that the emergency is severe and possible to cause injury, death, or loss of properties. Moreover, the emergency cannot be suppressed within 30 minutes by using prepared equipment and require help from other division. Thus, the power plant manager must be responsible to the emergency.

3) Emergency level 3: It is an emergency that expanded from the level 2 emergency. The power plant manager considered and see that it is a severe case that possible to cause impacts on the public in which the power plant cannot control the situation. Help from other organizations outside is needed to control the situation.

(2) Fire prevention and suppression plan

In order to comply with the Regulation of Ministry of Labor on occupational health and safety and environmental management related fire prevention and suppression B.E.2555 article 4 states that the workplace with higher than ten workers must provide a fire prevention and suppression plan. The plan must consist of monitoring, training on fire prevention, firefighting, evacuation, and

recovery plan. The employer must keep the fire prevention and suppression plan at the workplace that the investigator can check. Thus, the Project provided the fire prevention and suppression plan in according to the guideline of the Bureau of Labor Safety, Department of Labor.

From the regulations above, the Project provided emergency plans as follows:

- Monitoring plan
- Training plan
- Fire preventive campaign plan
- Fire suppression plan
- Fire evacuation plan
- Recovery plan

1) Monitoring plan

Relevant personnel:

(a) Management
(b) Personnel
(c) Safety officer
(d) Security guard

(a) Management

a) Plant layout management

b) Zoning, production control, and control of tools and equipment that possibly cause fire

c) Setting of code of practice for fire safety

d) Control the use fire, generating of sparks, heat, electrostatic, and others that can cause fire

e) Monitor activities related to fire prevention

f) Setting of a long-term fire prevention plan such as installing of flammable or smoke detection system, fire alarm, and automatic fire system in the presence of flammable or ignitable materials area

(b) Personnel that related to fire prevention

a) The employees must strictly follow the safety rules as follows:
   - Fire in restriction area or in the factory area without permission is prohibited
   - No smoking in the area with the "danger of flammable or explosive material" sign or no smoking in prohibited area
   - Do not fix the machinery or equipment with presence of flammable without a work permit

b) Control of the area with flammable or ignitable material
   Fire in any area must be at least far from the flammable or ignitable material for ten meters. In case of necessary, it must be done under the supervision of the safety officer

c) Fire prevention
   - Prevent the leak of fuel and flammable materials
   - Get rid of flammable waste or materials
   - Flammable material contaminated cloth, the worker must change the cloth immediately
   - Prevention of fire of electricity
     Electrical wire, light bulb, motor switch, fan, and electrical appliances used in the presence of flammable material must be monitored regularly especially on conditions, connection, earth wire, plug, and others that can cause fire
   - Fire prevention from welding activity
     * Welding equipment, wire, and joint that are dilapidated must be fixed
     * Regularly check for leak of joints and valves
     * Gas tube and fuel container must be places at the distance of seven meters from fire
     * During welding, wire and gas tube must not obstruct the way
     * Be aware of fire and sparks on flammable materials

(d) Safety officer

a) Demarcation of areas with risk of fire
b) Regularly check the areas with risk of fire
c) Setting of fire prevention and suppression plan's details as well as

conduct trainings and drills periodically

d) Provide, maintain, and check fire equipment in good conditions all the times

e) Reporting of danger or injury

(e) Security guard

a) Never let outsider enters the factory or the areas with the risk of fire

b) Be aware of casualty at the areas where explosive material is kept or the areas with the risk of fire

c) When exposing to what that would cause fire, report immediately

d) Support firefighting throughout the working hours

Monitoring plan

Area	Responsible person	Checking schedule	Reporting schedule
Fuel chip storage house	Operation	Dairy	Every Tuesday
Fuel chip silo	Operation	Dairy	Every Tuesday
Saw dust storage house	Operation	Dairy	Every Tuesday
Saw dust silo	Operation	Dairy	Every Tuesday
Fuel oil storage tank	Operation	Dairy	Every Tuesday
Acid and caustics storage tank	Operation	Dairy	Every Tuesday
Sodium hydroxide storage tank	Operation	Dairy	Every Tuesday
High-pressure steam pipe lines	Operation	Dairy	Every Tuesday
ST and ST lube oil reservoirs	Operation	Dairy	Every Tuesday
Emergency shower & Eye washer	Operation	Weekly	Every Tuesday
SCBA, 30 minutes	EH&S	Monthly	15 days after checked
Fire Hydrants	Operation	Monthly	15 days after checked
Chemical absorbent	Operation	Monthly	15 days after checked
Dry chemical and CO_2 extinguishers	Operation	Monthly	15 days after checked
Foam	EH&S	Monthly	15 days after checked
Fire pump	Operation	Weekly	Every Tuesday

Area	Responsible person	Checking schedule	Reporting schedule
Fire alarm system	Operation	Every six months	15 days after checked
Water sprinkler and deluge system	Operation	Annually	15 days after checked
First aid set	Admin	Monthly	15 days after checked
Telephone number of relevant persons both internal and external including of government agencies	EH&S	Annually	15 days after checked

2) Training plan

Topic	Duration	Training style	Trainee	Responsible person
Fire prevention and suppression plan	1 day	Lecture and Q&A	All employees	EH&S
Fundamental of firefighting	1 day	Lecture and practice	All employees	EH&S
Firefighting technique	2 days	Lecture and practice	Fire and rescue teams	EH&S
Fire drill	1 day	Lecture and practice	All employees	EH&S
First aid and rescue	1 day	Lecture and practice	All employees	EH&S

3) Fire prevention campaign plan

Project	Method	Duration	Target	Responsible person
Safety week/fire prevention	Prepare posters and boards,	1 week	All employees	EH&S and Admin

	exhibition, and invite speakers			

4) Fire suppression plan

(a) Fire suppression

In office hours during the day, the power plant manager (fire director) is responsible for controlling emergencies and safety of the power plant's workers.

Out of the office hours after normal working hours, the shift leader is responsible for controlling emergencies until back to normal or until the power plant manager comes to the power plant and on duty of fire director.

(b) Fire plan

Fire is an emergency case that would cause much damage to properties and persons. Therefore, fire plan must be detailed and drilling should be done regularly to ensure that in the real situation, things could be controlled. Details are as follows:

a) Procedure during normal office hours (in daytime): The worker who faces the situation will make a decision whether it can be controlled by himself or not. If not, notify the control room to assist and inform the power plant management which on the fire director duty. The fire director is responsible for estimating the severity of the emergency into level 1, 2, or 3 and it can be control by the power plant or not. The fire director is also responsible for making commands to control the emergency and bring the situation back to normal and to ensure the safety of all workers as well as properties of the power plant.

b) Procedure during out of normal office hours (in night time): If the fire occurs in a night time, the worker who faces the situation will make a decision whether it can be controlled by himself or not. If not, notify the control room to assist and inform the fire director which is the shift leader. The fire director is responsible for estimating the severity of the emergency into level 2 or 3 and notify the local fire organization immediately. After that, call the emergency staffs to be on duty and command the fire team and security guard to be on duty. In the case of injuries, call an ambulance. The circuit must be cut in the area where water will be sprayed. The fire director then informs the power plant manager.

(c) Control center

In the case of fire and assistance from outside is needed, the fire director will set a control center in the control room. If the fire occurs in the control room, another area will be set to suit the situation. The center will be used as a command center and a coordination center as well as follows:

a) The command center, command the operators in fire suppression

b) The coordination center, coordinate between the fire director and the power plant operators and external agencies

Responsibilities of the relevant personals as specified in the fire plan are as flows:

Personal	Responsibility
Fire director	1. Direct and command the fire suppression operation plan 2. Has the authority to command and ask for cooperation from external agencies for assistance 3. Has the authority to command all the parties to stop or fight the fire 4. Has the authority to command to ask for assistance from external agencies 5. Report the situation to the power plant manager immediately
News center	1. When informed about the case of fire, internally notify the case through telephone 2. Investigate the fire area in detailed by the operation supervisor and inform other divisions 3. Keep tracking of the fired case from: - Operation supervisor - Reporter 4. Contact external agencies for assistance when received command from the fire director or safety officer 5. When the fired case is over, inform every division
Communication and coordination	1. Assist and coordinate with the fire director, external agencies, security guard, and relevant person 2. Receive-send commands from the fire director to contact news center 3. Make a command if assigned by the fire director

Personal	Responsibility
Nurse (normal office hours)	1. When received a command, go to the scene with first aid equipment 2. Reporting to the fire director and wait for a command to assist and coordinate
Security guard	1. Rush to the assembly point to check for number and name of the workers 2. Rush to the scene to receive a command from the fire director and coordinator chief 3. Prevent outsider to enter the area without permission 4. Guard and control the properties that the mover keep in the area
Internal-external transfer	1. Send vehicle to the scene and wait for a command from the fire director to move the fire equipment and provide drinking water 2. Responsible for finding a safe place to keep materials and equipment as well as to move the materials and equipment
Operation	1. Ask for assistance and split into two operation team: Team 1: Control the machine to run until there is a command to shut down. In case that the machine cannot be run or received a command to shut down the machine, the team will assist in firefighting Team 2: This is the fire team. If the case of fire occurs in their own area, this team will be separated immediately from the machine control team to fight the fire. The team will work under the command of operation chief. In case that assistance from outside is needed, the operation chief will make a command.
Electric operation support	1. Rush to the scene to receive a command from the fire director to cut the circuit 2. Operate in according to the fire director in relation to electricity that may cause danger
Emergency pump operation	1. Switch on the pump immediately after informed about the fire 2. Control the water pump during fire 3. In normal situation, monitor the tools and equipment in according to the checklist
Rescue team	1. When received a command, reporting to the head of operating support team

Personal	Responsibility
	2. Search for victims and rescue in according to the command of the head of operating support team
Additional operators	1. Operators that are informed about the fire and come to assist report to the fire director for teams setting 2. For case of fire in the area of machinery, the fire team must be from the area, the additional team will be assisted in haulage 3. Wait in the area for a command from the fire director

(d) Evacuation plan

In severe case that evacuation is needed, there will be a notification by an alarm. Everybody must be evacuated through the exit to the assembly point. There, a number of workers will be checked. The workers must wait for a command from the fire director

Responsibilities of the relevant personals to the evacuation plan are as follows:

Personal	Responsibility	Responsible person
Fire director	1. Making decision to evacuate and notify by alarm 2. Check with the responsible unit to ensure that all the workers are evacuated by counting the number of workers 3. Inform other organizations and ask for facilitating 4. Notify and give signal that suits the situation 5. Supervise in according to the plan 6. Supervise the move of documents from the building 7. Make a command to shut down the unnecessary facility system except for emergency system	Power plant manager

	8. In case taker is needed for the Company's properties, provide a staff that will work voluntarily 9. Make a command to close all the doors and windows to prevent outsiders from entering 10. Notify the situations to police station and fire station	
Fire escape leader	Lead the workers to evacuate in according to the plan	Human resource manager
Check the number of workers	Check the number of workers whether all the workers are in the safe place	Administrative officer
Rescue and vehicle team	Responsible for search and rescue lives	Rescue team
Assembly point 1	- It is a safe place after evacuated from the danger area - It is the place where the number of the works will be checked	-
Assembly point 2	- It is the assembly point in case that the assembly point 1 is not safe	-

(e) Recovery plan comprises of the following:

a) Coordination with government agencies
b) Survey for damages
c) Reporting of every team and set a meeting point for the teams to wait for commands
d) Rescue and search for death
e) Move of victims and property of the death
f) Estimate the loss, report the operating results, and report the fire situations
g) Provide help and relief to the victims
h) Resolve the problem to as quick as possible to continue running the business

Details of responsibilities in the general recovery plan are as follows:

Responsibility	Operation
1. Coordinate with the government agencies	Plant Manager Operation Manager EH&S Manager
2. Estimate the damages and operating results and reporting the case of fire	Operation Manager Maintenance Manager Shift Leader
3. Rescue and search for the victims	Rescue Team
4. Move of the victims and properties of the death	Admin Manager
5. Help and relief to the victims	Admin Department
6. Resolve the problem to as quick as possible to continue running the business	Plant Manager Operation Manager Maintenance Manager

(f) Environmental impacts relief plan

In order to mitigate environmental impacts from the fire, the following must be implemented:

a) Water used to suppress the fire, if contaminated with chemical, block the flow and pump to the recovery tank to collect to wastewater retention pond for treatment

b) Water used to suppress the fire, if contaminated with oil, send to oil separator pit to separate oil prior sending the water to wastewater retention pond for treatment

(g) Recovery plan

This plan will be implemented after the emergency occurred in the power plant. In the implementation, all reports will be considered. Based on the real situations, plans will be improved, especially the emergency prevention plan and the relief plan (immediately when the situations back to normal). The weakness of the plans will be improved.

a) The planned improvement will be done when:

- Rules are changed

- The existing plan is not effective by assessing from the drills
- Adding of equipment in the power plant that may cause an unusual event
- Change or move of preventive and suppressing equipment
- Change of responsible unit in the power plant and private or government agencies

b) After an unusual event, the observer will give comments in order to draw the following conclusions:

- The prepared plan achieved the objectives and procedures or not
- The procedures are sufficient or not
- Necessary to improve the plans or not
- The plan was successful or not
- What area that extra precautions should be taken
- The coordination with other agencies was effective or not

c) Project that integrated with the recovery plan

- The Project of communicating about the cause of fire and preventive approaches
- The project of helping the victims
- The Project of renovation and bring the loss back to normal

(3) Emergency case of chemical and flammable liquid leakage

Type of hazardous chemicals

- Explosive substances
- Gases
- Flammable liquid
- Flammable solid
- Oxidizer and organic peroxide
- Toxic substance and infectious substance
- Radioactive substances
- Corrosive substances
- Miscellaneous dangerous substances

1) Data that must be notified

(a) Location of the scene
(b) Cause and characteristic of the leakage
(c) Severity
(d) Existing operation
(e) Name of the informer, division, and contact number

2) Investigation and warning

Production zone

Workers who are responsible for the area investigate and estimate the situation. In case that it may cause a fire, stop all the hot work and inform the control room to stop the machinery and notify workers in adjacent areas.

Out of production zone

The division who responsible for the area and safety officer investigate the situation. In case that it may cause a fire, stop all the hot work in the area and not allow those who are not related to entering the area.

3) Control of the area

The area with chemical leakage must be controlled not to allow those who are not related to entering the area by putting a red flag or other symbols to notify that there is a leakage of the chemical. In case that it is a flammable gas or flammable liquid, the source of sparks such as hot work and vehicle must be prevented. Those who are not related must be informed to leave the area to the assembly point.

4) Control of situation

(a) Gas

In the case of leakage of flammable gas, the source of sparks must be controlled and reduce the concentration of the leaked gas to prevent fire. It can be done by spraying of water to reduce the concentration and temperature in the area and split the system. This is to reduce the risk of fire.

(b) Flammable liquid

For the flammable liquid leakage, the source of sparks must be controlled and limit the spread. In case that it can be scooped or pumped, the equipment used must be explosion proof. If not, use absorbent to absorb and prevent the liquid from spreading into rainwater drainage gutter.

(c) Substances liable to spontaneous combustion

In the case of leakage of substance liable to spontaneous combustion when contacts with water or air, do not use water but chemical fire extinguisher or sand to prevent fire.

(d) Substances which emit gasses

For that case of a leak of substances that emit gasses, workers in adjacent areas must be informed to evacuate to a safe place (observe from the wind sock). Later, control the fume of vapor or chemical in the air by spraying water to dilute the gas to reduce dispersion of the vapor.

(e) Other chemicals

The leak of some solid or liquid substances does not require immediate actions. However, environmental impacts from the contamination in the air, soil, and water must be prevented by following the procedure on chemical management.

(f) Cleaning of the area and waste management

For the leak of solid or liquid chemicals, floor cleaning is required and the residues from cleaning materials and contaminations must be kept in a closed container. The waste will be sent to dispose of in according to the procedure on waste management.

(g) Water quality monitoring

In the case of liquid chemical leakage to rainwater drainage gutter, water sample must be taken to check whether it's contaminated or not. If the quality isn't met with the standard, block the gutter, collect the water, and send to dispose of by a waste disposer with an approval from the Department of Industrial Works.

(4) Procedure for the case of bomb threat

The procedure for the case of bomb threat and procedure for the case of a suspicious object is found (**Figure 3.10.9-7**), usually, the bomb threat is done by using the telephone to create the shock of excitement. Thus, when the news is received, analyzing of relevant data must be done and it's useful for the officers. In such case, the following must be done.

1) Things to do when received a bomb threat news

- Suppress the excitement or panic
- Listen attentively and do not interrupt the talk
- Remember all the words
- Talk politely at the time receiving the bomb threat news
- Try to delay the talk and tape the talk
- Observe interruptions while speaking whether there is machine noise, music, or others
- Ask for more details and sympathy and convince to repentance
- Immediately call the police through the worker of the power plant (control room)

2) **Questions to be used**

- Is there anything I can help?
- When the bomb will explode?
- Where is the bomb?
- How is the bomb look like?
- What kind of the bomb?
- How it will explode?
- Are you the one who drops the bomb?
- Why drop the bomb?
- Where are you?
- What's your name?

Conclusion Try to ask for details as much as possible especially about the bomb and place and focus that not wanting any injury.

(5) Emergency plan for the case of boiler explosion

1) Preventive plan (before the event)

(a) Workers whose control the boiler must pass a boiler control course
(b) Prepare the plan and regularly check the parts and equipment
(c) Maintain the parts and equipment as scheduled

2) Communication and emergency response (during the event)

(a) In case that the boiler cannot supply steam

- Fix immediately
- Inform relevant united to be prepared

(b) In case of boiler explosion

- If flood is found, close the big water valve in the area immediately
- If flame is observed, stop the fire immediately
- If injury is found, move the injury to a safe place and follows by first aid

(c) Report the shift leader and head of the division and record the time when the boiler could not supply steam. In the case of explosion, record the time when it begins and the time when situation back to normal for tracking.

3) Recovery plan (after the event)

Check for damages on properties and fix after situation is back to normal

(6) Emergency plan for the case of flood

1) Preventive plan (before the event)

(a) Keep following news and estimate the flood situation closely

(b) Prepare the plant layout

(c) The workers must be trained on emergency suppression and must be able to practice correctly

(d) Communicate to the workers to know about the warning system of the relevant government agencies

(e) Prepare equipment for flood prevention such as sandbags and water pumps

(f) Periodically check the plant area and the area with flood risk

2) Communication and emergency response (during the event)

(a) Inform the workers about the flood situation for the responsible persons to be prepared

(b) Prevent initial damages by constructing a sand bags dyke around the plant in addition to the existing dyke

(c) Report the shift leader and division heads to record the time when flood occur and when the situation backs to normal for tracking

3) Recovery plan (after the event)

Check for damages on properties and fix after situation is back to normal

3.11 Complaint management

Initially, the Project set a procedure and duration for complaint solving as shown in the complaint diagram, responsible persons, and duration for each step are shown in **Figure 3.11-1**.

3.12 Environmental impacts investigation committee

(1) Composition of the environmental impacts investigation committee

The environmental impacts investigation committee of the Project (draft) comprises of representatives of four parties which are the public, government, expert, and the Project.

(2) Recruitment method

1) A representative of the public will come from recruitment or nominate by the community, village committee, or group of representatives of each village.

2) Representative of the government will come from relevant government agencies such as Provincial Office of Industry, Provincial Environment and Natural Resources Office, Provincial Energy Office, Chana Office of Public Health, Chana Agricultural Office, Chief Executive of Sub-district Administrative Organization or representative, Director of Chana Hospital or representative, Director of Sub-district Health Promoting Hospital or representative, and Director of Chana Chanupathum School or representative.

3) Experts will come from nominate of the public and the government representatives.

4) The Project representative is the plant manager and other related divisions that are appointed by the Executive Director of Chana Green Company Limited.

(3) Structure of the committee

1)	Representatives of the public	19	persons
2)	Representatives of the government	6	persons

3)	Experts	2	persons
4)	Representatives of the Project	4	persons

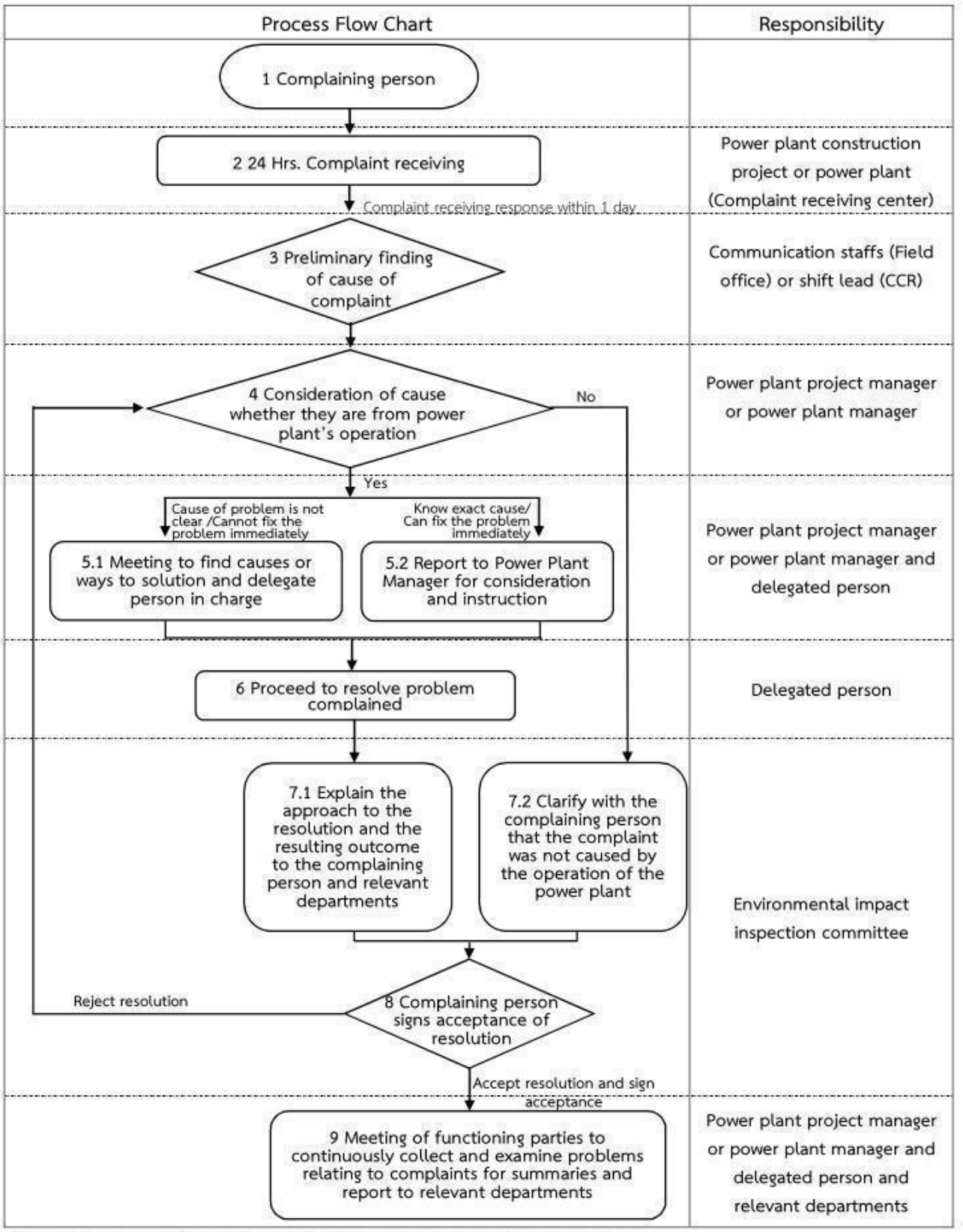


Figure 3.11-1 Scheme of operation on Chana Green Power Plant Project's complaint receiving

The committee will select a president and a vice president as well as a secretary. Later, the environmental impacts investigation committee will be appointed by the meeting agreement.

(4) Responsibilities of the committee

1) Consider the needs of the public, promote the understanding of the communities and the Project as well as coordinate with other relevant organization

2) Visit the Project, participate in an environmental quality monitoring activity and environmental impacts monitoring measures implementation for transparency in the Project environmental management

3) Discuss and set a guideline for problems solving together

4) Receive complaints and coordinate the complaint management

5) Participate in negotiation and settlement of environmental disputes between the Project and communities

6) Investigate the loss and consider compensate for the loss caused by the Project activity, the losses include community natural resources and environment, agricultural products, animals, and human health

(5) Tenure

The tenure is four years since the announcement date. The committee members can be reappointed but not more than two consecutive terms.

When the first term is completed and a new committee has not been appointed yet, the previous committee is still in function until the new committee is on duty. However, this should not be longer than 90 days.

In case that a committee member is terminated, the recruiting should be completed within 45 days. The new committee member, tenure will be on duty as long as the remaining period of the previous member.

In case that the remaining tenure of the committee member that is terminated is less than 90 days, the option of no appoint for a new member can be applied.

Out of the termination, a committee member is out of the position when:

1) Death
2) Resign
3) The committee members of two out of three agree to remove a member due to misconduct, corruption, or inability
4) Bankrupt
5) Mental disorder
6) Being incompetent
7) Has been sentenced by final judgment except for the penalty for offenses committed by negligence, the offense of defamation, or misdemeanors

(6) Meeting frequency

A meeting can be done with the presence of more than half of the committee members. The frequency is at least twice a year. In case that it is necessary, the meeting can take place before schedule. This is under the consideration of the half of the committee members.

(7) Operation

1) After the Project construction is approved, the meeting must take place within the period of six months. This is to inform about the progress and acknowledge about the measures that the Project must implement. Responsibilities of the committee will be informed. The committee will visit other places that can use as a case study to apply to the Project, the frequency is once in two years.

2) Source of funding for the operation of the environmental impacts investigation committee during initial state is the Company. About 100,000 Baht/year will be allocated. After that, the fixed budget of 100,000 Baht/year will be allocated. The money left from the previous year will accumulate to the next year for the operation of the environmental impacts investigation committee.

3.13 Green area

The Project will provide a green area of 18,000 square meters or 11.25 rai (counted for 6.21 percent of the whole Project area). The plants that will be cultivated are local plants such as neem trees (Songkhla provincial tree) and other trees such as ironwood and benth. They will be planted in punctuate with three rows of shrubs. The distance between trees is 2x2 meters and the distance between rows is 2x2 meters as shown in **Figure 3.2.1-1**. This aims to reduce the wind speed and the dispersion of dust. Moreover, it would also create a diversity of plants as well as beautiful scenery. Furthermore, it can be used as the Project buffer zone.

Characteristics of plants to cultivate in the Project area in accordance with the landscape Architecture are as follows:

(1) Leaves are taper, rough, wool, and sticky to trap dust

(2) High, thick canopy, much leaves, quickly grow, strong root system to be used as a buffer zone

(3) Has vertical shape and start to branch at the height of two meters or higher

The project will water the green area every day except during rainy season. Soil conditioning in the area will be responsible for the Project staff which will take care of it every day. The Project will use organic fertilizer and avoid using chemical fertilizer.

In case that plant dies, the Project will replant within 30 days and will maintain the rapid growth to benefit for reducing wind speed and dust dispersion.

3.14 Power development fund

According to the Energy Business Act B.E.2550 article 93 requiring an establishment of a fund called "power development fund" with an objective to support the power service expansion. This is to spread prosperity to the local communities that affected from the operation of power plants. It also aims to promote renewable energy and technology that causes less environmental impacts. Besides, considering the balance between the natural resources and fairness to the power users.

Sources of the fund are as follow:

(1) Money received in accordance with the article 96

(2) Fine from the electricity licensees in accordance with the article 128 and article 140

(3) Donated money or properties

(4) Interest or benefit from the fund

The fund can be used for the following:

(1) To compensate and support the electricity licensees that serves the disadvantaged users or to promote the policy to spread prosperity to the regions

(2) To compensate the users that pay higher rate of electricity from the electricity licensees that has electricity control system in contravene with the article 87, paragraph 2

(3) To develop to restore the region that was affected by the operation of power plant

(4) To promote renewable energy and technology that causes less environmental impacts

(5) To support the public to be aware and participate in the power system

(6) To use for the fund management

Therefore, in the future, the communities surrounding of the Project can use the fund to benefit their communities.

3.15 Activities during construction period

3.15.1 Construction workers

Activities during construction period can be classified into two type; (1) construct by the Company itself and (2) construct by sub-contractors. For the part that the company will construct itself is residents in the project area. The sub-contractors will provide accommodation themselves outside the Project area. The number of workers is 300 maximum.

3.14.2 Infrastructures and utilities

(1) Water

Water usage during construction can be categorized into two types, consumption of the workers and construction activities.

1) Water usage for the worker's consumptions is forecasted of approximately 21 cubic meters/day (calculated from consumption rate of 70 liters/capita/day x 300 workers, workers that stay in the Project). The Project will assign the contractor company to provide a water container that can store water to be used for three days. For drinking water, the Project will buy from the general market.

2) Water usage for construction activities will be used for cleaning of tools and equipment and concrete mixing with a ratio of one cubic meter concrete with 185 liters of water (Source: Council of Engineers, 2016). The quantity is small due to the use of ready mixed concrete. The water usage in construction activities is approximately two cubic meter/day. Source of water is same as the source of

water for worker consumption. However, the Project planned to excavate a reservoir to keep rainwater and runoff in the Project area.

(2) Electricity

The Project will use electricity that supply by Provincial Electricity Generating Authority of approximately 2 MW together with electricity generated from the diesel power generator provided by the contractors.

(3) Water drainage and flood prevention

For rainwater drainage in the construction area, the Project will construct a temporary gutter to drain rainwater in the construction area. It will be connected with the Project reservoir. For flood prevention, the Project will not allow the contractors to throw food residue or materials into drainage gutter. The gutter will be dredged every six months. The gutter conditions will be checked monthly. The Project will also check for materials not to place on an area that blocks the water flow or the gutter.

(4) Transport

Transports during construction are the main transport of construction materials and machine by trucks. The number of travel is forecasted of less than 10 times/day. The route is Highway No. 43 and Highway No. 408 which are the main routes to the Project area. In order to avoid impacts on the communities, the Project will provide temporary residents for the construction workers in the Project area. The 300 workers will stay in the Project area and use the Highway No.408 for the Project entrance-exit.

3.14.3 Pollution and control

(1) Air pollution

During construction, the air pollutions are dust and smoke. Dust will spread from the surface of the ground during piling, land leveling, and construction materials transport. Smoke will be generated from combustion of machinery, truck, and tractor. For dust that generated from the transport of construction materials, the Project has a measure to reduce the dispersion by spraying water on the construction area limit the vehicle speed in the Project area. This is to reduce the quantity of dust from transportation activities in the Project area.

(2) Water pollution and control

Wastewater that will be generated during construction period can be categorized into two sources, wastewater from consumption of the workers and wastewater from the construction activities.

1) Wastewater from the consumption of the 300 workers of 17 cubic meters/day (calculated from 80 percent of the water consumption) will be treated by a septic tanks-anaerobic filter before recirculate to reuse. Nevertheless, the Project will follow Ministerial Regulation (Ministry of Labor) on Welfare management B.E.2548 and Ministerial Regulation (Ministry of Interior) No.63 (B.E.2551) issued under the Building Act B.E.2522.

2) Wastewater from construction activities generated from cleaning of tools and equipment with low quantity (approximately two cubic meters/day) will be treated by a settling pond with a capacity of ten cubic meters. The treated wastewater will be sent to a water retention pond with a capacity of ten cubic meters to check the quality before reuse. It will be used for spraying on the road and construction area to reduce dispersion of dust. Water quantity will be checked once a month.

(3) Waste and control

Waste that will be generated during construction period can be categorized into two types as follows:

1) Waste from the worker's consumptions such as food residue and plastic bags is forecasted of approximately 300 kilograms/day (calculated from waste generation rate of one kilogram/capita/day x 300 workers). The Project will provide close waste containers with a capacity of 200 liters each. The waste will be disposed of by Baan Na Municipality.

2) Waste from construction activities such as steel, wood, and brick will be recycled or sold. For the part that cannot be recycled, the Project will use for land filling.

(4) Noise pollution and control

During construction, each activity creates noise at different levels depending on machinery and characteristic of the construction work. According to the data from U.S.EPA, 1972, noise levels during construction can be summarized as follows:

Activity	Noise level dB(A)	Distance (meter)
Land preparation	84	15
Drilling and foundation work	88	15
Structural work	79	15
Finalized work and decoration	84	15

Source: US. EPA, 1972

However, these noise levels can be controlled by specifying construction period during 8.00-17.00 o'clock to reduce impacts on the communities. This will be set as a measure as well as specified in the contracts with construction contractors to strictly follow.

3.14.4 Occupational health and safety

In selecting subcontractors, the Project will choose subcontractors with an agreement on occupational health and safety. In the agreement, safety practices in accordance with the laws and regulations that related to the Project activities will be followed.

(1) Safety supervisor

The Project will provide a safety supervisor to check in all steps of work (before work, during work, and after work). This is to comply with Ministerial Regulation (Ministry of Labor) on the standard of occupational health and safety and working environmental management related to construction work B.E.2551.

(2) Safety plan during construction work

The Project will provide a safety plan for construction work in comply with the Ministerial Regulation (Ministry of Labor) on standard of occupational health and safety and working environmental management related to construction work B.E.2551 and Notification of Department of Labor Protection and Welfare on criteria of safety plan preparation for construction work B.E.2552 since the acquisition in accordance with article 3 (1) "work with total area in the same building of larger than 2,000 square meters or building with a height of 15 meters or higher and total area of 1,000 square meter". The safety plan consists of the following:

1) A safety inspection plan that complies with safety laws
2) A safety training plan to acknowledge the workers about the safety work
3) A safety promoting plan
4) An emergency plan
5) An investigation and reporting plan

(3) Work permit system

The work permit system is the system that can ensure the safety of the work in factory area during maintenance work. It is also to prevent loss of machinery and equipment in the production process.

1) Work permit

It is a document with signed affidavits from the company that permits the work in a hazardous area that is not the routine work.

2) Type of the permit

Work permit is necessary for the following work:

(a) Hot work (welding, cutting, grinding, drilling, and radioactive)
(b) Confined space work
(c) Work at high

3) Personal protective equipment (PPE)

Personal protective equipment is the equipment that the workers wear during operation in the Project area to prevent general harmful in accordance with the Ministerial regulation (Ministry of Labor) on the standard of occupational health and safety and working environmental management related to construction work B.E.2551 as summarized in **Table 3.14.4-1**.

4) Safety inspection

The safety officer will responsible for inspecting safety in both building and surrounding environment which must be in the conditions that will not cause danger to the workers and others surrounding the area. Moreover, the safety officer will also responsible for appropriate use of personal protective equipment. This is necessary to reduce accidents. In case that anomaly is found, the safety officer will report and suggest the construction supervisor fix immediately.

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Table 3.14.4-1

Personal Protective Equipment

No.	Work	Helmet	Dust Mask	Gas mask	Face Sheild or Polarized glasses	Safety Glasses	Earplugs or Ear muff	Welding Apron	Safety Belt or Safty Harness	Gloves; Cotton or Lether	Gloves; rubber latex	Chemical gloves	Safety Boots	High-ankle Safety	Safety shoes
1	Wood or Painting work	√	-	-	-	-	-	-	-	-	-	-	-	-	√
2	Steel works, tunnels, assembly, installation, maintenance handling	√	-	-	-	-	-	-	-	√	-	-	√	-	-
	or carrying heavy bearers of the potential hazards														
3	Water supply work or Glaziery	√	-	-	-	-	-	-	-	√	-	-	-	-	√
4	Construction work	√	-	-	-	-	-	-	-	√	-	-	-	-	√
5	Concreete construction such as cement mixer	√	-	-	-	-	-	-	-	-	√	-	-	√	-
6	Welding work	-	-	-	√	-	-	√	-	√	-	-	√	-	-
7	Cutting, Demolition,Hammering or Drilling materials	√	√	-	-	√	-	-	-	√	-	-	√	-	-
8	Noise level over the regulation of safety	-	-	-	-	-	√	-	-	-	-	-	-	-	-
9	Chemical work	√	-	√	-	-	-	-	-	-	-	√	-	-	√
10	Weight Limitation of Lifting for worker	√	-	-	-	-	-	-	√	-	-	-	-	-	√

Source : Ministerial Regulation (Ministry of Labor) on thestandard of occupational health and safety and working environmental management related to construction work B.E.2551